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Comparative Analysis of Handgrip Strength and Handgrip Strength-to-BMI Ratio Among Male Thai Ultimate Frisbee Athletes, Male University Athletes, and Male University Students: A Cross-Sectional Study

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Abstract

Ultimate Frisbee has seen remarkable global growth, attracting millions of participants across community programs, educational institutions, and competitive venues. Hand Grip Strength (HGS) is vital for executing effective disc throws, making it a key performance factor. This study aimed to (1) compare HGS among male Thai Ultimate Frisbee athletes (UA), male university sports athletes (USA), and male sedentary university students (SUS), and (2) explore correlations between HGS, muscle strength, experience, weekly training duration, and peak scoring performance. A cross-sectional study was conducted involving 277 males aged 16 to 20 years: UA (n = 96), USA (n = 99), and SUS (n = 82). HGS was assessed bilaterally in a straight-arm position, recording the highest value from two trials. The HGS-to-BMI ratio was calculated for each participant. Data collected included age, weight, height, BMI, athletic experience, weekly training duration, and peak scoring performance. ANOVA was used to analyze differences in HGS and the HGS-to-BMI ratio among groups. Pearson's correlation was used to assess relationships among variables, while an independent t-test compared UA and USA groups. Significant differences in HGS and HGS-to-BMI ratios were found among the groups ($p < 0.001$). UA demonstrated superior relative handgrip strength compared to both USA and SUS. SUS had the lowest values for both left and right HGS and the HGS-to-BMI ratio. A notable correlation was identified between left-hand grip strength and peak scoring performance in UA ($r = 0.211$, $p = 0.001$). Additionally, weekly training frequency positively correlated with peak scoring performance in both athlete groups ($p < 0.05$). This study underscores the importance of training duration, experience, peak performance scores, and metrics like HGS and the HGS-to-BMI ratio in enhancing athletic performance, offering insights for coaches to develop tailored training programs.

Keywords**:** *handgrip strength (HGS); handgrip strength-to-BMI ratio (HGS-to-BMI ratio); ultimate frisbee athletes (UA); university sports athletes; sedentary university students*

1. Introduction

Ultimate Frisbee is a dynamic and fast-growing sport, engaging millions of participants worldwide (Muramoto at al., 2024). Combining elements of soccer, basketball, and American football, it demands high levels of agility, speed, muscular coordination, and cardiovascular endurance. Despite its increasing popularity, a decline in male participation has been observed over the past five years (Eisenhood, 2016). Nonetheless, countries such as the United States, China, and Thailand continue to show significant growth and potential in the sport's development (Palmer et al., 2022; Herrmann et al., 2024; Portillo et al., 2022).

Physical fitness plays a central role in Ultimate Frisbee performance. Athletes rely on explosive strength for sprinting, jumping, and throwing, as well as on agility and endurance to sustain performance during high-intensity, intermittent play (Santi, & Rangubhet, 2023). In particular, handgrip strength (HGS) is critical for disc control, accuracy, and power during throws such as the backhand and forehand (Kajiki et al., 2021). Previous studies have shown a positive correlation between HGS and scoring performance in Ultimate Frisbee and related sports (Portillo et al., 2022; Kao, & Wang, 2017).

While handgrip strength serves as a direct indicator of muscular capability, it does not fully account for differences in body size and composition among athletes. To address this, the handgrip strength-to-body mass index (HGS-to-BMI) ratio provides a normalized measure that reflects relative strength. This ratio allows for a more equitable comparison across individuals with varying body types by indicating how effectively an athlete can convert their body mass into functional strength.

Training practices in Ultimate Frisbee vary significantly based on an athlete's experience level (Catch the Spirit, n.d.). Beginners typically focus on mastering fundamental techniques in shorter sessions, whereas intermediate and elite players invest more time in refining skills, improving conditioning, and synchronizing with team strategies (Vaishya et al., 2024; Manzano-Carrasco et al., 2023). These differences in training commitment may influence both physical indicators and in-game performance metrics, yet the specific relationships between training volume, athletic experience, and performance outcomes require further investigation.

