

研究資料

Prevalence, methods of rapid weight loss amongst elite Japanese wrestlers:  
a questionnaire-based study of the 2016 Japanese Wrestling Championship  
エリート日本人レスリング選手を対象とした減量に関するアンケート調査報告

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**Abstract :** This study aims to investigate weight loss practices of elite Japanese wrestlers who participated at the 2016 Japanese Wrestling Championship. In this study, we defined rapid weight loss (RWL) as losing 5% or more of their weight relative to their intended weight class, one week before weigh-in. 241 wrestlers completed a questionnaire on their weight loss practices. 109 wrestlers reported RWL and were used for analysis. We found that wrestlers who cut weight over a longer duration utilized a greater variety of weight loss methods than those who cut weight over a shorter duration. Reduced carbohydrate intake was commonly used by wrestlers who cut weight over a longer duration, while reduced meal frequency and fluid intake was commonly used by wrestlers to cut weight over a shorter duration. Dehydration was commonly done by all wrestlers. We also identified that the use of low carbohydrate and low salt diets are not optimized for RWL, and suggest for wrestlers to be educated to improve the effectiveness of these methods. Studies to investigate the revision of the weigh-in rules are recommended to better understand the implications of these changes on RWL and recovery practices in wrestlers.

Key words : rapid weight loss, wrestling, dehydration, weight class, weight loss methods  
キーワード : 急速減量, レスリング, 脱水, 階級, 減量方法

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受付日 : 2019 年 10 月 3 日

受理日 : 2020 年 2 月 13 日

## I. Introduction

Wrestling is a sport wherein opponents are matched based on their weight class. Competitors are divided into weight classes to reduce inequality in muscle strength and power. However, it is common practice for wrestlers to lose weight in a relatively short time before the weigh-in to attain physical advantage over their opponents, followed by rapid post weigh-in recovery<sup>3)</sup>. Acute weight loss is typically defined as losing  $\geq 5\%$  of body weight within one week<sup>16)</sup>. Acute weight loss has been found to correlate with dehydration and muscle cramps that affect both athletic performance and health<sup>10)</sup>. In response to college wrestlers' deaths that occurred in 1997 caused by acute weight loss<sup>9)</sup>, the National Collegiate Athletic Association set specific rules to regulate weight loss practices<sup>22)</sup>. This also includes limiting weight losses to not more than 1.5% of body weight per week. The Japan Wrestling Federation Medical Science Committee has been conducting intervention programs to educate junior wrestlers on the adverse effects of acute weight loss. These programs were found to be successful at promoting better weight loss practices in Japanese wrestlers<sup>1)</sup>.

Weight cutting is common in combat sports. Almost all judokas<sup>4)</sup> and wrestlers engage in weight loss practices, regardless of age<sup>17), 31)</sup>. Combat sport athletes also tend to begin weight loss practices at a relatively young age of 12-14<sup>4), 17), 25), 31)</sup>. Relative weight loss has been found to be between 1-15% of body weight<sup>19)</sup>, and most athletes were found to repeatedly cycle between 3-6% of their body weight throughout a season<sup>6), 17), 25), 26)</sup>. In a survey of college wrestlers, 41% reported weight fluctuations of at least 5 kg per week during the competitive season<sup>31)</sup>.

The duration of weight loss can be categorized as gradual (lasting more than one week) and acute (within one week)<sup>13)</sup>. The major difference is that gradual weight loss is achieved by body fat reduction through negative energy balance<sup>15)</sup>, whereas acute weight loss is primarily achieved through fluid manipulation by

passive and active dehydration<sup>5), 18), 30)</sup>. Some acute weight loss methods include promoting perspiration through increased exercise, training in a sauna suit, use of a sauna, or restriction of fluid intake<sup>13)</sup>. The methods of weight loss may vary, depending on the extent and duration of weight loss. Although weight loss methods used by combat sport athletes have been well characterized in the literature, no study to date has examined the relationship between the duration of weight loss and the methods used for weight loss.

To prevent unsafe weight loss in weight-classified sports, it is necessary to first understand the practices used by athletes to make weight, including the extent and duration of weight loss within each weight class. This information will help to enforce safe weight loss practices that promote competition of the sport, and not weight control. The information can also help practitioners to establish individualized safe weight loss recommendations.

The aims of this study were to (i) profile the weight of Japanese wrestlers who competed in the 2016 Japanese Wrestling Championship one week before weigh-ins across all weight classes and wrestling styles; (ii) examine the relationship between the duration of weight loss and methods used for weight loss; (iii) investigate weight loss practices of wrestlers. This was a highly competitive championship as Japanese wrestlers won medals in Freestyle, Greco-Roman and Woman's wrestling at the 2016 Rio de Janeiro Olympics.

