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Assessing the Effects of Sports Disciplines on Body Composition and Bone Health: A Focus on Yoga, Weightlifting, and Long-Distance Running

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Abstract

Background. Understanding how different sports influence bone health and body composition is key to improving athletic performance and overall well-being. Weightlifting, yoga, and long-distance running each have unique impacts on the body. This study offers insights into how specific sports disciplines shape bone health and body composition, providing valuable guidance for enhancing fitness and health recommendations.

Objectives. The study aimed to assess the effects of weightlifting, yoga, and long-distance running on body composition and bone mineral density, highlighting how these activities significantly influence both factors.

Materials and methods. A random sampling method was used to select ninety (N = 90) interuniversity athletes. The sample consisted of long-distance runners (n = 30), weightlifting athletes (n = 30), and yoga practitioners (n = 30). Bone mineral density was measured using the Achilles EXPII (Part 1) Bone Mineral Density Analyzer, while body composition was assessed with the GS6.5B Body Building Weight Test System (Version 1.0).

Results. Significant differences were observed among the groups in bone mineral density $F_{(2, 87)} = 15.95$, $p = .000$, body fat percentage $F_{(2, 87)} = 26.15$, $p = .000$, and skeletal muscle mass $F_{(2, 87)} = 23.30$, $p = .000$. A post-hoc LSD test showed that weightlifters had the highest bone mineral density and skeletal muscle mass, whereas long-distance runners demonstrated the lowest body fat percentage among the groups.

Conclusions. The study revealed substantial differences in skeletal muscle mass, body fat percentage, and bone mineral density among weightlifters, yoga practitioners, and long-distance runners. These findings highlight the distinct physiological adaptations associated with each sport, emphasizing the need for customized training and health strategies to optimize performance and health outcomes across different athletic disciplines.

Keywords: body composition, bone density, muscle mass, endurance runner, yoga practitioner, weightlifting.

Introduction

Exercise is considered a protective factor that lowers the risk of osteoporosis; however, not all physical activities have an equal effect on bone health. Non-weight-bearing sports may have a neutral or even negative impact (Bellver et al., 2019), whereas weight-bearing exercises are well-documented to promote long-term bone health (Boreham & McKay, 2011; Karlsson & Rosengren, 2012). The development of bone during childhood and adolescence plays a crucial role in determining peak bone mass and the future risk of osteoporosis and fragility fractures in later life (Baxter-Jones et al., 2011).

Athletes in endurance sports like running or non-weight-bearing activities such as biking and swimming often have lower bone mineral density compared to those in ball or power sports (Scofield & Hecht, 2012), which require strength and power to perform game-related skills effectively (Rahman & Sharma, 2023). In some cases, their bone density is even lower than that of their sedentary peers (Fredericson et al., 2005; Fredericson et al., 2007; Nagle & Brooks, 2011). Low bone mineral density increases the risk of stress and fragility fractures in competitive athletes and later in life (Kelsey et al., 2007). Since adequate bone mineral density is linked to both long-term health and injury prevention—especially in high-impact sports like running and weightlifting—maintaining bone health is critical (Turner & Robling, 2003). Exercises involving multidirectional motions and high-impact forces, such as gymnastics and team sports, are associated with stronger bones than low-impact exercises (Sale & Elliott-Sale, 2019).

Maintaining optimal body composition and bone health is essential for overall health and athletic performance. These physical traits can be influenced differently by various sports, and it is crucial for athletes and healthcare professionals to understand these differences (Goolsby & Boniquit, 2017; Reza et al., 2024). Endurance sports like long-distance running and cycling, due to their high energy demands, often produce a leaner physique, while strength-based sports like weightlifting tend to increase muscle mass and result in a more muscular appearance (Kraemer et al., 1999). The physiological demands of each sport play a significant role in shaping athletes' body composition and bone health (Carbuhn et al., 2010). Weightlifting, for example, promotes skeletal muscle mass and improves bone mineral density by applying high-intensity resistance that stimulates bone formation (Hong & Kim, 2018).

