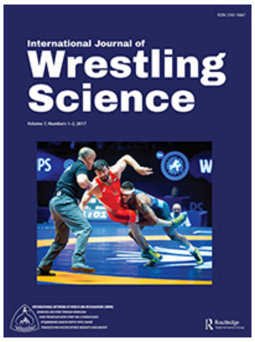

International Journal of Wrestling Science

ISSN: 2161-5667 (Print) 2161-3524 (Online) Journal homepage: http://www.tandfonline.com/loi/uijw20

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To cite this article: Daichi Yamashita, Hiroshi Arakawa, Takuma Arimitsu, Takahiro Wada, Kenichi Yumoto, Kotaro Fujiyama, Tomoyuki Nagami & Seshito Shimizu (2017) Physiological Profiles of International- and Collegiate-Level Japanese Male Freestyle Wrestlers in the Lightweight Classes, International Journal of Wrestling Science, 7:1-2, 21-25, DOI: 10.1080/21615667.2017.1341572

To link to this article: https://doi.org/10.1080/21615667.2017.1341572

Published online: 13 Mar 2018.

INTERNATIONAL JOURNAL OF WRESTLING SCIENCE, 7: 21–25, 2017

ISSN: 2161-5667 print / 2161-3524 online
DOI: https://doi.org/10.1080/21615667.2017.1341572

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Physiological Profiles of International- and Collegiate-Level Japanese Male Freestyle Wrestlers in the Lightweight Classes

Daichi Yamashita,[1] Hiroshi Arakawa,[2] Takuma Arimitsu,[3] Takahiro Wada,[4] Kenichi Yumoto,[5] Kotaro Fujiyama,[6] Tomoyuki Nagami,[7] and Seshito Shimizu[8]

ABSTRACT. The purpose of this study was to clarify the physiological abilities of international-level male wrestlers compared with those of collegiate-level wrestlers. Twenty Japanese male freestyle wrestlers in the lightweight classes were categorized into two groups. The first group comprised 11 international-level wrestlers. The second group comprised 9 collegiate-level wrestlers. Body composition was assessed by a multifrequency bioimpedance-analysis device. Isokinetic concentric knee and hip extension and flexion torque were measured using an isokinetic dynamometer at 180 and 60 deg/sec. Anthropometric data were obtained through three-dimensional scanning. Eleven circumferences (neck, both upper arms, both forearms, both thighs, both lower legs, chest, and hip) and four lengths (both arms and both legs) were computed. Simple reaction time was evaluated using an electronic device. Between-group comparisons of these variables were performed with unpaired *t* tests or Welch's tests. There were no differences in body composition, circumferences, and limb length between groups, other than chest circumference ($p < .05$). There were no differences in hip and knee strength and simple reaction time between groups. These results suggest that chest circumference is important for becoming an international-level wrestler. Additionally, other aspects, such as multijoint motor and technical skills, may be important for international-level wrestlers.

Keywords: wrestling, body composition, isokinetic strength, reaction time

INTRODUCTION

Wrestling is a combat sport that involves repetitive bouts of high-intensity action in 6 minutes (two 3-minute rounds with a 30-second rest between rounds). Wrestlers are categorized into a series of weight classes in order to promote fair competition. Therefore, wrestlers require high levels of strength, endurance, and perceptual performance. They generally choose the lightest weight category possible and try to maximize their fat-free mass and to minimize their body fat and total body weight.