Understanding these relationships is crucial for several reasons: 1) Performance Enhancement: By identifying the strength of association between HGS metrics and scoring performance, coaches can develop targeted training protocols that address specific physical attributes most relevant to competitive success. 2) Insights on Body Composition: The HGS-to-BMI ratio provides critical context for strength assessment by accounting for variations in body size and composition. This ratio reveals how effectively athletes convert body mass into functional strength—a key determinant of endurance, agility, and explosive movements essential in Ultimate Frisbee. Understanding this relationship allows for more personalized training approaches that consider individual physical characteristics. 3) Training Optimization: Analysis of weekly training duration in relation to performance outcomes may reveal threshold effects or optimal training volumes, potentially preventing overtraining while maximizing performance gains. 4) Experience Factors: Athletic experience typically correlates with skill refinement and tactical awareness. Examining how experience interacts with physical performance measures provides insight into the balance between technical proficiency and physical conditioning in Ultimate Frisbee. 5) Injury Prevention Applications: Robust correlations between these variables may inform injury prevention strategies, as suboptimal strength-to-mass ratios could indicate increased vulnerability to certain injuries, suggesting the need for targeted conditioning programs. 6) Talent Identification: Identifying the physical and experiential factors most strongly associated with superior performance can enhance talent identification protocols and developmental pathways for emerging athletes.

Analyzing these relationships yields significant insights into the complex structure of athletic performance in Ultimate Frisbee, informing evidence-based decisions in training, talent development, and performance enhancement. To establish such relationships, empirical data specific to Ultimate Frisbee athletes is essential. This highlights a critical gap in the current literature that this study aims to address. There is limited empirical research on this critical gap, particularly regarding the understudied relationship between handgrip strength (HGS), body mass index (BMI), training experience, and performance outcomes in this sport.

This study addresses two key questions: 1) Do Ultimate Frisbee athletes (UA) differ from university athletes (USA) and sedentary university students (SUS) in handgrip strength and HGS-to-BMI ratio? 2) What correlations exist between HGS, HGS-to-BMI ratio, athletic experience, weekly training duration, and peak scoring performance?

The findings can inform targeted training program design to enhance muscular strength and endurance for optimal performance. Additionally, understanding these relationships can help establish performance benchmarks and health promotion strategies for young athletes, with potential applications to other dynamic sports. University sports athletes were selected as a participant group due to their engagement in various team and individual sports, while sedentary university students serve as a control group, matching the age range of

Ultimate Frisbee participants but lacking regular physical exercise habits.

2. Objectives

This study aimed to (1) compare handgrip strength (HGS) and handgrip strength-to-BMI ratio among male Thai Ultimate Frisbee athletes (UA), male university sports athletes (USA), and Male sedentary university students (SUS), and (2) investigate the correlations between HGS, HGS-to-BMI ratio, athletic experience, weekly training duration, and peak scoring performance.

3. Materials and Methods

3.1 Design

This study was a cross-sectional design. The project has received ethical approval from the Ethical Committee of Rangsit University with the Certificate Number: RSUERB2024-109.

3.2 Participants

The research employed a purposive sample of 277 male participants, comprising 96 Ultimate Frisbee athletes (UA) whose data were gathered at competition venues from March to April 2024. The 99 players of university sports athletes (USA) include 30 soccer players, 25 Ultimate Frisbee players, 14 volleyball players, 11 basketball players, 11 judo players, and 8 e-sports players. Eighty-two sedentary university students (SUS) were recruited during the same timeframe (Table 1). The inclusion criteria mandated that athlete participants be healthy males aged 14 to 23 years with a minimum of one year of competitive experience, whereas SUS participants were healthy males aged 16 to 20 years with no previous sports competition experience. Individuals with existing hand injuries or those who opted out of the trial were excluded. All participants gave verbal informed consent following a comprehensive description of the study's aims, methodologies, advantages, and any dangers. Participation was wholly voluntary.