Yogic practices have shown potential in enhancing physiological and physical metrics, which are essential for unlocking the body's full potential and improving sports performance (Pramanik et al., 2024). By integrating weight-bearing postures with isometric exercises, yoga not only supports bone mineral density but also aids in muscle maintenance, providing these benefits in a gentler, less strenuous manner (Ross & Thomas, 2010). Long-distance running, with its consistent aerobic activity, generally leads to a leaner body composition and lower body fat (Willis et al., 2012). However, its impact on bone health can vary depending on factors like exercise intensity and duration. Long-term participation in endurance sports, such as long-distance running or cycling, may be associated with lower peak bone density (Tenforde & Fredericson, 2011; Barrack et al., 2010).

Understanding how these factors influence bone mineral density and body composition is vital for improving both athletic performance and long-term health. Evaluating the effects of different exercise regimens on bone mineral density is essential in determining which activities provide the most health benefits. The purpose of this study is to offer evidence-based recommendations to motivate individuals to engage in exercise that optimizes both bone health and body composition.

Materials and Methods

Study Participants

In this study, ninety (N = 90) male university-level participants from Punjabi University, Patiala, India, were selected using a random sampling technique. The participants included (n = 30) weightlifters, (n = 30) long-distance runners, and (n = 30) yoga practitioners, all aged between 18 and 25 years and having competed in interuniversity-level competitions in their respective sports. Long-distance runners were defined as those participating in events of 3,000 meters or more. The subjects were recruited from interuniversity camps, ensuring they were actively preparing for upcoming competitions.

The research scholar explained the objectives and procedures of the study, and after obtaining informed consent, the athletes voluntarily participated. All subjects were healthy and free of musculoskeletal problems, with those having medical conditions excluded from the study.

Table 1. The anthropometric data (M ± SD) of the subjects

Variables	Weight Lifters	Long Distance Runners	Yoga Practitioners
Age (yrs)	19.67 ± 1.88	20.13 ± 1.99	23.33 ± 1.53
Height (cm)	173.12 ± 9.71	172.51 ± 5.61	175.00 ± 6.40
Weight (kg)	67.40 ± 3.78	58.73 ± 4.48	63.43 ± 5.01
BMI (kg/m^2)	22.85 ± 2.62	20.07 ± 0.829	20.74 ± 2.24

Test Procedure

To assess the participants' lean body mass and body fat percentage, the Body Composition Analyzer GS6.5B Body Building Weight Test System (Version 1.0) was used. Bone mineral density (stiffness index) was measured using the Achilles EXPII (Part 1). All tests were conducted in the Physiology Lab of the Department of Physical Education at Punjabi University, Patiala, India. Prior to testing, participants' queries were addressed, and the procedure was thoroughly explained. A certified lab technician was responsible for recording all measurements. For the purposes of the study, skeletal muscle mass (kg), body fat percentage (%), and bone mineral density (stiffness index) were measured and compared among the groups.

Body Composition Analysis

Participants were instructed to remove heavy clothing and accessories and were informed in advance to refrain from eating for at least two hours before the test to ensure accurate measurements (Kyle et al., 2004a). The test administrator guided participants to stand barefoot on the electrode platform and grip the electrode rods with both hands, ensuring full contact between their feet and the electrodes (Sergi et al., 2017). The GS6.5B was calibrated before each session to ensure precision. This system uses bioelectrical impedance analysis (BIA) to measure body composition parameters such as body fat percentage and lean body mass (Kyle et al., 2004b; Mialich et al., 2014).

Bone Mineral Density Analysis

Participants were instructed to remove their shoes and socks. After getting into a comfortable position, they were asked to place their feet between the membranes for the heel scan (Lu et al., 2022; Li et al., 2019). The measurements were performed with the participant seated and one foot placed on the footplate (Weerasinghe et al., 2020). The device sends ultrasonic waves through the heel, and bone mineral density is determined by measuring how much these waves attenuate (Bi et al., 2023). The Achilles EXPII combines speed of sound (SOS) and broadband ultrasound attenuation (BUA) readings to create a clinical metric known as the Stiffness Index, which represents the ultrasound results (Gonnelli et al., 2002; Moayyeri et al., 2012).

Statistical Analysis

The data was analyzed using IBM SPSS software (version 29). Descriptive statistics and one-way ANOVA were employed to fulfil the study's objectives, followed by a post hoc LSD test to identify significant differences. The Shapiro-Wilk test confirmed that the data followed a normal distribution, while Levene's test verified the equality of variances. A significance level of 0.05 was set for all analyses.