Researchers have focused on optimizing talent selection for wrestling to maximize the potential for success in future Olympic Games. A study of the Olympic Games in 2004 showed that age at the onset of wrestling as a main sport was quite early (11.2 years old; Vaeyens, Gullich, Warr, & Philippaerts, 2009), so adolescent wrestlers undergo wrestling-specific changes in their physical qualities. Gerodimos et al. (2013) found that young wrestlers adopted wrestling-specific changes in handgrip strength during the developmental years. Garcia-Pallares, Lopez-Gullon, Muriel, Diaz, and Izquierdo (2011) compared physical fitness between elite and nonelite youth wrestlers and found that maximum strength, muscle power, and anaerobic power were important in the elite youth wrestlers. Some studies have suggested that dynamic strength in the lower limbs is a key factor for elite adolescent wrestlers. Wrestlers need to produce explosive hip and knee power to take an opponent down. A previous study

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showed that high-school wrestlers showed greater isokinetic peak torque at the knee with age (Housh et al., 1989; Weir, Housh, Johnson, Housh, & Ebersole, 1999). High-level high-school wrestlers have greater isokinetic knee strength than their average-level counterparts do (Cisar et al., 1987). In contrast, such findings related to physical aspects in elite male wrestlers postadolescence have been limited.

For experienced wrestlers, perceptual abilities seem to become more important with age because their training experience is longer, and more complex technical skills seem to be needed. Among these abilities, fast reactions enable wrestlers to fight more effectively by implementing adequate technical and tactical actions as well as allowing them to anticipate any complex moves by their opponent. Elite wrestlers with shorter simple reaction times have been shown to perform more technical and tactical actions during a match (Gierczuk, Lyakh, Sadowski, & Bujak, 2017). On the other hand, another study reported that there were no correlations between reaction time and win–loss record in college wrestlers (Whitley & Montano, 1992), so findings related to perceptual abilities and reaction time remain controversial.

Japan is one of the leading nations for men's freestyle wrestling in the lightweight category. Seven lightweight wrestlers participated in the previous three Olympic games (the 55-, 60-, and 66-kg categories in the Beijing and London games and the 57-kg category in the Rio de Janeiro Olympic games) and won one gold medal, three silver medals, and one bronze medal. Understanding the physiological factors of international-level wrestlers could help determine an optimal skill- and physical-training plan. The purpose of this study was to clarify the physiological abilities of elite male wrestlers compared to those of nonelite wrestlers.

METHODS

Participants

Twenty Japanese male freestyle wrestlers with no history of recent lower-limb injury or neuromuscular disorders in the lightweight classes (former 55, 60, or 66 kg) were categorized into two groups. Eleven wrestlers (mean age: 23.9 ± 3.8 years; height: 166.2 ± 3.0 cm; body weight: 67.5 ± 4.4 kg) performed at the international level, including three medalists from the 2008 Beijing and 2012 London Olympic Games. Nine wrestlers (mean age: 19.6 ± 1.0 years; height: 168.9 ± 2.6 cm; weight: 66.8 ± 3.4 kg) belonged to Division 1 collegiate wrestling teams in Japan. They provided written informed consent to undergo experimental procedures. This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of our institute.

Data Analysis

This study was carried out in January and February 2015, one to two months after a national championship that occurred in late December 2014. None of these wrestlers was involved in a weight-cutting approach or had restricted water or food intakes.

Standing height was measured using a stadiometer (DC-250, Tanita, Tokyo, Japan). Body composition was assessed by a multifrequency bioimpedance-analysis device with eight-point contact electrodes using a commercially available apparatus (InBody 730, InBody Japan Inc., Tokyo, Japan).

Anthropometric data were obtained by means of a three-dimensional scanning method (Body line Scanner; BLS, Hamamatsu Photonics KK, Shizuoka, Japan). Eleven circumferences (neck, both upper arms, both forearms, both thighs, both lower legs, chest, and hip) and four lengths (both arms and both legs) were computed. The reference locations were the same as those used in a previous study (Arakawa, Yamashita, Arimitsu, Sakae, & Shimizu, 2015). Absolute and relative (normalized by their body height) values were evaluated.

Isokinetic concentric extension and flexion torque of the knee and hip were measured using an isokinetic dynamometer at angular velocities of 60 and 180 deg/sec (System 4, Biodex medical Systems, New York, USA). Peak torque through the range of motion was evaluated. Each participant performed three and two maximal effort reciprocal repetitions at 180 deg/sec and 60 deg/sec tasks, respectively. Relative (normalized by their body weight) values were evaluated.

