



ORIGINAL SCIENTIFIC ARTICLE

INTERLIMB ASYMMETRY OF MAXIMAL HANDGRIP STRENGTH AND WRIST CIRCUMFERENCE IN ELITE INTERNATIONAL MALE BOXERS

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Abstract

The purpose of the study was to examine interlimb maximal handgrip strength asymmetry and wrist circumference asymmetry in amateur boxing across three weight classes and two different stances.

Materials and methods. The study sample comprised 12 (flyweight: 4; bantamweight: 4; featherweight: 4) amateur elite international boxers of India. Both limbs were tested for maximal handgrip strength and wrist circumference. For both tests, interlimb asymmetry was calculated using the interlimb asymmetry equation validated by Bishop et al. (2018). One-way ANOVA was used to compare asymmetries in three different weight classes, and an independent samples t-test was used to compare asymmetries in two different boxing stances.

Results. The average wrist circumference asymmetry in different weight classes was 2.85 ± 1.97 for flyweight, 1.29 ± 0.75 for bantamweight, and 2.44 ± 1.23 for featherweight, whereas the average maximal handgrip strength asymmetry was 4.91 ± 3.75 for flyweight, 7.69 ± 1.89 for bantamweight, and 5.80 ± 2.89 for featherweight. Non-significant differences in interlimb asymmetry for wrist circumference and maximal handgrip strength in three different weight classes and two different stances were obtained ($p > 0.05$).

Conclusions. The maximal handgrip strength asymmetry and wrist circumference asymmetry in elite international boxers were found to be less than 10 percent and observed non-significant differences in weight classes as well as stances indicate elite amateur international boxers to be less prone to interlimb asymmetry-related injuries and have favourable conditions for high performance.

Keywords: flyweight, bantamweight, featherweight, southpaw, orthodox, boxing.

Introduction

Boxing is one of the oldest combat sports in human history and is historically referred to as the “noble art” and pugilism. The International Boxing Association has stated that the first proof of this was found in Egypt around 3000 B.C. Boxing probably started in Ethiopia around 6000 B.C., and in 688 B.C., at the first Olympic Games, boxing made its historical debut as an Olympic sport (Chaabène et al., 2014). In order to be successful in boxing, a person must possess a wide range of skills, knowledge, and traits that can be measured, analyzed, and ultimately improved through the use of the right tools and techniques throughout their athletic career (Kapo et al., 2021). Boxers choose between the orthodox or southpaw stance. The term “orthodox stance” describes how the boxer should stand, with the left foot and hand

forward and the right foot and hand back. The term “southpaw,” which comes naturally to left-handers, describes having one's right foot and right hand in the front (Sorokowski et al., 2014). What we call the difference between one limb in relation to the other is known as inter-limb asymmetry (also known as bilateral asymmetry or bilateral difference) (Bishop et al., 2018). Öktem et al. (2017) has determined a highly positive correlation between hand grip strength and upper extremity parameters. Specific sports practice also affects the morphological differences of the body sides. Additionally, participating in sports activities that primarily use one side of the body results in asymmetrical changes to some tissues, and martial arts may be an example of a discipline in which one side of the body is emphasized over the other (Burdukiewicz et al., 2020a). The most popular way to evaluate the strength of the muscles in the upper extremities is by measuring hand grip strength, which also serves as a key performance indicator for athletes (Fry et al., n.d.). Using magnetic resonance imaging, Ducher et al. (2005) and Daly

