

KINESIOLOGY & COACHING

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Handgrip strength laterality of young Kendo athletes in the developmental period

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Key words: asymmetry, bamboo sword, combat sports, grip strength, growth

Abstract

Background and Aim. Handgrip strength asymmetry and weakness are associated with future morbidity and functional disabilities. However, the impact of environmental factors on handgrip strength asymmetry is poorly understood. In Kendo, the left hand is believed to have a stronger grip on the bamboo sword than the right. Thus, we examined the association between handgrip strength laterality and the Kendo experience in young Kendo athletes.

Material and Methods. A total of 159 right-handed young Kendo athletes (106 males and 53 females) between 6.0 and 15.2 years old participated in this study. Handgrip strength was measured using a dynamometer, and the value of the right and left hands was used for data analysis. Sports experience was determined when they started practicing Kendo in a dojo. Handgrip strength was compared between the hands and sex. Within-subject moderation was used to test whether any possible difference depended upon experience level and age.

Results. Right-handed Kendo athletes had significantly greater ($t = 2.87, p = 0.005$) handgrip strength in the right hand than the left hand [mean difference of 0.52 (95% CI: 0.16, 0.88) kg]. There was no hand*experience ($t = -0.93, p = 0.35$) or hand*age ($t = -0.41, p = 0.68$) interaction with handgrip strength.

Conclusions. The difference in handgrip strength did not depend upon experience level in right-handed young Kendo athletes. These results suggest that even though the use of the left hand is higher than the right hand in Kendo practice, it may not specifically lead to greater handgrip strength of the left hand.

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Introduction

The difference in handgrip strength between hands (asymmetry) is associated with several health conditions [McGrath *et al.* 2021; Parker *et al.* 2021; Klawitter *et al.* 2022]. For example, handgrip strength asymmetry (>10% difference between hands) and weakness (<26 kg for men and <16 kg for women) together are associated with future morbidity and functional disabilities in middle-aged and older (>50 years old) Americans [McGrath *et al.* 2021; Klawitter *et al.* 2022]. In general, handgrip strength asymmetry was higher in older than middle-aged adults [McGrath *et al.* 2023], and it was influenced by environmental factors such as playing music and sports [Bardo *et al.* 2021]. However, despite several tracking studies [Abe T *et al.* 2022; Fraser *et al.* 2023], the impact of environmental factors on handgrip strength asymmetry needs to be better understood.

Kendo is a traditional Japanese martial art that involves fighting with bamboo swords. Typically, striking and defending movements with a bamboo sword are repeated in children, adolescents, and adults during a Kendo practice of approximately two hours. A study examined the magnitude of the gripping force of a bamboo sword during Kendo practice [Hayashi *et al.* 1981]. The researchers attached strain gauges to the grip of the bamboo sword and measured the grip strength of four fingers, excluding the thumb. Usually, the Kendo athlete grips the bamboo sword anteriorly with their right hand and posteriorly with their left hand, and the tip of the grip of a bamboo sword is located at the left palm. As highlighted by Hayashi and colleagues [Hayashi *et al.* 1981], the gripping strength generated during the main striking motion of Kendo was higher in the left hand than in the right hand. They also reported that the peak values during those motions were comparable to the maximum values during handgrip strength measurement, although there were differences between fingers. It can be inferred from these results that the training adaptation of gripping the left hand may be higher than that of the right hand during Kendo practice. In general, in sports where athletes do not hold equipment in their hands during practice or competition, the handgrip strength of the one (dominant or right) hand of youth athletes is higher than that of the other (non-dominant or left) hand [Ivanovic, Dopsaj 2012; Wasik *et al.* 2022; Parpa *et al.* 2022; Tavares Junior *et al.* 2023]. However, we hypothesized that the handgrip strength of the left hand would be higher in Kendo athletes than the right hand due to their proportion to the practical experience of Kendo. This study examined the association between handgrip strength laterality and Kendo experience in young Kendo athletes.

Methods

Participants

A total sample of 171 young Kendo athletes (115 boys and 56 girls) were recruited from the Fukuoka City area with the cooperation of their parents and coaches. The inclusion criteria were to be between 6.0 and 15.2 years of age and provide written consent from the parents/legal guardians. The exclusion criteria were athletes who could not use their arms due to an injury and less than six months after starting Kendo practice at the beginning of this study. Out of the 171 young Kendo athletes, 12 used their left hand or mixed hands to eat and write (9 boys and three girls). This study targeted right-handed Kendo athletes, so the participants were 106 males and 53 females (Table 1). All athletes and their parents were fully informed about the purpose of the research and its safety, and written informed consent was obtained from the parents of each athlete. Data collection was conducted in the evening (17:00-19:00) at a Kendo training facility for each athlete. This study received approval from the University's Institutional Review Board (HSS #29-17 & amendment #2021-82; SG #2021-2-2) and was conducted according to the World Medical Association Declaration of Helsinki.

Table 1. Anthropometrical variable, kendo experience, and handgrip strength in young kendo athletes.