Whole-body simple reaction time was recorded in five trials using a reaction-time-measurement system (YB-1000, Yagami, Nagoya, Japan). Participants stood still with their knees slightly bent on a sensory mat in front of the apparatus and lifted off their feet as soon as the red LED light was lit. To exclude outliers, the best and worst trials were removed, and the averages of three out of five trials were used for the analysis.

Statistical Analysis

Statistical analyses were carried out using EXCEL 2013 (Microsoft, Washington, DC, USA). The Kolmogorov-Smirnov test was employed to assess the normality of the data distribution. F tests were used to determine whether these variances between two groups were equal. When the variances between the two groups were equal, unpaired t tests were performed and effect sizes (Cohen's d) were calculated. Otherwise, Welch's tests were performed. The alpha level was set at .05.

RESULTS

There were no differences in physical attributes and body composition between the two groups (see Tables 1 and 2).

TABLE 1 Body Composition Profiles of International- and Collegiate-Level Wrestlers

	International (n = 11)	Collegiate (n = 9)	Effect Size Cohen's d
Height (cm)	166.2 ± 3.0	168.9 ± 2.6	0.91
Weight (kg)	67.5 ± 4.4	66.8 ± 3.8	0.17
%Body Fat (%)	13.4 ± 2.4	12.1 ± 3.3	0.43
Fat Free Mass (kg)	58.4 ± 3.5	58.6 ± 3.4	0.06

Note. When variances between two groups were equal, unpaired *t*-tests were performed and effect sizes (Cohen's d) were calculated. Otherwise, Welch's tests were performed.

$^*p < .05$.

TABLE 2 Absolute and Relative Limb Lengths of International- and Collegiate-Level Wrestlers

			International (n = 11)	Collegiate (n = 9)	Effect Size Cohen's d
Absolute Value (cm)					
	Arm	R	70.6 ± 2.7	72.1 ± 1.7	0.66
		L	69.9 ± 2.6	71.9 ± 1.8	0.85
	Leg	R	82.7 ± 1.9	83.7 ± 1.8	-
		L	82.6 ± 1.9	83.7 ± 1.6	-
Relative Value					
	Arm	R	0.425 ± 0.013	0.427 ± 0.011	0.20
		L	0.421 ± 0.012	0.426 ± 0.012	0.42
	Leg	R	0.497 ± 0.007	0.496 ± 0.009	0.19
		L	0.497 ± 0.007	0.496 ± 0.008	0.21

Note. When variances between two groups were equal, unpaired *t*-tests were performed and effect sizes (Cohen's d) were calculated. Otherwise, Welch's tests were performed. R = right; L = left.

$^*p < .05$.

The absolute and relative values for chest circumference in international-level wrestlers were significantly greater than those of collegiate wrestlers ($p < .05$) (see Table 3). There were no differences in isokinetic strength (see Table 4) and whole-body simple reaction time (see Table 5) between the two groups.

DISCUSSION

The purpose of this study was to clarify the physiological abilities of elite male wrestlers compared to those of nonelite wrestlers. First, we confirmed that there were no differences in height and weight between the two groups (see Table 1). Therefore, the comparison of these groups was reasonable for determining factors related to elite-level wrestlers.