et al. (2004) have determined in tennis players that the radius, ulna and humerus have a larger diameter compared to the non-dominant upper limb, in the dominant upper limb. Simenko et al. (2017) determined significant differences between right and left body pairs in -73 kg youth judo players. Krzykała and Leszczyński (2015) uncovered a significant increase in muscle mass and bone mineral density on the left side of the bodies of both male and female professional field hockey players. Guidetti et al. (2002) has established that the isometric muscle contraction, especially that of the upper limb (i.e., the dominant arm), is closely associated with boxing competition ranking. The boxer's hand-grip isometric strength is a significant physical fitness indicator. Indian National Boxers' morphological, physiological, and biochemical characteristics between Senior and Junior levels (Khanna & Manna, 2006). Hand-grip strength performance of the main hand correlates with both the power of the straight and the side blow (Chaabène et al., 2015). Sporrang et al. (1996) and Guidetti et al. (2002) suggested that hand-grip strength is one of the most important medical control indicators in boxing training. The performance of left and right hand-grip isometric strength by weight category was examined, and it was found that there is a substantial difference between the lightweight, middleweight, and heavyweight categories (Ramírez-García et al., 2010). However, scientific literature related to interlimb grip strength and wrist circumference asymmetry in elite international boxers is scarce. During an amateur boxing bout, a pugilist executes combination of punches from dominant as well as non-dominant hand. Therefore, reduction in interlimb asymmetry may be an influential factor to determine outcome of a bout as well as prevention of injuries during the course of a bout. By identifying any significant differences in handgrip strength and wrist circumference between the dominant and non-dominant limbs, coaches can customise exercises and routines to promote symmetrical development, potentially reducing the risk of injuries and optimising sports performance. The investigation of elite boxers' handgrip strength and wrist circumference asymmetry can contribute to the development of injury prevention strategies and could aid in talent identification and selection process. The research may shed light on the biomechanical aspects of boxing as well as the possible effects of specific stances on handgrip strength and wrist circumference. Understanding these biomechanical differences can aid in the refinement of boxing techniques, the optimisation of movement patterns, and the improvement of boxing performance as a whole. The findings of study may serve as a basis for comparing interlimb asymmetry in athletes from other combat sports or even athletes from other sports to differentiate the asymmetry patterns in boxing.

The aim of this study was to compare the wrist circumference asymmetry and interlimb hand grip strength asymmetry in three different weight classes and two different stances. On the basis of findings of previous studies, we hypothesized that there would be no significant difference in wrist circumference asymmetry and interlimb hand grip strength asymmetry in three different weight classes and two different stances. However, interlimb handgrip strength asymmetry and wrist circumference asymmetry would be less than 10 percentage in all the three-weight classes and two different stances.

Materials and Methods

Experimental Approach to the Problem

Indian elite international male boxers were the focus of this descriptive cross-sectional study. Anthropometric profiles were established, and interlimb asymmetry for hand grip strength and wrist circumference was compared among three different weight classes: flyweight (48-51 kg), bantamweight (51-54 kg), and featherweight (54-57 kg) (International Boxing Association, 2023). The National Boxing Training Center, situated in the Netaji Subhash National Institute of Sports in Patiala, served as the testing site. All athletes didn't need any special introductions or familiarisation since they had already taken part in the ensuing tests. Prior to their regular morning boxing training, the athletes underwent anthropometric and hand grip strength evaluations by an ISAK level 1 anthropometrist who was also a national boxing coach.

Study participants

Twelve (7 southpaw + 5 orthodox) of the best male boxers in India from three different weight classes (flyweight (48-51 kg), bantamweight (51-54 kg), and featherweight (54-57 kg)) were chosen for the study. Data from all available boxers in specified weight classes in national camp was collected and limited resources were the key factor in determining the size of the sample the researchers were able to gather. The participants were international boxers from India who were also a part of either the Olympic Games, the World Championships medal winners, the Commonwealth Games medal winners, the Asian Championship medal winners, or the Senior National Champions. After the goals and steps of the experiment were explained to each participant, they all signed an informed consent form. The Lakshmibai National Institute of Physical Education in Gwalior's Ethics Review Committee gave its approval for this study, which was carried out in compliance with the Helsinki Declaration. During the time leading up to the Asian Boxing Championship, the assessment was done. A survey was used to find out the participants' birth dates, their preferred boxing stances (Southpaw or Orthodox), and any injuries they might have