Results

A one-way ANOVA (Table 3) revealed significant differences in bone mineral density $F_{(2, 87)} = 15.95$, $p = .000$, body fat percentage $F_{(2, 87)} = 26.15$, $p = .000$, and skeletal muscle mass $F_{(2, 87)} = 23.30$, $p = .000$ among weight lifters, long-distance runners, and yoga practitioners. These results indicate that the type of physical activity significantly influences these physiological parameters.

Table 2. Descriptive statistics of the variables

Parameters	Groups	n	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Bone Mineral Density	Weight Lifters	30	110.40	6.59	1.20	98	118
	Long Distance Runners	30	105.00	5.19	0.95	90	115
	Yoga Practitioners	30	101.77	6.07	1.11	85	117
Body Fat %	Weight Lifters	30	16.69	2.09	0.38	14	20
	Long Distance Runners	30	15.02	1.93	0.35	11	18
	Yoga Practitioners	30	18.39	1.28	0.23	14	20
Skeletal Muscle Mass	Weight Lifters	30	30.78	1.53	0.28	29	34
	Long Distance Runners	30	26.82	2.41	0.44	22	31
	Yoga Practitioners	30	28.46	2.69	0.49	24	33

Table 3. One-way ANOVA of selected parameters of weight lifters, long-distance runners and Yoga practitioners

Variables	Groups	Sum of Squares	df	Mean Square	F-ratio	p-value
Bone Mineral Density	Between Groups	1141.489	2	570.744	15.953	.000
	Within Groups	3112.567	87	35.777		
Body Fat %	Between Groups	170.092	2	85.046	26.145	.000
	Within Groups	283.004	87	3.253		
Skeletal Muscle Mass	Between Groups	238.311	2	119.155	23.296	.000
	Within Groups	445.000	87	5.115		

* Significant at 0.05 level

Table 4. Post-hoc (LSD) test

Parameters	Groups	Groups	Mean Difference	Std. Error	Sig. Level
Bone Mineral Density	Weight Lifters	Long Distance Runners	5.400*	1.544	.001
		Yoga Practitioners	8.633*	1.544	.000
	Long-Distance Runners	Weight Lifters	-5.400*	1.544	.001
		Yoga Practitioners	3.233*	1.544	.039
	Yoga Practitioners	Weight Lifters	-8.633*	1.544	.000
		Long-Distance Runners	-3.233*	1.544	.039
Body Fat Percentage	Weight Lifters	Long-Distance Runners	1.663*	0.466	.001
		Yoga Practitioners	-1.704*	0.466	.000
	Long Distance Runners	Weight Lifters	-1.663*	0.466	.001
		Yoga Practitioners	-3.367*	0.466	.000
	Yoga Practitioners	Weight Lifters	1.704*	0.466	.000
		Long-Distance Runners	3.367*	0.466	.000
Skeletal Muscle Mass	Weight Lifters	Long Distance Runners	3.967*	0.584	.000
		Yoga Practitioners	2.322*	0.584	.000
	Long Distance Runners	Weight Lifters	-3.967*	0.584	.000
		Yoga Practitioners	-1.645*	0.584	.006
	Yoga Practitioners	Weight Lifters	-2.322*	0.584	.000
		Long Distance Runners	1.645*	0.584	.006