There were no differences in the percentage of body fat, fat-free mass, and limb lengths between international- and collegiate-level wrestlers (see Tables 1 and 2). These results support the findings of a previous study that compared Japanese senior elite and junior elite wrestlers in the lightweight categories (Arakawa, Yamashita, Arimitsu, Sato, et al., 2015). In contrast to the previous study, upper-arm and forearm circumferences did not differ between the two groups in our study (see Table 3). This result may be because of differences in the populations of the control groups. In the previous study, the control group consisted of wrestlers in junior age categories, and the fat-free mass was smaller in the junior elite group than that in the senior elite group. However, in the current study, the control group consisted of collegiate-level wrestlers, and there were no differences in the fat-free mass between groups (see Table 1). Instead, our results suggested that chest circumference, which was not reported in the study by Arakawa, Yamashita, Arimitsu, Sato et al. (2015), was the key factor differentiating international-level wrestlers from nonelite wrestlers in the lightweight categories. A greater chest circumference indicates greater chest and back muscle volumes. Changes in chest circumferences are also consistent with training-induced adaptations (Waldron, Worsfold, Twist, & Lamb, 2014). Chest circumference is also related to chest press strength (Reynolds & Day, 2005). A previous study reported that elite senior Greco-Roman wrestlers performed better in pull-up repetition tests and 30-second Wingate arm crank peak power tests than did nonelite wrestlers (Nikooie, Cheraghi, & Mohamadipour, 2017). Callan et al. (2000) also evaluated upper-body power using rope climbing and the Wingate arm crank test for the US freestyle world team. Physical characteristics of the upper body seem to be of benefit for catching and pulling the opponent's legs during leg attacks. Therefore, our results strongly suggest that upper-body muscle strength is the factor differentiating international-level wrestlers from nonelite wrestlers.

There were no differences in isokinetic peak torque at the knee and hip between groups (see Table 4). This result did not support that of a previous study of adolescent wrestlers. High-level high-school wrestlers showed greater isokinetic knee extension and flexion torque than did their average-level counterparts (Cisar et al., 1987). Housh et al. (1989) performed the same isokinetic measurement that was used in the current study for high-school wrestlers (means: 17.6 years old, 171.1 cm in height, and 68.7 kg in weight) and reported results of 1.72 and 1.06 Nm/kg for knee extension and flexion of 180 deg/sec, respectively. Compared to their results, the current results from collegiate wrestlers seem to be superior (2.08 and 1.19 Nm/kg in right-knee extension and flexion, respectively), even though their percentage of body fat was similar (10.6 ± 0.5% and 12.1 ± 3.3% in the high-school wrestlers and the current collegiate wrestlers, respectively). It remains doubtful whether dynamic lower-limb strength is truly unimportant for international success. Further study is needed to investigate muscle strength in elite senior wrestlers.

There were no differences in simple reaction times between groups (see Table 5). This result supports those of

TABLE 3 Absolute and Relative Circumferences of International- and Collegiate-Level Wrestlers

			International (n = 11)	Collegiate (n = 9)	Effect Size Cohen's d
Absolute Value (cm)					
	Neck		40.0 ± 1.5	39.3 ± 2.2	0.34
	Chest		97.7 ± 4.1*	93.7 ± 2.6	1.11
	Hip		92.1 ± 2.4	90.9 ± 3.2	0.42
	Upper Arm	R	30.0 ± 1.3	29.9 ± 1.5	0.07
		L	30.5 ± 1.3	30.2 ± 1.5	0.26
	Fore Arm	R	25.7 ± 1.0	26.0 ± 1.2	0.31
		L	26.2 ± 1.0	26.1 ± 1.0	0.02
	Thigh	R	51.9 ± 1.8	52.0 ± 2.0	0.44
		L	51.9 ± 1.7	51.2 ± 2.1	0.33
	Lower Leg	R	35.7 ± 1.1	35.6 ± 1.4	0.08
		L	35.9 ± 1.1	36.0 ± 1.6	0.06
Relative Value					
	Neck		0.241 ± 0.009	0.233 ± 0.015	0.58
	Chest		0.588 ± 0.027*	0.555 ± 0.022	1.28
	Hip		0.555 ± 0.015	0.538 ± 0.024	0.76
	Upper Arm	R	0.181 ± 0.009	0.177 ± 0.011	0.33
		L	0.184 ± 0.008	0.179 ± 0.011	0.52
	Fore Arm	R	0.154 ± 0.006	0.154 ± 0.009	0.04
		L	0.157 ± 0.007	0.155 ± 0.007	0.35
	Thigh	R	0.312 ± 0.011	0.302 ± 0.014	0.75
		L	0.312 ± 0.011	0.303 ± 0.015	0.65
	Lower Leg	R	0.215 ± 0.008	0.211 ± 0.010	0.42
		L	0.216 ± 0.008	0.213 ± 0.011	0.30

Note. When variances between two groups were equal, unpaired *t*-tests were performed and effect sizes (Cohen's d) was calculated. Otherwise, Welch's tests were performed. R = right; L = left.