## II. Materials and Methods

### 1. Participants

Responses through the original questionnaire were collected before weigh-in from 241 wrestlers who participated in the 2016 Japanese Wrestling Championship from December 21 to 23. The purpose and content of the questionnaire was explained to the participants, and their informed consent was obtained. In the case of underage participants, informed consent was obtained from their legal guardians. Participants answered the

questionnaires either before or after the official weigh-ins. This study was conducted with approval from the Ethics Committee of the Japan Institute of Sports Sciences (approval No. 058, 2016).

## 2. Questionnaires

To investigate the pre-competition weight-cutting practices of wrestlers, we created a self-reported questionnaire based on previous studies<sup>2), 20)</sup>. The questionnaire investigates the following: (i) weight one week before weigh-ins; (ii) the duration it took to make weight for the competition (number of days); (iii) weight loss methods utilized Multiple answers were could be selected from these options: decreasing in meal frequency, increasing in meal frequency, decreasing carbohydrate intake, decreasing fat intake, decreasing fluid intake, increasing fluid intake, low-salt diet, increasing volume of exercise (more than usual), saunas and bath, training with rubber/plastic suit; (iv) age at which the participants started competing; and (v) age at which they first cut weight for competition. In this study, excess weight (EW) is defined as the weight above the intended weight class one week before weigh-in. Excess weight was calculated as follows:

Excess weight (EW)(%) = (body weight one week before weigh-in – weight class (kg))/weight class (kg)

Hence in this study, we will define rapid weight loss (RWL) as losing 5% or more of their weight relative to their intended weight class, one week before weigh-in.

## 3. Statistical Analysis

An unpaired t-test was used to compare the age at which female and male wrestlers started competing and when they started to cut weight. Chi-squared tests were used to examine the relationship between the type of weight loss method and the duration of weight loss in male wrestlers with  $\geq 5\%$  of EW. Descriptive analysis of the Woman's Wrestling data was presented

as the sample size was too small. Chi-squared tests were also used to examine the relationship between the duration of weight loss 1 week before weigh-in (%) and wrestling style in male wrestlers. Pearson's product-moment correlation coefficient was used to examine the relationship between EW (%) 1 week before weigh-in and the duration of weight loss. Woman's Wrestling was excluded from this analysis as the sample size was too small to provide meaningful data. Table.1 summarises the weight classes and wrestling styles at the 2016 Japanese Wrestling Championship. A one-way ANOVA was used to compare EW (kg) and EW (%) among weight classes within each wrestling style, and Bonferroni's method was used for multiple comparison tests. When equal variance was not assumed, a nonparametric test (Kruskal–Wallis H test) was used. IBM SPSS for Windows (Ver.24) was used for statistical processing. The significance level was set at 5%. The duration of weight loss was classified into four categories ( $\geq 8$ -days, 6–7 days, 4–5 days,  $\leq 3$ -days) as done in previous studies<sup>4)</sup>.

## III. Results

Female wrestlers were found to start competing at a significantly younger age ( $7.2 \pm 3.8$  years) compared with their male counterparts ( $10.8 \pm 4.9$  years) ( $P < 0.001$ ). They also began to cut weight at a significantly younger age ( $13.8 \pm 2.3$  years) compared with their male counterparts ( $15.6 \pm 2.1$  years) ( $P < 0.001$ ).

The distribution of EW within each wrestling style is shown in Figure 1. Significantly fewer women wrestlers were found have between 5–9.9% EW than Freestyle and Greco-Roman wrestlers ( $P < 0.05$ ).

We found that wrestlers in the lighter weight categories, regardless of wrestling styles, tend to have greater EW than those in the heavier weight categories. Freestyle wrestlers competing in the three lightweight classes (57 kg, 61 kg, and 65 kg) had significantly greater EW (kg) as compared to those competing in the heaviest weight class (125 kg) (Table.2). Similarly,

Table.1 Weight classes and wrestling styles at the 2016 Japanese Wrestling Championship

Male		Female
Freestyle	Greco-Roman	Woman's Wrestling
57 kg	59 kg	48 kg
61 kg	66 kg	53 kg
65 kg	71 kg	55 kg
70 kg	75 kg	58 kg
74 kg	80 kg	60 kg
86 kg	85 kg	63 kg
97 kg	98 kg	69 kg
125 kg	130 kg	75 kg