3.3 Measures

3.3.1 Assessment of Handgrip Strength (HGS) and Study Parameters

Participants provided biometric data, including age, body weight, and height, measured using the TANITA Model WB-380H, a high-quality digital weighing scale from Japan. This device supports a maximum weight capacity of 300 kg with a precision of 100 grams, ensuring accurate measurements. Participants then stood upright with their arms naturally extended downward, approximately one handspan apart from their bodies to maintain a consistent starting position. Bilateral handgrip strength was assessed using the T.K.K.5401 Grip-D digital dynamometer (Japan), which has a measuring range of 5.0 to 100.0 kg, an accuracy of ± 2 kg, and operates within a temperature range of 5 to 35°C. Participants held the dynamometer with the meter indicator facing outward and adjusted the grip width so that the second joint of the index finger formed a right angle. They then grasped the dynamometer with maximal force. Each arm was tested in two trials, alternating sides, while researchers provided verbal encouragement to enhance performance. The maximum grip strength (in kg) for each trial was recorded. All participants were familiar with and accustomed to the testing process. Most of the participants were right-hand dominant. Cronbach's Alpha indicated a reliability coefficient of 0.775.

3.3.2 Data Calculation

Body weight and height were utilized to calculate the Body Mass Index (BMI). Absolute grip strength (HGS) was defined as the maximum recorded value (in kg) for each arm, while relative grip strength, or the handgrip strength-to-BMI ratio (HGS-to-BMI ratio), was determined by dividing maximum grip strength (in kg) by BMI (in kg/m²). Participants, particularly athletes, reported their sport type, athletic experience, weekly training duration, and peak performance score. The peak performance score was rated on a scale from 1 (poor) to 3 (good), using a scale specifically developed for this study.

For Ultimate Frisbee athletes (UA), scoring levels were categorized: Level 1: 1-2 points per match; Level 2: 3-5 points per match; and Level 3: 6-7 points per match. University sports athletes (USA) received peak performance scores assigned by their coaches based on individual peak scoring achievements or overall performance during competitive events, with scores ranging from Level 1: (poor) to Level 3: (good).

3.4 Statistical Analysis

Descriptive statistics, including mean and standard deviation, were computed for the independent variables: age, weight, height, BMI, years of sports experience, weekly training time in days, and peak performance score. The Kolmogorov-Smirnov test evaluated the normality of all variables. ANOVA was employed to compare groups when data were normally distributed;

otherwise, the Kruskal-Wallis test was utilized, with the Bonferroni procedure performed for pairwise comparisons. The Independent t-test compared means between the two groups using normally distributed data, whereas Pearson's correlation analysis assessed correlations between muscular strength and other study variables. A 95% confidence interval was employed, with significance established at $\alpha = 0.05$. All analyses were performed using SPSS version 26. Effect size is a statistical concept that quantifies the strength of the relationship or difference between variables. It denotes the practical importance of a study finding. In the application of Cohen's d for calculations, a big effect size (exceeding 0.8) signifies practical significance, whereas a small effect size (0.2) denotes limited practical applicability.

4. Results

4.1 Participant Demographics

Table 1 summarizes participant demographics. The USA group was significantly older and had higher body weight, height, and BMI than UA and SUS ($p < 0.05$).

4.2 Muscle Strength Comparison

Table 2 presents the ANOVA test results comparing muscle strength between the three groups. Absolute Handgrip Strength (HGS): USA exhibited significantly higher absolute HGS than both UA and SUS ($p < 0.01$). HGS-to-BMI Ratio: Conversely, the UA group demonstrated a higher HGS-to-BMI ratio on the right side than the USA and SUS groups ($p < 0.01$). Additionally, UA had a higher LHGS-to-BMI ratio than the SUS group.