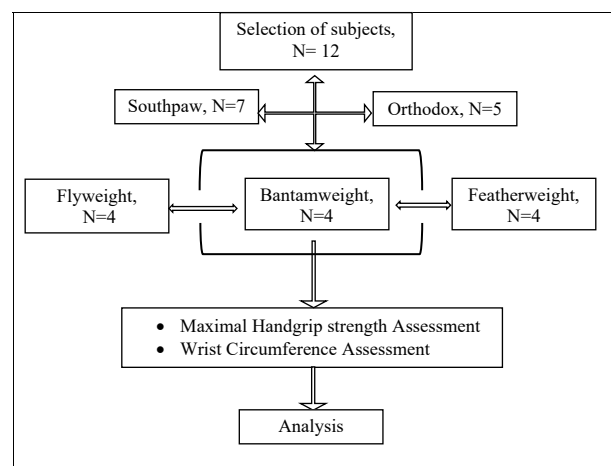


Fig. 1. Cross sectional design of the study

had in the past six months. None of the athletes have reported any injuries.

Procedure of data collection

Anthropometrics:

Height was measured using a stadiometer and the standard ISAK procedure for stretch stature to reduce the effect of diurnal variations. The subjects were instructed to stand with their feet together and their heels, buttocks, and upper back touching the scale. The measurer placed the hands along the jaw of the subject and gently lifted the subject's head upward through the mastoid processes. The recorder tightly compressed the hair and made sure that the head remained in the Frankfort plane and that the feet did not leave the ground. At the end of a deep inspiratory manoeuvre, the measurement was made (Norton, 2018). An electronic weighing scale made for professional boxers (Ohaus SD200L Boxing Scale) was used to measure body mass. The subjects were directed to put on the bare essentials of clothing, verify the zero, and then position themselves at the centre of the scale with their weight evenly distributed on both feet, heads held up, and eyes fixed forward. The wrist circumference was measured as the minimal girth distal to the radial styloid process. Non-elastic tape was used to measure the circumference of both wrists (left and right). The subject sat back with his non measuring arm at his side in a comfortable state. The measuring forearm was supinated, the hand was relaxed, and the elbow was slightly extended. It was necessary to manipulate the tape measure to get the minimal girth without compressing the tissues with too much tape tension. The measurement was recorded to the nearest 0.1 cm (Rogowski et al., 2008).

Maximal Handgrip Strength Test

The Takei T.K.K.5401 GRIP-D handgrip dynamometer (Takei Scientific Instruments Co., Ltd., Tokyo, Japan) was used for all data collection to measure the maximum isometric handgrip strength of the dominant and non-dominant hand (Gatt et al., 2018). Prior to the test, the athletes performed a warm-up consisting of two sets of five submaximal grip strength exercises. The participants were told to do the test for 5 seconds while standing with their elbows fully extended and their shoulders bent 90 degrees (Bonitch-Góngora et al., 2012). The interval between attempts was between 30 and 60 seconds. For further analysis, the average of three handgrip strength attempts was used.

Wrist Circumference Measurement

The cescorf anthropometric tape with 2 meter range and 6 millimeter width was used. The subject assumed a relaxed pose, with the left arm hanging at the body's side. The right elbow was slightly extended, the forearm was supinated, and the hand was relaxed. The measurer stood in front of the subject. It was necessary to use the tape measure to ensure that the minimum circumference was reached, and the tissues were not compressed by excessive tape tension. The measurement was recorded in centimeter (Norton, 2018).



