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Article

A biomechanical perspective on the relationship between basketball performance and college students' physical and mental health: An integrated analysis of athletic performance and psychological regulation

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Abstract: This study delves into the integration of biomechanics in analyzing basketball performance and its profound impact on the physical and mental health of college students. By focusing on biomechanical factors influencing athletic performance, the research investigates how basketball, as a dynamic physical activity, contributes to improving physical fitness and mental well-being. Through advanced biomechanical analysis, the study examines key aspects such as joint kinematics, muscle activation patterns, and force distribution during basketball movements like jumping, running, and shooting. These insights provide a deeper understanding of how proper body mechanics—such as optimized alignment, enhanced movement efficiency, and effective load management—can elevate athletic performance and reduce the risk of injuries. The research further explores the relationship between students' physical fitness and mental health, identifying prevalent psychological challenges among college students, including anxiety, depression, and interpersonal sensitivity. By integrating biomechanical evaluations with psychological assessments, the study highlights how the optimization of movement mechanics in basketball can promote physical endurance and agility while fostering psychological resilience and reducing stress. For example, improvements in core stability and proprioception not only enhance sports performance but also support mental clarity and emotional regulation. The findings advocate for incorporating biomechanics-informed physical education programs, particularly those centered on basketball, into university curricula. Such programs could utilize technologies like motion capture systems and wearable sensors to monitor and improve students' biomechanical efficiency while simultaneously addressing their psychological needs through structured physical activities. This integrated approach underscores the dual benefits of sports for physical and mental health, providing actionable insights into how biomechanics can be leveraged to optimize athletic performance and promote holistic well-being among college students.

Keywords: biomechanics; basketball; physical health; mental health; athletic performance; psychological well-being; physical education

1. Introduction

In recent years, the integration of physical education and mental health education has gained increasing recognition, especially for college students who face mounting academic pressures, career uncertainties, and social challenges. Psychological issues such as anxiety, depression, and interpersonal difficulties are prevalent among this population, often impairing overall well-being and academic performance [1]. While traditional interventions emphasize psychological counseling, emerging evidence highlights the significant role of physical activity—particularly sports—in promoting mental health. Among these, basketball stands out for its dual benefits of improving physical fitness and fostering psychological resilience. This study focuses on

integrating biomechanics into basketball training to enhance both physical performance and mental health among college students [2,3].

Biomechanics, the study of the mechanical principles of living organisms, provides valuable insights for optimizing movement and physical performance. In basketball, biomechanical analysis can improve the efficiency of actions like jumping, running, and shooting, reducing injury risks while enhancing performance and overall physical health. By fostering a sense of control and efficiency, biomechanically optimized movements can positively impact mental well-being, helping students manage stress and build resilience [4,5].

Physical activity promotes mental health by triggering the release of mood-enhancing neurochemicals and encouraging social interaction, self-confidence, and focus. Basketball, with its team dynamics and skill demands, reduces rumination and alleviates symptoms of anxiety and depression [6]. Biomechanics enhances these benefits by improving posture, movement efficiency, and muscle activation patterns, minimizing physical discomfort and supporting consistent participation [7].

By integrating biomechanics into basketball training, this study underscores the dual benefits of optimized physical performance and improved mental health. The findings advocate for collegiate athletic programs that combine physical and mental health education, offering a comprehensive and scientifically informed approach to student well-being [8,9].

2. Analysis of the relationship between college students' physical and emotional health

2.1. Examining and analyzing the mental health of college students

2.1.1. The overall state of the research on college students' mental health status

The Symptom Checklist-90 (SCL-90) is widely used to assess an individual's mental health status. It consists of 90 items, with higher scores reflecting poorer physical and mental health. Conversely, lower scores are indicative of better overall health [10]. According to established criteria, an SCL-90 score of ≥ 180 is considered indicative of a psychological problem. Specifically, scores between 180 and 224 indicate a mild psychological problem**,** scores between 225 and 269 suggest a moderate psychological problem**,** and scores ≥ 270 reflect a severe psychological problem. Additionally, a score of ≥ 3 on any of the nine dimensions of the SCL-90 is also regarded as a positive indicator of a mental health issue [11,12].