4.3 Experience, Training Duration, and Peak Scoring Performance

Table 3 compares experience, weekly training time, and highest performance scores between the UA and USA groups. The USA group had significantly more experience and higher scoring performance scores than the UA group, while no significant difference was observed in weekly training frequency between the groups. A large effect size was observed for experience and scoring performance between the two groups.

Table 1 Physical characteristics of male participants among three groups (Mean ± SD)

Physical characteristics	UA n = 96	USA n = 99	SUS n = 82	Kruskal-Wallis χ^2	df	Sig.
Age (years)	16 ± 2[a,c]	20 ± 2	20 ± 1	165.321	2	0.000
Height (cm)	170 ± 6[a]	173 ± 6	173 ± 6	9.544	2	0.008
Body weight (kg)	59 ± 9[a,c]	73 ± 12	66 ± 10[a]	74.204	2	0.000
BMI (kg/m$^{2)}$	19.7 ± 2.3[a,c]	24.5 ± 3.6	21.9 ± 2.9[a]	91.518	2	0.000

Note: Superscripts indicate significant differences in median ranks between groups: a = Significantly different from University Sports Athletes (USA), b = Significantly different from Ultimate Frisbee Athletes (UA), c = Significantly different from Sedentary University Students (SUS). Statistical analysis was conducted using the Kruskal–Wallis test, followed by pairwise comparisons with Bonferroni correction. Statistical significance was set at $p < 0.01$.

Table 2 Right handgrip strength (RHGS) and left handgrip strength (LHGS), RHGS-to-BMI ratio, LHGS-to-BMI ratio of male participants among three groups (Mean ± SD)

HGS	UA	USA	SUS	F	*p*	95% CI
RHGS (kg)	37.1 ± 6.2[a]	41.2 ± 6.5	35.8 ± 7.0[a]	17.440	<0.001	-7.760, 7.760
LHGS (kg)	35.0 ± 6.6[a]	39.6 ± 6.7	34.3 ± 6.8[a]	17.473	<0.001	-7.613, 7.613
RHGS-to-BMI ratio (kg/kg/m^2)	1.9 ± 0.4[a]	1.7 ± 0.3	1.7 ± 0.4[b]	10.889	<0.001	-0.387, 0.387
LHGS-to-BMI ratio (kg/kg/m^2)	1.8 ± 0.4	1.7 ± 0.4	1.58 ± 0.4[b]	7.291	0.001	-0.346, 0.346

Note: Superscripts indicate significant differences in median ranks between groups: a = Significantly different from University Sports Athletes (USA), b = Significantly different from Ultimate Frisbee Athletes (UA), c = Significantly different from Sedentary University Students (SUS), Statistical analysis was performed using ANOVA, followed by post-hoc comparisons with Bonferroni and Dunnett T3 corrections. Statistical significance was set at $p< 0.01$.

Table 4 displays the relationships between the muscle strength of the UA and USA groups and the study variables. In the UA group, notable associations were observed: RHGS correlated with LHGS ($r = 0.729$, $p < 0.01$), the RHGS-to-BMI ratio ($r = 0.701$, $p < 0.01$), and the LHGS-to-BMI ratio ($r = 0.534$, $p < 0.01$). In a similar manner, LHGS exhibited a correlation with the RHGS-to-BMI ratio ($r = 0.474$, $p < 0.01$), the LHGS-to-BMI ratio ($r = 0.719$, $p < 0.01$), and the scoring performance ($r = 0.211$, $p < 0.05$). A similar correlation pattern was noted in the USA group; however, the association between LHGS and scoring performance was not significant. No link was found between RHGS, LHGS, RHGS-to-BMI ratio, LHGS-to-BMI ratio, and experience or training duration. There were no correlations between RHGS, LHGS, RHG-to-BMI ratio, LHG-to-BMI ratio, and experience, training duration times.