*$p < .05$.

TABLE 4 Isokinetic Concentric Peak Torque of International- and Collegiate-Level Wrestlers

Peak torque (Nm/kg)		International (n = 11)	Collegiate (n = 9)	Effect Size Cohen's d
Knee				
Extension (60 deg/s)	R	3.02 ± 0.30	2.86 ± 0.30	0.46
	L	3.12 ± 0.36	2.96 ± 0.35	0.43
Flexion (60 deg/s)	R	1.69 ± 0.15	1.63 ± 0.16	0.37
	L	1.64 ± 0.17	1.16 ± 0.16	0.16
Extension (180 deg/s)	R	2.15 ± 0.24	2.08 ± 0.19	0.24
	L	2.15 ± 0.27	2.13 ± 0.20	0.09
Flexion (180 deg/s)	R	1.29 ± 0.15	1.19 ± 0.14	0.60
	L	1.25 ± 0.13	1.19 ± 0.15	-
Hip				
Extension (60 deg/s)	R	3.85 ± 0.60	3.93 ± 0.62	0.13
	L	3.88 ± 0.59	3.67 ± 0.68	0.35
Flexion (60 deg/s)	R	2.26 ± 0.26	2.36 ± 0.27	0.38
	L	2.31 ± 0.31	2.33 ± 0.34	0.05
Extension (180 deg/s)	R	2.87 ± 0.62	3.08 ± 0.68	0.33
	L	2.90 ± 0.60	3.06 ± 0.65	0.25
Flexion (180 deg/s)	R	1.76 ± 0.24	1.90 ± 0.28	0.45
	L	1.80 ± 0.30	1.86 ± 0.34	0.19

Note. When variances between two groups were equal, unpaired *t*-tests were performed and effect sizes (Cohen's d) was calculated. Otherwise, Welch's tests were performed. R = right; L = left.

*$p < .05$.

TABLE 5 Whole-Body Simple Reaction Time of International- and Collegiate-Level Wrestlers

	International (n = 11)	Collegiate (n = 9)	Effect Size Cohen's d
Reaction time (ms)	292.3 ± 58.0	287.7 ± 22.5	-

Note. When variances between two groups were equal, unpaired *t*-tests were performed and effect sizes (Cohen's d) was calculated. Otherwise, Welch's tests were performed.

*$p < .05$.

previous studies in which there was no correlation between reaction time and win–loss record in college wrestlers (Whitley & Montano, 1992) and in which there was no significant difference in simple reaction times between karate athletes and novices (Mori, Ohtani, & Imanaka, 2002). These findings suggest that other perceptual abilities might be important, such as anticipation and specific movement times. However, it is interesting to note that there was large interparticipant variability even in medalists' reaction time. For example, one medalist had the best reaction time (203 ms) out of 20 participants, but the other two medalists had the fifth highest (270 ms) and the worst (395 ms) reaction times. These medalists may have different preferred wrestling strategies; for example, a medalist with a fast reaction time may prefer defensive strategies because he can react quickly against an opponent's attack. Indeed, technical–tactical analyses of men's freestyle wrestling have revealed that world champions use different techniques as their individual winning strategies (Tünnemann, 2016).

In conclusion, this study compared the physiological abilities of international-level male wrestlers to those of wrestlers with a collegiate skill level but similar body compositions. Chest circumference was shown to be one of the key factors differentiating international-level wrestlers in the lightweight categories. Such findings related to physical aspects of elite male wrestlers postadolescence have been limited. Many researchers and strength coaches have introduced wrestling-specific training programs based on these previous findings (Kraemer, Vescovi, & Dixon, 2004; Murlasits, 2004). Further study is needed to determine the key to international success for wrestlers and to prescribe optimal training programs.

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