Preliminary statistical analysis revealed that out of the surveyed students, 226 students (13.2%) exhibited mild psychological problems, 157 students (9.7%) had moderate psychological problems, and 32 students (1.3%) suffered from severe psychological problems. Furthermore, 173 students (10.1%) scored ≥ 3 on at least one dimension, representing the overall positive detection rate for mental health problems.

When examining the types of psychological problems most commonly reported by university students, symptoms related to obsessive-compulsive disorder**,** interpersonal sensitivity, and paranoia were found to be the most prevalent. These were followed by issues such as depression, anxiety, and hostility. Such mental health challenges often result in a range of negative consequences for affected students.

These include: Emotional difficulties, such as persistent uneasiness, low self-esteem, and a tendency toward self-doubt. Social challenges, characterized by barriers to effective communication, difficulties in forming and maintaining relationships, and an increased sense of isolation. Behavioral symptoms, including avoidance of group activities, decreased interest in competitive or collaborative endeavors, and sluggishness in responding to academic and social demands.

These challenges have significant implications for students' academic performance, social integration, and overall quality of life. Students facing these mental health issues often experience diminished motivation and engagement in academic and extracurricular activities. For instance, they may avoid participating in group discussions, collaborative projects, or sports activities due to feelings of inadequacy or fear of judgment. Over time, this can exacerbate their sense of alienation and lead to a vicious cycle of negative emotions and reduced social interaction.

Further compounding these issues is the observation that many students with psychological problems hesitate to seek help due to stigma, lack of awareness about mental health resources, or fear of being perceived as weak. This underscores the importance of early detection and intervention, as well as the need for universities to create a supportive environment that fosters open discussions about mental health.

In conclusion, the mental health status of college students is a critical area of concern, with a significant percentage of students showing signs of psychological distress. By addressing common issues such as obsessive-compulsive behavior, interpersonal sensitivity, and paranoia, alongside underlying emotional and social challenges, universities can develop targeted interventions to improve the overall mental well-being of their students. These efforts could include counseling services, peer support programs, and awareness campaigns aimed at reducing stigma and promoting mental health literacy.

2.1.2. An examination of the mental health traits of college students

This study analyzed mental health traits among 1715 university students, including 792 males and 923 females, with a male-to-female sex ratio of 1:1.17. The participants ranged in age from 17 to 25 years, with an average age of 20.41 ± 3.65 years. Among these students, 1614 were Han Chinese, while 101 belonged to ethnic minority groups, yielding a ratio of 15.98:1. The study also categorized students by household registration type, with 1183 students registered in urban areas and 532 in non-urban areas, resulting in a ratio of 2.22:1. Additionally, 1263 students were identified as only children, while 452 were not, giving a ratio of 2.79:1.

The investigation aimed to explore the relationship between demographic factors and mental health issues in college students. It utilized the Chi-square (X^2) test to examine potential links between mental health problems and variables such as gender, ethnicity, household registration type, and only-child status. The results, summarized in **Table 1**, highlight the occurrence rates of psychological disorders under different demographic categories [13].

Table 1. Examination of the impact of demographic traits on college students' mental health.

Demographic traits		Number of persons	Number of psychological disorders	Occurrence rate (%)	X^2	*P*
Gender	male	792	197	24.87	1.455	0.217
	female	923	218	23.62		
nation	Han nationality	1614	390	24.16	0.438	0.792
	minority	101	25	24.75		
Registered permanent residence category	urban residence registration	1183	312	26.37	5.412	0.018
	Non urban household registration	532	103	19.36		
children status	Only child	1263	317	25.10	6.374	0.025
	Non only child	452	98	21.68		

The analysis revealed that household registration type and only-child status significantly affected the prevalence of psychological disorders ($p < 0.05$). Specifically, students with urban household registration and those who were only children exhibited higher rates of mental health problems. However, no significant associations were found between mental health outcomes and either gender or ethnicity ($p > 0.05$).

Further analysis focused on comparing scores across nine psychological factors between urban and non-urban students, as well as between only-child and non-only-child students. The results demonstrated that non-urban students scored higher on five factors: depression, somatization, interpersonal sensitivity, tension, and obsessive-compulsive disorder (OCD) ($p < 0.05$). Similarly, only children scored higher on five factors: paranoia, depression, interpersonal sensitivity, tension, and OCD ($p < 0.05$). These findings are summarized in **Table 2**.