5. Discussion

According to the World Health Organization's BMI standards, the biometric data (Table 1) from participants in the UA, USA, and SUS groups exhibited normal Body Mass Index (BMI) levels (Lim et al., 2023). Nevertheless, the USA group exhibited signs of being overweight in comparison to the Asian population standard. BMI is a commonly utilized metric; nonetheless, it has been criticized for insufficiently characterizing adiposity, since it fails to differentiate between fat mass and fat-free mass and does not effectively reflect fitness levels in either children or adults (Manzano-Carrasco et al., 2023).

Table 3 Comparison of experience, training, and peak scoring performance between UA and USA groups (Mean ± SD)

Variable	UA	USA	df	t	*p*	95% CID	Effect size
Experience (years)	1.37 ± 1.10[a]	8.34 ± 3.45	115	-18.889	0.001	-7.691, -6.231	2.713
Training (days/week)	4.42 ± 1.40	4.59 ± 0.85	156	-1.009	0.314	-4.951, 0.160	0.144
Peak scoring performance	1.00 ± 0.54	2.03 ± 0.39	193	-15.261	0.001	-1.164, -0.897	2.184

Note: Statistical analysis was performed using independent t-tests with a significance level set at $p < 0.01$. Effect sizes were calculated according to Cohen's criteria. Superscript "a" indicates statistically significant differences between groups.

Table 4 Pearson correlation between RHGS, LHGS, and study factors

Study factors	UA 'r' value (n=96)	USA 'r' value (n-99)	SUS 'r' value (n=82)
RHGS: LHGS	.729**	.848**	0.792**
RHGS: RHGS-to-BMI ratio	.701**	.508**	0.725**
RHGS: LHGS-to-BMI ratio	.534**	.428**	0.586**
RHGS: Experience	-.008	-.058	
RHGS: Training duration	-.054	.038	
RHGS: High-scoring performance	.088	-.050	
LHGS: RHGS-to-BMI ratio	.474**	.441**	0.541**
LHGS: LHGS-to-BMI ratio	.719**	.574**	0.674**
LHGS: Experience	-.054	-.044	
LHGS: Training duration	-.014	.004	
LHGS: High scoring performance	.211*	-.142	
RHGS-to-BMI ratio: LHGS-to BMI ratio	.824**	.852**	.884**
RHGS-to- BMI ratio: Experience	-.043	-.021	
RHGS-to- BMI ratio: Training duration	-.052	-.029	
RHGS-to- BMI ratio: High-scoring performance	.025	.019	
LHGS-to- BMI ratio: Experience	-.159	-.050	
LHGS-to- BMI ratio: Training duration	-.092	.014	
LHGS-to- BMI ratio: High-scoring performance	.002	-.051	
Experience: Training duration	.000	-.321**	
Experience: High-scoring performance	.188	-.053	
Training: High-scoring performance	.437**	.224**	

**indicates significance at $p < 0.01$ and *indicates significance at $p < 0.05$.

The Takei dynamometer employed in this work is acknowledged as a robust and reliable instrument for assessing hand and wrist functionality, illustrating its applicability in healthy populations, athletic contexts, and clinical environments. Research substantiates its efficacy in quantifying grip strength among varied populations, encompassing athletes and individuals with hand and wrist disorders, rendering it indispensable for both routine evaluations and specialized applications in health and fitness domains (Gatt et al., 2018; Savas et al., 2023).

The handgrip strength (HGS) scores for the UA and SUS groups exceeded the average HGS of 26.7 kg documented for males aged 11-18 with a normal BMI. Nevertheless, the HGS outcomes for all three groups were categorized as “very low” to “poor” based on the standards established by Topend Sports (n.d.). Furthermore, when comparing the relative strength with Thai norms in the same age group (Department of Physical Education, 2019) it was found that the grip strength of the UA group was categorized as “low” to “average”, the USA was categorized as “low” to “very low”, and the SUS group as “low” HGS. Discrepancies may stem from differences in testing positions and equipment utilized; this study employed the same equipment and protocol as advised by Topend Sports (n.d.).