* The mean difference is significant at the 0.05 level

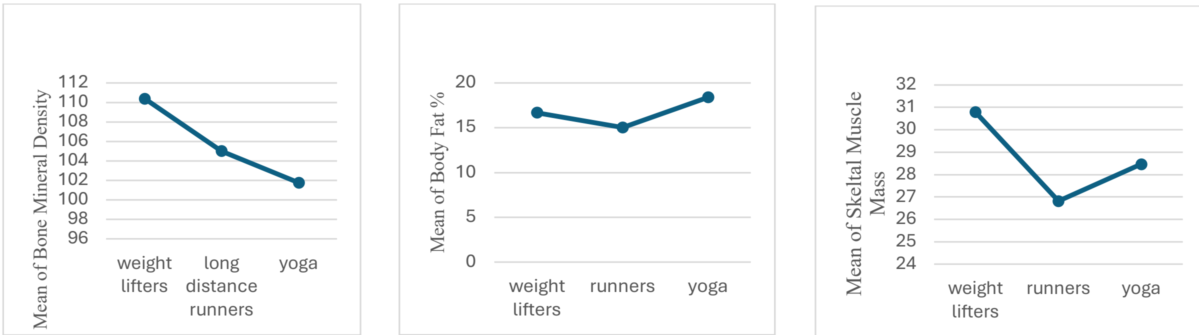

Fig. 1. Showings mean plots of variables between groups

A post-hoc LSD test (Table 4) revealed significant differences between the groups for all parameters. For bone mineral density, weight lifters had significantly higher values than long-distance runners (p = .001) and yoga practitioners (p = .000), and long-distance runners had higher values than yoga practitioners (p = .039). Regarding body fat percentage, long-distance runners had lower percentages than weight lifters (p = .001) and yoga practitioners (p = .000), with weight lifters also having lower body fat than yoga practitioners (p = .000). For skeletal muscle mass, weight lifters showed greater mass compared to long-distance runners (p = .000) and yoga practitioners (p = .000), with yoga practitioners having more muscle mass than long-distance runners (p = .006).

Discussion

The present study revealed significant differences in bone mineral density (BMD), body fat percentage, and skeletal muscle mass across three groups of athletes: weight lifters, long-distance runners, and yoga practitioners. Weightlifters exhibited the highest bone mineral density (BMD) among the groups, which is consistent with research showing that high-intensity mechanical loads, such as those encountered during weightlifting, stimulate bone adaptation and enhance BMD (Kohrt et al., 2010; Kohrt et al., 2004). The mechanical stress induced by the loading forces of weightlifting leads to significant bone strengthening (Souza et al., 2020; Hackett & Sabag, 2021). In contrast, long-distance runners had moderate BMD. Although running provides mechanical load, it is less intense than weightlifting, which may explain why runners have lower BMD compared to weightlifters (Tenforde et al., 2011). The continuous, moderate impact of endurance running contributes positively to bone health but falls short of achieving the higher BMD that weightlifting promotes (Borer, 2005; Kohrt et al., 2004). Meanwhile, yoga practitioners had the lowest BMD, likely due to the lower impact of yoga. Despite incorporating weight-bearing poses, yoga does not generate sufficient mechanical stress to significantly enhance BMD (Fernández-Rodríguez et al., 2021; Greendale et al., 2002).

Skeletal muscle mass is a crucial component of overall physical health and well-being, particularly during the formative years of youth. Maintaining optimal skeletal muscle mass can have far-reaching benefits, from improved physical performance to the prevention of age-related muscle loss (sarcopenia) later in life (Aversa et al., 2019; Tieland et al., 2018). Study found that weightlifters had the highest skeletal muscle mass, which is a direct result of the hypertrophic effects of resistance training (Hackett & Sabag, 2021; Benito et al., 2020). Mechanical loads and muscle contractions during weightlifting promote muscle size and strength through increased protein synthesis and muscle fiber recruitment (Morton et al., 2016; Schoenfeld, 2010). In contrast, long-distance runners exhibited the lowest skeletal muscle mass, as their training focuses on endurance and cardiovascular efficiency rather than hypertrophy. The high energy expenditure during endurance exercise can lead to muscle breakdown rather than growth, as muscle development is not prioritized in this type of training (Konopka & Harber, 2014; Fyfe et al., 2014). Enhance the eccentric strength of the hamstrings, significantly reducing the risk of muscle strains in athletes participating in high-intensity sports (Islam et al., 2024). Yoga practitioners displayed moderate skeletal muscle mass. While yoga involves isometric contractions that help maintain muscle mass, the intensity and frequency of muscle engagement are lower than those seen in weightlifting, resulting in more modest muscle development (Cramer et al., 2013; Ross & Thomas, 2010).

Long-distance runners showed the lowest body fat percentage among the groups, corresponding to the high caloric expenditure and fat oxidation associated with sustained aerobic activity (Mooses et al., 2013). The prolonged aerobic nature of endurance running leads to increased fat metabolism and energy expenditure, making it highly effective for fat reduction (Willis et al., 2012). Weightlifters, while having a higher body fat percentage than runners, maintained lower fat levels than yoga practitioners. Increased muscle mass from resistance training elevates basal metabolic rate and facilitates fat loss (Kraemer & Ratamess, 2004; Schoenfeld, 2010). Yoga practitioners had the highest body fat percentage, likely due to the lower intensity and caloric expenditure of yoga compared to weightlifting and running. According to Lauche et al. (2016), yoga does not promote the same level of metabolic activity necessary for substantial fat reduction due to its focus on flexibility, balance, and mental health (Cowen & Adams, 2005).