Table 2. Comparison of nine psychological factor scores between college students who are only children and those who are not.

Aspects of psychology	The only child	Not only one child	*U*	*P*
Somatization	1.54 ± 0.45	1.26 ± 0.38	1.845	0.2367
forced	1.68 ± 0.68	1.74 ± 0.55	2.8954	0.0342
interpersonal relationship	1.87 ± 0.68	1.78 ± 0.86	3.7265	0.0184
depressed	1.84 ± 0.58	1.85 ± 0.58	4.0148	0.0001
anxious	1.78 ± 0.46	1.47 ± 0.53	3.5172	0.0024
hostile	1.75 ± 0.56	1.76 ± 0.65	0.0951	0.8325
terror	1.78 ± 0.52	1.26 ± 0.32	1.0226	0.2434
Bigotry	1.78 ± 0.56	1.58 ± 0.25	2.1872	0.0285
Psychovenereal illness	1.68 ± 0.46	1.46 ± 0.65	1.1455	0.6018

This comprehensive examination of mental health traits highlights the importance of considering demographic variables, particularly household registration type and only-child status, in understanding and addressing mental health challenges among college students. The observed differences in psychological factor scores

underline the need for tailored mental health interventions to address the unique challenges faced by these demographic groups.

2.1.3. Comparative evaluation of pupils' mental health across grades

The study included students across four academic years: 521 freshmen, 507 sophomores, 435 juniors, and 252 seniors, with a ratio of 2.07:2.01:1.73:1. The analysis revealed that the prevalence of positive psychological disorder screenings in these groups was 10.6%, 9.7%, 9.4%, and 10.3%, respectively. Regarding psychological questionnaire scores, the percentages of students scoring less than or more than 180 points were 25.1%, 23.7%, 21.4%, and 19.5%, respectively, suggesting a gradual improvement in overall mental health as students advanced through their academic years. However, the accuracy of positive mental health assessments did not significantly differ across grade levels ($p > 0.05$).

Further analysis examined scores across nine mental health dimensions, revealing nuanced trends in the challenges faced by students at different academic stages. Juniors exhibited elevated scores in depression, anxiety, paranoia, and psychosis, while seniors demonstrated higher levels of somatization and anxiety compared to sophomores and juniors. Freshmen reported the highest scores in interpersonal sensitivity, tension, hostility, and fear. Despite these trends, the differences across academic years were not statistically significant ($p > 0.05$), as detailed in **Table 3**. These findings highlight the diverse mental health challenges students face throughout their college journey, emphasizing the need for targeted interventions tailored to their evolving needs.

Table 3. List of college students' ratings on nine psychological characteristics across various grade levels.

Aspects of psychology	first year in college	Sophomore year	junior at the University	University fourth year
Somatization	1.35 ± 0.42	1.48 ± 0.65	1.68 ± 0.26	1.26 ± 0.24
force	1.88 ± 0.52	1.82 ± 0.58	1.87 ± 0.58	1.74 ± 0.59
interpersonal relationship	2.06 ± 0.68	1.92 ± 0.58	1.65 ± 0.58	1.87 ± 0.68
depressed	1.87 ± 0.65	1.74 ± 0.68	1.78 ± 0.68	1.67 ± 0.56
anxious	1.85 ± 0.68	1.85 ± 0.26	1.74 ± 0.68	1.87 ± 0.48
hostile	1.88 ± 0.64	1.85 ± 0.52	1.87 ± 0.62	1.74 ± 0.68
terror	1.68 ± 0.68	1.54 ± 0.48	1.86 ± 0.68	1.41 ± 0.68
Bigotry	1.76 ± 0.62	1.62 ± 0.55	1.62 ± 0.62	1.65 ± 0.55
Psychovenereal	1.58 ± 0.62	1.26 ± 0.32	1.65 ± 0.48	1.58 ± 0.65

The data demonstrate nuanced differences in mental health traits across academic years. Freshmen appeared more vulnerable to issues such as interpersonal sensitivity and tension, possibly reflecting the challenges of adjusting to college life. Juniors, who scored higher in depression and paranoia, might be facing academic and career-related pressures. Seniors, despite their proximity to graduation, exhibited higher scores in somatization and anxiety, suggesting potential stressors related to the transition to post-college life.