The examination of handgrip strength (HGS) (Table 2) indicated a considerably higher strength in right-hand grip strength (RHGS) compared to left-hand grip strength (LHGS), possibly due to right-hand dominance in over 80% of participants. This corresponds with studies indicating that handgrip strength (HGS) serves as a signal for muscle mass deficiency and underscores the necessity of considering lateral dominance in evaluations (Zaccagni et al., 2020). The USA group exhibited greater absolute handgrip strength (HGS) compared to the UA group, presumably attributable to age-related growth and strength enhancement (Table 2). The USA group surpassed the SUS group of equivalent age, presumably due to variations in training and inactive habits. The reduced handgrip strength (HGS) in the sedentary group aligns with the findings of Vaishya et al., (2024), which indicated diminished HGS values during sedentary activities.

The use of absolute handgrip strength (HGS) rather than relative values (adjusted for body weight) is justified by its direct measurement of maximum force, which strongly correlates with muscle mass and overall physical capability. This is particularly relevant in rehabilitation and athletic performance, where total strength is crucial. Unlike relative HGS, which may underestimate the strength of individuals with higher body fat despite significant muscle mass, absolute HGS provides a more accurate measure of physical capability. Clinically, it is a reliable indicator of health and functional ability, linked to outcomes such as mortality risk and metabolic health (Farías-Valenzuela et al., 2024; Lee et al., 2016). However, a prior study found a stronger correlation between relative strength and athletic performance than absolute strength (Wagner et al., 2023), this issue requires further explanation from the athletes' perspective.

When comparing the HGS-to-BMI ratio among the three groups, the UA group exhibited the highest functional grip strength, particularly in the RHGS-to-BMI ratio. This likely reflects the sport-specific demands of their activities, which require muscle strength for throwing, catching, and skill refinement.

Practical Implications: The higher RHGS-to-BMI ratio observed in the UA group suggests that sport-specific training significantly enhances functional grip strength. This highlights the importance of incorporating targeted grip strength exercises into training programs, especially for sports that rely heavily on upper-body performance. Coaches and athletic trainers could use the HGS-to-BMI ratio as a practical assessment tool to monitor athletes' progress and identify potential imbalances or weaknesses that may affect performance or increase injury risk. Furthermore, this metric could be valuable in talent identification, helping to distinguish athletes with superior functional strength relative to their body composition.

Physiological Basis: The elevated RHGS-to-BMI ratio in the UA group can be attributed to physiological adaptations resulting from regular training. Repetitive activities such as throwing and catching in sports like Ultimate Frisbee promote neuromuscular efficiency, enhanced muscle fiber recruitment, and hypertrophy of the forearm and hand muscles. Additionally, dominant hand usage leads to asymmetrical development, explaining why the right-hand grip strength shows more pronounced differences. These adaptations enhance not only grip strength but also overall coordination, proprioception, and endurance of the involved muscle groups.

Theoretical concepts related to differences in training adaptations between the studied groups: The observed differences in training adaptations among the studied groups, particularly regarding handgrip strength (HGS) and the HGS-to-BMI ratio, can be explained through several theoretical concepts related

to sport-specific demands, training regimens, and physiological adaptations. When comparing Ultimate Frisbee athletes to athletes from other sports, the following key concepts emerge:

1. Specificity of Training Principle

The principle of specificity suggests that the body adapts to the specific demands imposed by the type of training performed. Ultimate Frisbee requires frequent sprinting, rapid directional changes, jumping, throwing, and catching, all of which demand a combination of aerobic endurance, anaerobic power, agility, and upper-body strength, particularly grip strength.

Ultimate Frisbee: Emphasizes dynamic movements and repetitive throwing, leading to greater development of forearm muscles, wrist stabilizers, and hand flexors, which directly contribute to higher HGS and HGS-to-BMI ratios.

Other Sports, for example, sports like swimming focus on overall upper-body strength and endurance, while e-sports require minimal physical training, explaining lower HGS values in those athletes.