Variables	Age 6-10		Age 11-15		Overall	
	Boys	Girls	Boys	Girls	Boys	Girls
N	53	26	53	27	106	53
Age (year)	9.1 (1.3)	8.5 (1.6)	13.0 (1.1)	12.8 (1.2)	11.1 (2.3)	10.7 (2.6)
Height (cm)	130.6 (10.3)	127.7 (12.0)	156.5 (12.1)	154.0 (7.6)	143.6 (17.1)	141.1 (16.6)
Body mass (kg)	30.1 (7.3)	28.8 (7.2)	48.1 (10.9)	45.3 (8.2)	39.1 (12.9)	37.2 (11.3)
Body mass index (kg/m ²)	17.4 (2.2)	17.4 (2.3)	19.3 (2.3)	18.9 (2.2)	18.4 (2.5)	18.2 (2.3)
Handgrip strength right (kg)	17.3 (4.6)	16.0 (5.1)	32.5 (9.5)	27.6 (5.7)	24.9 (10.7)	21.9 (7.9)
Handgrip strength left (kg)	16.8 (4.9)	15.3 (4.8)	32.1 (9.1)	27.1 (5.3)	24.4 (10.6)	21.3 (7.8)
Difference (right minus left, kg)	0.5 (2.0)	0.7 (1.8)	0.5 (3.0)	0.5 (2.0)	0.5 (2.5)	0.6 (1.9)
Kendo experience (year)	2.2 (1.3)	2.3 (1.4)	5.6 (2.7)	4.5 (2.4)	3.9 (2.7)	3.4 (2.2)

Values are expressed by mean and standard deviation (in parentheses).

Anthropometric measurements

Standing height and body mass were measured to the nearest 0.1 cm and 0.1 kg, respectively, by using a height scale and an electronic weight scale (WB-260A, TANITA Co., Ltd., Tokyo, Japan) prior to the handgrip strength measurements. Body mass index was calculated as the body mass divided by height square (in kilograms per square meter). The forearm circumference of the right

and left arms was measured at the widest part of the forearm using a tape measure. Hand length was measured as the linear distance between the distal wrist crease and the tip of the middle finger.

Handgrip strength measurements

Maximum voluntary handgrip strength was measured with the right and left hands using a Smedley handgrip dynamometer (Takei Kiki Kogyo Co., Ltd., Grip-D, Niigata, Japan). The distance of the dynamometer grip bars (grip span) was adjusted to the hand size of the athletes (about 30% of hand length). Each athlete held a handgrip dynamometer to check whether the grip span was appropriate before measurement and fine-tuned if desired. All athletes were instructed to maintain an upright standing position and keep their arms at their sides. After checking the grip span, the athlete held the dynamometer in their hand with the elbow extended downward without squeezing. Athletes were allowed to perform two maximal trials with a one-minute break for the right and left hands (alternating right and left). All the athletes appeared motivated during the strength tests [Abe *et al.* 2022]. This judgment was assessed by the participant's comprehension of the instructions, rapid gripping movement of the dynamometer, and facial expressions during maximum effort. The highest value was used for data analysis.

Kendo practice history

Kendo athletes generally belong to a *dojo* (school) and practice. We asked each athlete how old (or what grade, kindergarten, or elementary school) they were when they started practicing Kendo in a *dojo*. Parents were consulted if necessary for children.

Statistical analysis

We used a paired sample t-test to determine if handgrip strength differed between the right (dominant) and left (non-dominant) hands and an independent sample t-test to determine if this difference depended upon sex. We also performed within-subject moderation to test whether any possible difference depended upon experience level (in years) and a separate model tested whether it depended upon age (in years). Moderation was performed using the MEMORE macro. All statistical analysis was performed using SPSS version 27. Statistical significance was set at $p \leq 0.05$.

Results

Handgrip strength between hands

There was a statistical difference in handgrip strength with the right hand being significantly greater ($t=2.87$, $p=0.005$) than the left hand [mean difference of 0.52 (95% CI: 0.16, 0.88) kg]. If normality was not assumed,

there was still a statistical difference (Wilcoxon $Z=2.92$, $p=0.003$). This difference did not depend upon sex [boys: 0.49 SD 2.5 kg; girls: 0.59 SD 1.8 kg; $p=0.791$]. If normality was not assumed, there was still no evidence of a statistical difference (Mann-Whitney $p=0.97$). There was no statistical evidence that the homogeneity of variance assumption was violated (Brown-Forsythe $p=0.13$).

Does experience moderate the difference in strength?

There was no hand*experience ($t = -0.93$, $p=0.35$) or hand*age ($t = -0.41$, $p=0.68$) interaction with handgrip strength. In other words, the difference in handgrip strength did not depend upon the number of years the athlete participated in Kendo or the age of the child. There were, however, conditional effects of the moderators on the strength of each hand. In the right hand, every 1-year difference in experience is related to a 2.8 (95% CI: 2.39, 3.2) kg difference in handgrip strength ($t = 13.06$, $p < 0.001$) and every 1-year difference in age is related to a 3.3 (95% CI: 3.01, 3.75) kg difference in handgrip strength ($t=18.18$, $p < 0.001$). In the left hand, every 1-year difference in experience is related to a 2.89 (95% CI: 2.48, 3.30) kg difference in handgrip strength ($t=13.92$, $p < 0.001$) and every 1-year difference in age is related to a 3.4 (95% CI: 3.06, 3.76) kg difference in handgrip strength ($t=19.07$, $p < 0.001$).