Although the differences in scores were not statistically significant, the trends highlight the importance of providing grade-specific mental health support.

Universities should consider implementing tailored intervention programs addressing the unique needs of students at different stages of their academic journey to enhance their overall well-being and academic success.

2.2. Comparative analysis of college students' physical and mental health

The six physical fitness indicators were ranked based on evaluations conducted through an online platform. As shown in **Table 4**, the data revealed that 96.97% of university graduates achieved a passing grade or higher in overall physical fitness, indicating a generally good level of fitness among the students [14]. However, significant disparities were noted in specific indicators. Notably, failure rates for the standing long jump and lung capacity-to-weight ratio were alarmingly high, exceeding 44.02% and 24.90%, respectively. This imbalance underscores critical gaps in the holistic development of students' physical fitness.

The analysis highlights the uneven emphasis on different aspects of physical education, with certain indicators receiving insufficient focus during training. For instance, the high failure rate in the standing long jump may point to inadequate attention to lower-body strength and explosive power in physical education programs. Similarly, suboptimal performance in the lung capacity-to-weight ratio suggests the need for improved aerobic conditioning and respiratory health initiatives.

These findings emphasize the urgent need to reform physical education curricula in universities. A more balanced approach, incorporating targeted interventions for weaker fitness indicators, could promote comprehensive physical development among students. Programs should integrate diverse training modalities, such as strength training, endurance exercises, and flexibility drills, to address specific deficiencies. Additionally, incorporating regular assessments and personalized fitness plans could help track progress and motivate students to achieve better outcomes.

By addressing these imbalances, universities can enhance the physical readiness of graduates, equipping them with the fitness levels required for both academic and professional challenges. This reform would not only foster physical well-being but also contribute to broader educational goals, supporting the development of resilient, health-conscious individuals.

Table 4. List of college students' physical conditions.

	Height standard Weight grade		**Vital capacity weight Index grade**		**Grip strength and weight Index grade**		**Standing long jump grade**		**Bench test Score grade**		**Overall physique Evaluation grade**	
	Number of persons	**percentage**	**Number of persons**	**percentage**	**Number of persons**	**percentage**	**Number of persons**	**percentage**	**Number of persons**	**percentage**	**Number of persons**	**percentage**
Excellent (Normal)	515	30.03%	191	11.14%	875	51.02%	35	2.04%	221	12.89%	154	8.98%
Good (low)	1028	59.94%	411	23.97%	549	32.01%	231	13.47%	726	42.33%	738	43.03&
Pass			686	40%	206	12.01%	694	40.47%	664	38.72%	771	44.96%
Pass	172	10.03%	427	24.09%	85	4.96%	755	44.02%	104	6.06%	52	3.03&

2.2.1. Correlation analysis between the physical and mental health indices of college students

The weights of the height-standard body weight, step test, lung capacity body mass index, standing long jump, and grip strength body mass index are 0.15, 0.20, 0.15, 0.30, and 0.20, respectively. The percentage method is typically used to assess the overall level of physical fitness among college students. Descriptive statistics and a one-way ANOVA (Analysis of Variance) were employed to determine whether the six physical indices of college students with varying mental health levels differed significantly. The findings are displayed in **Table 5** along with statistics. The research reveals that college students with varying degrees of mental health in different locations had varied scores of the other five indicators (Sig < 0.05), with the exception of the height-standard body mass index, which does not significantly differ (Sig > 0.05). Six markers showed significant differences between the severe group and the healthy group; in the moderate group, there were significant differences in the other four indicators except for height-standardized body weight and step test; and only the standing long jump, height-standardized body weight, and lung capacity body mass index differed in the mild group. This suggests that college students' physical health deteriorates with the degree of their mental illness.

Table 5. Comparing six measures of physical fitness among college students with varying degrees of mental health.