2. Neuromuscular Adaptations

Neuromuscular efficiency improves through sport-specific practice (Tunintaraarj, & Homsombat, 2024). Ultimate Frisbee athletes develop superior motor unit recruitment and synchronization, especially in muscles involved in grip and throwing mechanics.

Ultimate Frisbee: Requires fine motor control for disc handling and quick, explosive upper-body movements, enhancing neuromuscular coordination specific to grip strength.

Other Sports: Athletes in soccer or basketball may develop more prominent lower-body neuromuscular adaptations due to the primary role of leg muscles in their sports.

3. Muscle Hypertrophy and Functional Strength

While hypertrophy (muscle growth) contributes to strength, functional strength - defined as the ability to exert force in specific movement patterns - is more relevant in sports performance.

Ultimate Frisbee: Promotes hypertrophy in the forearm and upper-body muscles, but also improves functional grip strength through repetitive sport-specific actions.

Other Sports: Strength sports like judo may show higher overall muscle mass, but grip strength adaptations might not be as pronounced unless directly targeted.

4. Energy System Demands

Different sports rely on varying energy systems (aerobic, anaerobic, or phosphagen), influencing muscle adaptations.

Ultimate Frisbee: Involves high-intensity, intermittent activity with both anaerobic bursts (sprinting, throwing) and aerobic recovery, leading to mixed adaptations that support both endurance and explosive power.

Other Sports: Endurance sports like long-distance running prioritize aerobic capacity, while powerlifting focuses on the phosphagen system for maximal strength output.

5. Bilateral Asymmetry and Dominance Effects

Hand dominance influences grip strength, with the dominant hand often exhibiting superior strength due to more frequent use.

Ultimate Frisbee: As a unilateral sport (dominant-hand throwing), athletes often show significant differences between right-hand and left-hand grip strength, especially in the RHGS-to-BMI ratio.

Other Sports: Sports that require symmetrical movements (e.g., swimming, rowing) tend to produce more balanced bilateral strength. In conclusion, the observed differences in the HGS-to-BMI ratio underscore the interplay between sport-specific demands, training intensity, and physiological adaptations. Recognizing these factors can inform the development of more effective training and conditioning programs to optimize athletic performance. In contrast, the SUS group showed significantly lower HGS-to-BMI ratios on both sides, highlighting muscle weakness. This underscores the need to promote healthy lifestyles and regular exercise among sedentary students (Vaishya et al., 2024; Manzano-Carrasco et al., 2023). The use of relative functional grip strength (HGS-to-BMI ratio) is justified as it accounts for body composition and fitness, offering insights into the health and development of young populations. This marker has been associated with metabolic risk (Pramkratok et al., 2024; Gontarev et al., 2020), central adiposity in children and adolescents (Sirikulchayanonta et al., 2023), as well as hypertension and type 2 diabetes in adults (Manzano-Carrasco et al., 2023).

UA group with lower experience levels demonstrated reduced peak scoring performance, despite similar weekly training time (Table 3). This discrepancy may stem from differences in sport-specific tactics and practical training methods used in competitive settings (Ultimate Athlete Project, 2024; Ultimate Frisbee workout guide, n.d.).

A positive correlation was observed between HGS and the HGS-to-BMI ratio on both the left and right sides among the three groups (Table 4). These findings are consistent with research indicating a positive relationship between HGS and the HGS-to-BMI ratio over a four-year follow-up in a young population (Manzano-Carrasco et al., 2023). The HGS-to-BMI ratio has been suggested as a tool for identifying children at risk of sarcopenic obesity (Bianco et al., 2015) and Steffl et al., (2017) for diagnosing sarcopenia in the elderly (McCarthy, 2006).

A notable positive correlation existed between left-hand grip strength (LHGS) and high performance in Ultimate Frisbee, corroborating the hypothesis that increased grip strength and effective tactics improve scoring via enhanced control and precision in disc throwing or passing (Lam et al., 2021). A favorable link was identified between training duration and peak scoring performance in both Ultimate Frisbee ($r = 0.437$) and university athletes ($r = 0.224$; $p < 0.01$). This indicates that great athletes dedicate significant effort to practicing skills pertinent to their sport's strategies.