Conclusions

Weightlifting is the most effective method for increasing muscle mass and bone mineral density while maintaining lower body fat levels. Long-distance running, which emphasizes endurance, leads to decreased muscle mass, moderate bone mineral density, and lower body fat. Yoga has minimal impact on muscle mass and bone mineral density but can help maintain muscle through isometric contractions during poses. These results suggest that combining exercise modalities provides a balanced approach to improving overall health, combining the fat loss and cardiovascular benefits of endurance training with the muscle and bone-building effects of resistance training.

Limitations

This study had a cross-sectional design, which limits the ability to establish causal relationships between training programs and the observed differences in skeletal muscle mass, body fat percentage, and bone mineral density. Additionally, the sample size of 90 participants, with 30 in each group, may be relatively small, potentially affecting the generalizability of the findings. Furthermore, the study did not account for confounding variables, such as diet and individual training intensity, which could have influenced the results. Future research should consider using longitudinal designs and controlling for these variables to provide a more comprehensive understanding of the effects of different athletic disciplines on body composition and bone health.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Оцінка впливу спортивних дисциплін на композицію тіла та здоров'я кісткової тканини: Акцент на заняттях йогою, важкою атлетикою та бігом на довгі дистанції

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 3 табл., 1 рис., 52 джерела.

Історія питання. Розуміння того, як різні види спорту впливають на стан кісткової тканини та композицію тіла, є ключовим чинником для покращення спортивної результативності та загального самопочуття. Важка атлетика, йога та біг на довгі дистанції мають унікальний вплив на організм. Це дослідження містить аналіз того, як конкретні спортивні дисципліни формують здоров'я кісткової тканини та композицію тіла, а також надає цінні рекомендації щодо поліпшення рівня фізичної підготовленості та стану здоров'я.

Мета дослідження. Дослідження мало на меті оцінити вплив занять важкою атлетикою, йогою та бігом на довгі дистанції на композицію тіла та мінеральну щільність кісткової тканини, а також визначити, наскільки суттєво ці види фізичної активності впливають на обидва фактори.

Матеріали та методи. За методом рандомізації було відібрано дев'яносто (N = 90) міжуніверситетських спортсменів. Вибірка складалася з бігунів на довгі дистанції (n = 30), спортсменів-важкоатлетів (n = 30) та практиків йоги (n = 30). Вимірювання мінеральної щільності кісткової тканини проводилось за допомогою аналізатора мінеральної щільності кісткової тканини "Achilles EXPII" (Частина 1), що передбачає ультразвукове дослідження п'яткової кістки, а композиція тіла оцінювалась із використанням тест-системи "GS6.5B Body Building Weight Test System" (Версія 1.0) з метою визначення компонентного складу маси тіла спортсменів.

Результати. Спостерігалися значні відмінності між групами за показниками мінеральної щільності кісткової тканини $F_{(2, 87)} = 15,95$, p = 0,000, відсоткового вмісту жиру в організмі $F_{(2, 87)} = 26,15$, p = 0,000 та маси скелетних м'язів $F_{(2, 87)} = 23,30$, p = 0,000. Post-hoc тест найменшої значущої різниці показав, що важкоатлети мали найвищий рівень мінеральної щільності кісткової тканини та маси скелетних м'язів, тоді як бігуни на довгі дистанції продемонстрували найнижчий показник відсоткового вмісту жиру в організмі серед досліджуваних груп.

Висновки. За результатами дослідження встановлено суттєві відмінності у показниках маси скелетних м'язів, відсоткового вмісту жиру в організмі та мінеральної щільності кісткової тканини серед важкоатлетів, практиків йоги та бігунів на довгі дистанції. Отримані дані вказують на чітко виражені фізіологічні адаптації, пов'язані із кожним видом спорту, підкреслюючи необхідність розробки індивідуальних тренувальних та оздоровчих стратегій щодо оптимізації результативності та показників стану здоров'я в різних спортивних дисциплінах.

Ключові слова: композиція тіла, щільність кісткової тканини, м'язова маса, легкоатлет з бігу на витривалість, практик йоги, важка атлетика.

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