Score on the physical index	Typical group	Gentle group	Group that is moderate	Extreme group	*F*	Sig
Total score for physical fitness	75.6 ± 4.26	78.6 ± 6.85	76.3 ± 6.23	71.3 ± 8.25	3.24	0.014
Standard weight score for height	9.87 ± 2.65	10.65 ±2.25	11.23 ± 3.56	9.54 ± 2.54	1.57	0.254
score on a bench test	15.87 ± 1.88	18.57 ± 2.65	15.87 ± 1.87	14.86 ± 2.68	4.87	0.025
Vital capacity index of body mass	13.54 ± 2.54	12.67 ± 1.85	10.87 ± 1.86	9.98 ± 2.47	3.58	0.026
Score for standing long jump	20.78 ± 2.87	20.03 ± 3.47	18.57 ± 1.56	18.57 ± 3.26	16.25	0.000
Body mass score for grip strength	18.69 ± 2.54	17.68 ± 1.58	18.65 ± 2.06	16.88 ± 2.68	2.68	0.065

2.2.2. Multiple comparative investigation of the physical and psychological circumstances of students

To gain deeper insights into the interplay between physical fitness and mental health factors among college students, this study categorized physical fitness into four levels (Factor A) and assessed psychological conditions across nine dimensions (Factor B). The nine psychological dimensions included somatization, obsessive-compulsive tendencies, interpersonal sensitivity, depression, anxiety, hostility, phobia, paranoia, and psychosis.

Table 6 presents a detailed comparison of the psychological characteristics of students across different physical fitness levels. Statistical analysis revealed that there were significant differences ($p < 0.0001$) in all nine psychological dimensions among students with varying physical fitness grades.

Students in the physically unqualified group scored significantly higher on paranoia, somatization, hostility, and psychosis compared to their peers in the excellent and good physical fitness groups. This indicates a clear association between poor physical fitness and increased psychological distress in these areas. The physically qualified group outperformed the good physical fitness group on four

psychological factors: interpersonal sensitivity, obsessive-compulsive disorder, paranoia, and anxiety. However, the differences in the remaining five dimensions, including depression, hostility, phobia, somatization, and psychosis, were not statistically significant ($p > 0.05$).

The good physical fitness group displayed noticeable differences from the excellent and passing groups on three dimensions: paranoia, anxiety, and interpersonal relationships. This suggests that even among students with relatively good physical fitness, specific psychological challenges may persist. While physical fitness appeared to have a notable impact on dimensions like interpersonal sensitivity, stress, and paranoia, it had a less significant effect on obsessive-compulsive tendencies, depression**,** somatization, and hostility. The dimensions of phobia and psychosis were the least affected by physical fitness levels.

Table 6. Nine mental health characteristics of college students with various physical circumstances are compared.

Mental health factors	Excellent physique group	Good constitution group	Physical fitness passing group	Physical fitness unpassed group	*F*	*P*
Somatization	1.38 ± 0.41	1.42 ± 0.47	1.53 ± 0.47	1.82 ± 0.46	16.71	0.0001
forced	1.79 ± 0.59	1.84 ± 0.64	1.89 ± 0.60	2.10 ± 0.63	15.16	0.0001
interpersonal relationship	1.65 ± 0.67	1.89 ± 0.62	1.92 ± 0.67	2.08 ± 0.68	16.06	0.0001
depressed	1.56 ± 0.63	1.74 ± 0.61	1.79 ± 0.61	1.92 ± 0.66	16.91	0.0001
anxious	1.58 ± 0.52	1.73 ± 0.54	1.75 ± 0.57	1.91 ± 0.65	18.34	0.0001
hostile	1.68 ± 0.58	1.71 ± 0.62	1.77 ± 0.70	1.98 ± 0.69	20.25	0.0001
terror	1.43 ± 0.51	1.45 ± 0.53	1.45 ± 0.48	1.61 ± 0.66	12.53	0.0001
Bigotry	1.49 ± 0.47	1.62 ± 0.62	1.67 ± 0.63	1.90 ± 0.54	14.81	0.0001
Psychovenereal	1.48 ± 48	1.47 ± 0.55	1.63 ± 0.51	1.94 ± 0.36	15.37	0.0001

3. Discussion

The relationship between physical and mental health in college students is a complex issue influenced by diverse demographic, psychosocial, and physical fitness factors. This study adds to the growing body of research by shedding light on critical trends and associations that can inform targeted interventions to enhance the well-being of this population.

3.1. Key findings and implications

3.1.1. Prevalence of psychological challenges

The findings indicate a notable prevalence of psychological problems among college students, with 13.2% experiencing mild issues, 9.7% moderate, and 1.3% severe. Prominent symptoms included obsessive-compulsive tendencies, interpersonal sensitivity, and paranoia, reflecting the significant mental health challenges young adults face during the transitional college years. These results align with previous studies linking academic, social, and environmental pressures to increased vulnerability among this demographic [15].