The absence of a link among training duration, experience, peak performance scores, and measurements like handgrip strength (HGS) or the HGS-to-BMI ratio might be ascribed to many causes. Ultimate Frisbee and analogous games prioritize agility, coordination, and tactical acumen over sheer strength, rendering grip strength less pertinent to performance results. Moreover, although grip strength may be associated with overall muscle strength, it does not inherently forecast effectiveness in sports necessitating varied physical abilities. The variability in personal training programs and the distinct requirements of other sports may obscure any potential correlations between these variables. The specificity of grip strength assessments and the complex nature of athletic performance indicate that relying solely on HGS or BMI ratios may not yield a thorough comprehension of an athlete's skills. (Huebner et al., 2023; Keogh et al., 2018; Skyd Magazine, n.d.; Ultiworld, n.d.; Play Ultimate Frisbee, n.d.).

A negative correlation exists between training duration and experience among university athletes in the USA, attributed to several factors. First, experienced athletes often prioritize training efficiency, employing superior strategies that emphasize quality over quantity. Their physiological adaptations allow for optimized strength and endurance gains in shorter training sessions. Additionally, seasoned athletes are adept at managing fatigue and recovery, enabling effective training within condensed timeframes. They also follow targeted regimens tailored to their specific needs, which further reduces overall training duration. Finally, enhanced confidence and mental resilience contribute to more intense and focused workouts in less time (Hamlin et al., 2019). These factors enable experienced athletes to maintain or improve performance with reduced training duration; without these efficiencies, a negative association between training duration and experience can arise.

Limitations, Benefits, and Further Investigation

This research possesses multiple constraints: 1) The UA group was younger than the other cohorts, 2) the sample size was limited, and 3) hand dominance was reported without empirical assessment. Moreover, the peak performance ratings for the USA group were assigned by coaches, potentially introducing bias.

The results concerning handgrip strength (HGS) and its association with performance can guide training techniques for Ultimate Frisbee athletes and comparable sports. Coaches ought to prioritize functional strength training that targets grip strength in conjunction with agility and coordination, as these elements are essential for skills such as throwing and catching. Integrating grip strength evaluations with regular training can customize conditioning regimens to improve performance. Experienced athletes should prioritize training efficiency by utilizing specific routines that stress quality over quantity, thereby increasing strength and endurance gains in shorter training sessions. This method reduces the danger of injury while conforming to the sport-specific requirements of Ultimate Frisbee, where strategic acumen is essential. For sedentary university students (SUS), diminished handgrip strength (HGS) may signify inadequate physical fitness, indicating that assessment of HGS and the HGS-to-BMI ratio could encourage consistent physical activity and mitigate the risk of sarcopenia and associated health complications.

Subsequent research should focus on: 1) augmenting participant numbers with uniform age distribution, 2) explicitly delineating methodologies for assessing hand dominance, and 3) formulating more consistent evaluations for ascertaining performance metrics across diverse sports. Employing HGS and the HGS-to-BMI ratio as reliable health metrics can bolster public health efforts to enhance daily physical activity.

6. Conclusions

Ultimate Frisbee athletes had superior functional handgrip strength (HGS-to-BMI ratio) compared to university athletes and inactive university students. Nonetheless, the absolute HGS of the USA group has exhibited the highest value when compared to the three groups. The SUS group exhibited the lowest handgrip strength (HGS) and HGS-to-BMI ratio. A positive link was observed between LHGS and good performance in Ultimate Frisbee (UA). A negative link exists between training duration and experience in the USA. Conversely, there was a lack of correlation between training length, experience, peak performance scores, and metrics such as handgrip strength (HGS) or the HGS-to-BMI ratio in the UA and USA groups.

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8. References

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