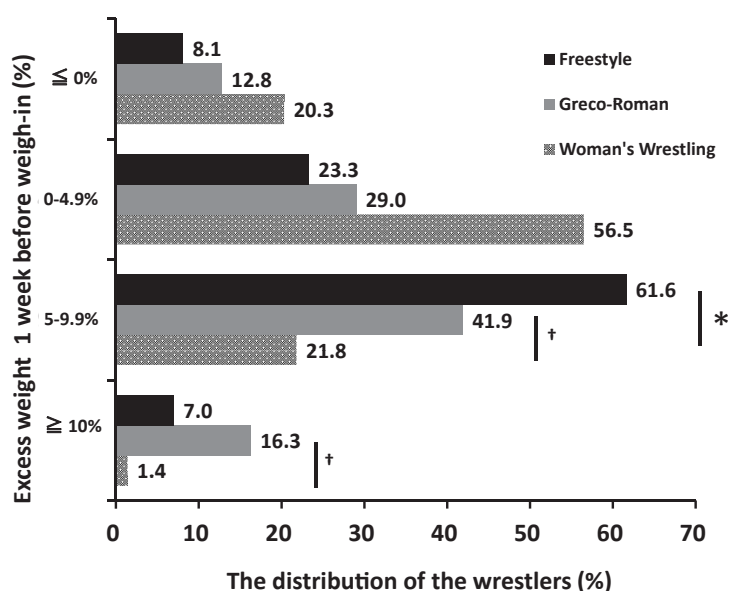


Figure.1 The distribution of wrestlers with excess weight within each wrestling style (Freestyle : n=86, Greco-Roman : n=86, Woman's Wrestling : n=69). \*P<.05 between Freestyle vs. Woman's Wrestling. †P<.05 between Greco-Roman vs. Woman's Wrestling.

EW (%) was significantly greater in the lightest weight class (57 kg) compared with three heavyweight classes (86 kg, 97 kg, and 125 kg). Greco-Roman wrestlers competing in the two lightweight classes (59 kg and 66 kg) had significantly greater EW (%) as compared with the heaviest weight class (130 kg) (Table.3). EW (%) was significantly higher in the lightest weight class (59

kg) as compared with the heavier weight classes (85 kg and 130 kg). In Woman's Wrestling, EW (kg) was significantly higher in the 48 kg weight class compared with the 69 kg and 75 kg weight classes (Table.4). EW (%) was significantly higher in the lightest weight class (48 kg) compared with the heavier weight classes (63 kg, 69 kg, and 75 kg).

Table.2 Amount and percentage of EW in Freestyle wrestlers

Weight class (kg)	57	61	65	70	74	86	97	125		
Total	18	13	12	10	11	6	10	6	<i>P</i>	Multiple comparison test
(Wrestlers who weighed >5% of weight class)	(17)	(11)	(11)	(6)	(8)	(1)	(4)	(0)		
EW (kg)										
Average (kg)	4.7	4.6	4.9	4.0	4.7	1.6	2.5	-3.7		
SD	1.6	1.4	1.1	2.3	2.0	3.5	5.2	5.3	< 0.05	57,61,65>125
Max (kg)	7.5	8.0	7.0	7.0	7.0	6.0	9.0	3.2		
Min (kg)	0.0	2.5	3.0	0.0	1.5	-4.0	-10.0	-8.0		
EW (%)										
Average (%)	8.3	7.5	7.6	5.7	6.4	1.9	2.6	-3.0		57>86,97,125
SD	2.7	2.3	1.7	3.3	2.7	4.1	5.4	4.2	< 0.01	65>86
Max (%)	13.2	13.1	10.8	10.0	9.5	7.0	9.3	2.6		65,74>125
Min (%)	0.0	4.1	4.6	0.0	2.0	-4.7	-10.3	-6.4		

(n) = The number of athletes who weighed more than 5% of their weight class

Table.3 Amount and percentage of EW in Greco-Roman wrestlers

Weight class (kg)	59	66	71	75	80	85	98	130		
Total	17	14	12	7	9	10	9	7	<i>P</i>	Multiple comparison test
(Wrestlers who weighed >5% of weight class)	(15)	(13)	(6)	(5)	(3)	(4)	(4)	(0)		
EW (kg)										
Average (kg)	4.5	5.5	3.4	4.9	4.1	2.6	2.2	-7.7		
SD	2.8	1.7	1.7	2.6	2.3	2.8	4.3	8.2	< 0.01	59,66>130
Max (kg)	8.0	8.0	6.0	9.5	9.0	5.0	7.5	5.0		
Min (kg)	-2.5	2.5	0.0	2.0	2.0	-2.5	-6.0	-17.0		
EW (%)										
Average (%)	7.6	8.3	4.8	6.5	5.1	3.1	2.3	-5.9		59>85,130
SD	4.7	2.6	2.4	3.4	2.9	3.3	4.1	6.3	< 0.01	66>85
Max (%)	13.6	12.1	8.5	12.7	11.3	5.9	7.7	3.8		66,71,75,85
Min (%)	-4.2	3.8	0.0	2.7	2.5	-2.9	-6.1	-13.1		>130
(n) = The number of athletes who weighed more than 5% of their weight class.										