3.1.2. Impact on academic and social functioning

Mental health difficulties were found to significantly affect academic and social performance, manifesting as emotional distress, social withdrawal, and avoidance behaviors. These outcomes highlight the pressing need for universities to implement early detection mechanisms and accessible mental health interventions. Strategies such as reducing stigma, promoting mental health awareness, and establishing counseling and peer support programs are imperative [16].

3.1.3. Demographic influences

Household registration type and only-child status emerged as significant factors influencing mental health outcomes. Urban students and only children exhibited higher rates of psychological distress, while non-urban students demonstrated higher scores in depression, somatization, interpersonal sensitivity, tension, and obsessive-compulsive symptoms. Similarly, only children displayed elevated levels of paranoia, depression, and interpersonal sensitivity. Interestingly, no significant associations were observed for gender or ethnicity, emphasizing the dominant role of environmental and contextual factors over biological or cultural determinants [17]. Tailored interventions that address the unique needs of urban and non-urban students, as well as only children, are recommended.

3.1.4. Academic year trends

Mental health challenges varied across academic years. Freshmen reported higher levels of interpersonal sensitivity and tension, likely reflecting adjustment difficulties. Juniors exhibited heightened depression and paranoia, potentially tied to academic and career pressures, while seniors demonstrated increased somatization and anxiety, possibly related to post-graduation uncertainties. Although these patterns were not statistically significant, they underscore the importance of grade-specific mental health initiatives to address these unique stressors [17].

3.1.5. Physical fitness and its interplay with mental health

The study found an overall satisfactory level of physical fitness among students, with a 96.97% passing rate. However, disparities in specific indicators, such as high failure rates in the standing long jump and lung capacity-to-weight ratio, highlight areas for improvement. These deficiencies may reflect lifestyle patterns, such as insufficient physical activity or inadequacies in physical education programs.

A strong correlation between physical and mental health was observed. Students with poorer physical fitness showed significantly higher levels of psychological distress, particularly in dimensions like paranoia, somatization, and hostility. This finding reinforces the established link between physical fitness and psychological resilience, suggesting that improved physical activity can mitigate mental health challenges.

3.2. Recommendations for universities

1) Holistic health integration: Universities should adopt a comprehensive approach, integrating physical and mental health initiatives. Enhanced physical education programs emphasizing balanced development can positively impact students' mental health.

2) Demographic-specific strategies: Tailored interventions addressing the unique challenges of urban students, non-urban students, and only children are critical to fostering equitable well-being outcomes.
3) Grade-specific support: Mental health programs should be adapted to the unique stressors of each academic year, offering tailored support for freshmen, juniors, and seniors.
4) Promoting awareness and reducing stigma: Awareness campaigns, peer mentoring, and open forums are essential to normalize mental health discussions and foster a supportive environment.
5) Physical education reform: Rebalancing physical education curricula to address deficiencies in specific fitness indicators and promoting lifelong physical activity habits are necessary for sustained physical health.

3.3. Study limitations and future directions

While this study provides valuable insights, it is limited by its reliance on self-reported measures, which may introduce response biases. Additionally, the cross-sectional design restricts causal inferences. Future research should employ longitudinal methods to explore causal pathways between physical and mental health. Qualitative approaches could also deepen understanding by capturing students' lived experiences, thereby enriching the psychosocial context of these findings.

In conclusion, this study underscores the interwoven nature of physical and mental health among college students and highlights the need for targeted, multifaceted strategies to enhance their overall well-being.

4. Conclusion

This study underscores the intricate interplay between physical and mental health in college students. By addressing both domains through integrated, targeted, and grade-specific interventions, universities can foster a healthier and more supportive environment for their students. This holistic approach has the potential to enhance not only individual well-being but also academic performance and social integration, ultimately contributing to the long-term success and resilience of college graduates.

Biomechanics in basketball training ensures efficient movement patterns, which reduces physical discomfort and injury, encouraging consistent participation in the sport. This leads to greater engagement, emotional resilience, and better coping strategies for academic and personal pressures.

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