Discussion

In this study, we tested the association of handgrip strength laterality with Kendo's practical experience in right-handed young Kendo athletes. Our results revealed that the right hand was significantly stronger than the left hand (0.5 kg difference). Further, we found no evidence that the difference in handgrip strength between the right and left hands was related to Kendo's practical experience or age. Table 1 shows the strength values separated by two different age categories. This is for descriptive purposes, our statistical analysis treated age as a continuous variable.

It is known that the handgrip strength of the dominant hand is, on average, approximately 10% stronger than that of the non-dominant hand [Petersen *et al.* 1989; Armstrong *et al.* 1999; Abe, Loenneke 2015], although there are also studies that do not support this phenomenon [Bechtol 1954; Jarjour *et al.* 1997]. This difference in handgrip strength between the dominant and non-dominant hands has also been observed in young athletes. For example, Ivanovic J, Dopsaj M [2012] measured the handgrip strength of the dominant and non-dominant hands of 275 female youth athletes. They reported that the difference in handgrip strength between the dominant and non-dominant hands was large in events such as handball (13%), synchronized swimming (13%), and karate (11%) and

that the handgrip strength of the dominant hand was approximately 10% higher than that of the non-dominant hand when used an overall sample of the athletes. In contrast, it has been reported that the difference in handgrip strength between the hands of athletes in their mid-teens is smaller than that of youth athletes, at approximately 5% [Parpa *et al.* 2022; Wasik *et al.* 2022; Tavares Junior *et al.* 2023]. In the present study, handgrip strength in right-handed Kendo athletes was greater in the right hand than the left hand. However, this difference was relatively small (within a 2% difference). As mentioned above, the gripping strength generated during the main striking motion of Kendo is higher in the left hand than in the right hand during practice [Hayashi *et al.* 1981]. In daily life, where the right hand is dominant, there is a possibility that the handgrip strength of the right hand becomes stronger. We speculate that the strong grip of the bamboo sword in the left hand during Kendo practice might serve as a stimulus to minimize the difference between the left and right hands. Young athletes are expected to use a bamboo sword appropriate for their age to perform quick movements, so they are expected to have a firm grip on it during their practice. Future studies need to experiment with young Kendo athletes' ability to grip the bamboo sword during Kendo practice. It is also worth comparing this to sports that do not require holding equipment to understand better what might explain differences (or lack thereof).

In conclusion, contrary to our hypothesis, we did not observe the association between the difference in handgrip strength between the right and left hands and the Kendo practical experience in right-handed young Kendo athletes. These results suggest that even though the use of the left hand is higher than the right hand in Kendo practice, it may not specifically lead to greater handgrip strength of the left hand.

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Conflicts of Interest

The authors have no conflicts of interest directly relevant to the content of this article.

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Lateralność siły chwytu dłoni młodych zawodników Kendo w okresie rozwojowym

Słowa kluczowe: asymetria, miecz bambusowy, sporty walki, siła chwytu, wzrost

Streszczenie

Tło i cel. Asymetria i osłabienie siły chwytu dłoni są powiązane z przyszlą zachorowalnością i niepełnosprawnością funkcjonalną. Jednakże wpływ czynników środowiskowych na asymetrię siły chwytu dłoni jest słabo poznany. W Kendo uważa się, że lewa ręka mocniej trzyma bambusowy miecz niż prawa. W związku z tym autorzy pracy zbadali związek między lateralnością siły chwytu dłoni a doświadczeniem młodych zawodników Kendo. Materiał i metody. W badaniu wzięło udział łącznie 159 praworęcznych młodych zawodników Kendo (106 mężczyzn i 53 kobiety) w wieku od 6,0 do 15,2 lat. Siłę chwytu dłoni mierzono za pomocą dynamometru, a do analizy danych wykorzystano wartość siły prawej i lewej ręki. Doświadczenie sportowe zostało określone, gdy zaczęli ćwiczyć Kendo w *dojo*. Porównano siłę chwytu dłoni w odniesieniu do płci. Do sprawdzenia, czy jakakolwiek możliwa różnica zależy od poziomu doświadczenia i wieku, zastosowano moderację wewnątrzsobniczą. Wyniki. Praworęczni zawodnicy Kendo mieli istotnie większą ($t=2,87$, $p=0,005$) siłę chwytu ręki prawej niż lewej [średnia różnica 0,52 (95% CI: 0,16, 0,88) kg]. Nie stwierdzono interakcji ręka*doświadczenie ($t=-0,93$, $p=0,35$) ani ręka*wiek ($t=-0,41$, $p=0,68$) z siłą chwytu dłoni.

Wnioski. Różnica w sile chwytu dłoni nie zależała od poziomu doświadczenia młodych praworęcznych zawodników Kendo. Wyniki te sugerują, że chociaż w praktyce Kendo częściej używa się lewej ręki niż prawej, nie musi to konkretnie prowadzić do większej siły chwytu lewej ręki.