Fig. 2. Cescorf anthropometric tape



Fig. 3. Takei T.K.K.5401 GRIP-D handgrip dynamometer

Interlimb Asymmetry

Interlimb asymmetry was calculated using the equation validated by Bishop et al. (2018)

$$\text{Interlimb asymmetry} = (\text{Max (left or right)} - \text{Min (left or right)}) \div \text{Max (left or right)} \times 100$$

Statistical Analysis

Analyses were conducted using jamovi version 2.3 (2022). Shapiro Wilk normality test was run which indicated no evidence of non-normality in the data set for wrist circumference asymmetry ($W=0.97$, $p=0.91$) and maximal hand grip strength asymmetry ($W=0.89$, $p=0.12$). In case of homogeneity of variances, Levene's test indicated variances of all the groups to be equal ($p=0.27$) for wrist circumference asymmetry. However, variances of the all the groups were unequal for maximal handgrip strength asymmetry ($p=0.02$). Therefore, ANOVA (Fisher's) test was carried out for wrist circumference asymmetry and Welch's test was used for maximal handgrip strength asymmetry. For WC_A and MHGS_A comparison between orthodox and southpaw stance independent t test was employed after verification of normality and homogeneity of the data.

Results

The values of mean, standard deviation and standard error of mean are reported in Table 1. The mean and standard deviation values reported by the researchers for wrist circumference asymmetry in different weight classes was (flyweight: 2.85 ± 1.97 ; bantamweight: 1.29 ± 0.75 ; and featherweight: 2.44 ± 1.23), whereas for maximal handgrip strength asymmetry was (flyweight: 4.91 ± 3.75 ; bantamweight: 7.69 ± 1.89 ; featherweight: 5.80 ± 2.89). The mean and SD values for wrist circumference asymmetry in different stances was (orthodox: 2.39 ± 0.96 ; and southpaw: 2.05 ± 1.78), whereas for maximal handgrip strength asymmetry was (orthodox: 6.92 ± 3.00 and southpaw: 5.57 ± 2.97).

Fisher's one-way ANOVA was used to compare the difference in interlimb wrist circumference asymmetry (WC_A) in three different weight classes. The researchers found that there was no significant difference between flyweight, bantamweight, and featherweight boxers in terms of WC_A; ($F_{(2,9)} = 1.32$, $p = 0.315$). Welch's one-way ANOVA was used to compare the maximal handgrip strength asymmetry (MHGS_A) of boxers in three different weight classes and insignificant difference was obtained; ($F_{(2,5.55)} = 1.05$, $p = 0.410$). From Table 2, it is evident that the t value for WC_A obtained was 0.39, and its associated p value

Table 1. Descriptive Statistics for wrist circumference asymmetry and maximal handgrip strength asymmetry in different stances and weight classes

Variable(s)	Stance	Weight Class	N	Mean	SD	SE
WC_A		Flyweight	4	2.85	1.98	0.98
		Bantamweight	4	1.29	0.76	0.37
		Featherweight	4	2.44	1.23	0.61
	Orthodox		5	2.39	0.96	0.43
	Southpaw		7	2.05	1.78	0.67
MHGS_A		Flyweight	4	4.91	3.75	1.87
		Bantamweight	4	7.69	1.89	0.94
		Featherweight	4	5.80	2.89	1.44
	Orthodox		5	6.92	3.00	1.34
	Southpaw		7	5.57	2.97	1.12

Table 2. One way ANOVA for wrist circumference asymmetry and maximal handgrip strength asymmetry in three different weight classes and two different stances in boxing

Statistical technique	Variable	t	F	MD	SED	df	df1	df2	p
Fisher's ANOVA	WC_A		1.32				2	9	0.32
Welch's ANOVA	MHGS_A		1.05				2	5.55	0.41
Independent t test	WC_A	0.39		0.35	0.88	10			0.71
	MHGS_A	0.77		1.35	1.75	10			0.46

Note. $H_0: \mu_{\text{Orthodox}} = \mu_{\text{Southpaw}}$ Abbreviations: WC_A- wrist circumference asymmetry; MHGS_A- maximal handgrip strength asymmetry; MD- mean difference; SED- standard error difference

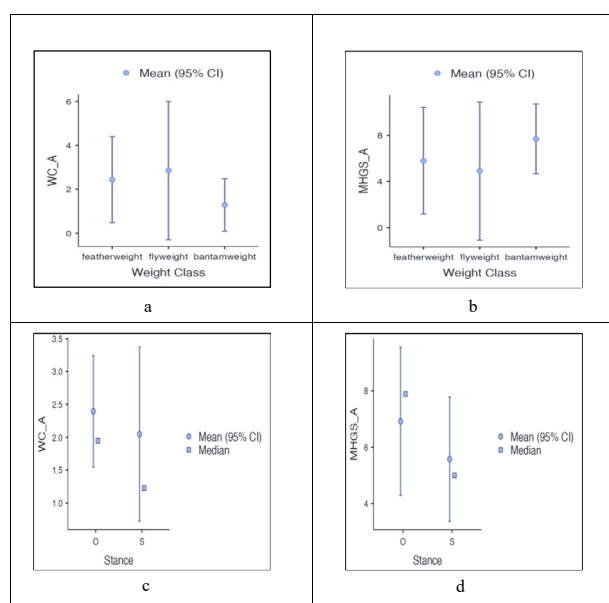


Fig. 4. Mean and median of different weight classes and stances (O: Orthodox; S: Southpaw) for wrist circumference asymmetry (WC_A) and maximal handgrip strength asymmetry (MHGS_A) in elite amateur international boxers.

was 0.71. Since the p value was greater than 0.05, it may be concluded that the null hypothesis was not rejected at the 5% level. Hence, it may be inferred that there was no significant difference between orthodox and southpaw boxers in wrist circumference asymmetry. In the case of MHGS_A, the t value was 0.77 and the corresponding p value was 0.46. Since

the p value was higher than 0.05, there were no statistically significant difference between the two boxing stances in MHGS_A as well.

Discussion

The aim of the study was to compare the interlimb wrist circumference asymmetry and hand grip strength asymmetry in three different weight classes and two different stances in boxing. Results revealed no significant difference in physical attributes (WC_A and MHGS_A) in three different weight classes (flyweight, bantamweight, and featherweight) as well as two different stances (Orthodox and southpaw) in boxing. Different weight classes and stances of boxers may have training adaptations that produce similar asymmetries in wrist size and handgrip strength. Previous studies have demonstrated that regardless of weight class or stance, boxers' handgrip strength significantly increases with training (Ramírez-García et al., 2010). Cronin et al. (2017) and Guidetti et al. (2002) have mentioned a strong positive relationship between handgrip strength and boxing competition ranking. India is ranked third in the latest AIBA world rankings (IBA, 2023) and indian boxers, regardless of their weight classes, are precisely adjusted in terms of physical qualities.

However, mean values for WC_A and MHGS_A were less than 10 percentage in all three weight classes as well as both stances. Previous studies have reported maximal handgrip strength asymmetry of less than 10 percentage in Turkish athletes (Ziyagil et al., 2015), bodybuilders and martial artists (Burdukiewicz et al., 2020b). Asymmetry less than 10 percentage is an indicator of readiness for training and being less prone to injuries (Kyritsis et al., 2016; Rohman et

al., 2015). Inter-limb asymmetries higher than 15 percentage have been linked to higher injury rates in athletes and non-athletes (Grindem et al., 2011; Impellizzeri et al., 2007; Barber et al., 1990). The findings of previous studies were in line with the current study, wrist circumference asymmetry reported by Rogowski et al. (2016) was less than 3 percentage whereas Kannus et al. (1995) reported less than 5 percentage bilateral differences in wrist girth.

Our study demonstrates that stance is not a predictor of asymmetries and when boxers are performing at their highest level, asymmetries do not differ between lighter weight classes. While the present study provides novel insights into interlimb asymmetry, it is equally important to acknowledge the study's limitations. Due to possible differences in fitness level, gender, and playing level, the results cannot be extrapolated to female boxers or boxers competing at lower levels. Second, the study lacked useful lower limb asymmetry parameters, precluding definitive lower limb asymmetry details for international boxers. However, future research on this subject should include the middleweight and heavyweight divisions, female boxers, and lower limb asymmetry parameters at various playing levels.

Conclusion

In conclusion, the results of this study indicate that there were no significant differences in wrist circumference asymmetry (WC_A) and maximal handgrip strength asymmetry (MHGS_A) between orthodox and southpaw stances among elite international male boxers. These findings contribute to our comprehension of interlimb asymmetry in boxers and may be useful for optimising the training and performance of boxers. The maximal handgrip strength asymmetry and wrist circumference asymmetry in elite international boxers were found to be less than 10 percent, and observed non-significant differences in weight classes as well as stances indicate elite amateur international boxers to be less prone to inter-limb asymmetry-related injuries and have favourable conditions for high performance. MHGS_A & WC_A does not depend on boxing stance in elite amateur international boxers. However, additional research is encouraged to investigate other factors that may influence asymmetry in handgrip strength and wrist circumference among boxers and other athletes.

Acknowledgement

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Conflict of Interest

The authors state that no commercial or financial ties that might be considered a possible conflict of interest existed during the conduct of the study.

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АСИМЕТРІЯ КІНЦІВОК ЗА ПОКАЗНИКАМИ МАКСИМАЛЬНОЇ СИЛИ СТИСКАННЯ РУКИ ТА ОБХВАТУ ЗАП'ЯСТКА В ЕЛІТНИХ БОКСЕРІВ-ЧОЛОВІКІВ МІЖНАРОДНОГО КЛАСУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 2 табл., 4 рис., 30 джерел.

Метою дослідження було вивчення асиметрії максимальної сили стискання руки між кінцівками та асиметрії обхвату зап'ястка в любительському боксі в трьох вагових категоріях і двох різних стійках.

Матеріали та методи. Вибірка дослідження складалася з 12 (найлегша вага: 4; легка вага: 4; напівлегка вага: 4) елітних міжнародних боксерів-любителів з Індії. Обидві кінцівки тестували на максимальну силу стискання руки та обхват зап'ястка. Для обох тестів асиметрію між кінцівками розраховували за допомогою рівняння асиметрії між кінцівками, валідність якого підтверджена в дослідженні Bishop et al. (2018). Для порівняння асиметрій у трьох різних вагових категоріях використовували однофакторний дисперсійний аналіз, а для порівняння асиметрій у двох різних боксерських стійках використовували t-критерій Стюдента для незалежних вибірок.

Результати. Середня асиметрія обхвату зап'ястка в різних вагових категоріях становила $2,85 \pm 1,97$ для найлегшої ваги, $1,29 \pm 0,75$ для легкої ваги та $2,44 \pm 1,23$ для напівлегкої ваги, тоді як середня асиметрія максимальної сили стискання руки становила $4,91 \pm 3,75$ для найлегшої ваги, $7,69 \pm 1,89$ для легкої ваги та $5,80 \pm 2,89$ для напівлегкої ваги. Були одержані незначущі відмінності в асиметрії між кінцівками для показників обхвату зап'ястка та максимальної сили стискання руки в трьох різних вагових категоріях і двох різних стійках ($p > 0,05$).

Висновки. Асиметрія максимальної сили стискання руки та асиметрія обхвату зап'ястка в елітних міжнародних боксерів виявилася меншою за 10 відсотків, а спостережувані незначущі відмінності у вагових категоріях, а також у стійках вказують на те, що елітні міжнародні боксери-любителі менше схильні до травм, пов'язаних з асиметрією кінцівок, і мають сприятливі умови для високої результативності.

Ключові слова: найлегша вага, легка вага, напівлегка вага, боксер-лівша, боксер-правша, бокс.

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