Table.4 Amount and percentage of EW in Woman's Wrestling wrestlers

Weight class (kg)	48	53	55	58	60	63	69	75		
Total (Wrestlers who weighed >5% of weight class)	15	9	4	8	9	6	11	7	<i>P</i>	Multiple comparison test
	(7)	(2)	(1)	(1)	(4)	0	0	(1)		
EW (kg)										
Average (kg)	2.4	1.7	2.3	1.6	1.9	0.1	-0.4	-0.3		
SD	1.3	1.3	1.2	1.3	2.3	1.3	1.6	3.1	< 0.01	48>69,75
Max (kg)	5.0	4.0	4.0	3.5	4.0	2.0	2.0	5.8		
Min (kg)	0.5	0.0	1.0	-1.2	-3.2	-2.0	-3.0	-3.0		
EW (%)										
Average (%)	5.0	3.2	4.2	2.7	3.2	0.2	-0.6	-0.3		
SD	2.7	2.5	2.3	2.3	3.8	2.1	2.4	4.1	< 0.01	48>63,69,75
Max (%)	10.4	7.5	7.3	6.0	6.7	3.2	2.9	7.7		
Min (%)	1.0	0.0	1.8	-1.2	-5.3	-3.2	-4.3	-4.0		

(n) = The number of athletes who weighed more than 5% of their weight class.

The relationship between EW (%) and the duration of weight loss in male wrestlers with  $\geq 5\%$  EW is shown in Figure 2. No significant correlation was found. The duration taken for male wrestlers with  $\geq 5\%$  EW to make weight is summarized in Figure 3. More Freestyle wrestlers made weight within  $\leq 3$ -days than Greco-Roman wrestlers ( $P < 0.05$ ) and more Greco-Roman wrestlers required  $\geq 8$ -days to make weight than Freestyle wrestlers ( $P < 0.05$ ).

Table.5 summarizes the methods used by wrestlers to make weight as categorized by the duration of weight loss. Common methods used to make weight include reduced meal frequency and restriction in fluid intake. Wrestlers who cut weight over a longer duration ( $\geq 8$  days) utilized a greater variety of weight loss methods, such as manipulation of macronutrient (fat and carbohydrate) intake, as compared with those who cut weight within a shorter duration ( $P < 0.05$ ). Carbohydrate reduction was most commonly used by those who cut weight over  $\geq 8$ -days than those who cut

weight within  $\leq 3$ -days ( $P < 0.05$ ). Similarly, reduction in fat intake was reported to be commonly used by those who cut weight over  $\geq 8$ -days than those who cut weight over a shorter duration ( $P < 0.05$ ). A low salt diet was more likely to be used by those who cut weight over  $\geq 8$ -days than those who cut weight over 4-5 days ( $P < 0.05$ ).

Table.6 summarizes the weight loss methods used by female wrestlers with  $\geq 5\%$  EW, as categorized by the duration of weight loss. Descriptive analysis of the Woman's Wrestling data was presented as the sample size was too small.

#### IV. Discussion

The aims of this study were to profile the weight of Japanese wrestlers who competed in the 2016 Japanese Wrestling Championship; examine the relationship between the duration of weight loss and methods used for RWL; and to investigate the weight loss practices of wrestlers across all wrestling styles and weight

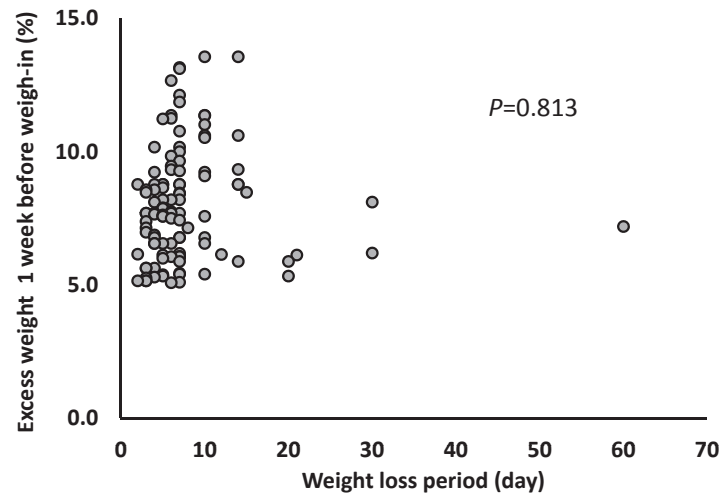


Figure.2 The correlation between EW (%) and weight loss period in male wrestlers with  $\geq 5\%$  EW.

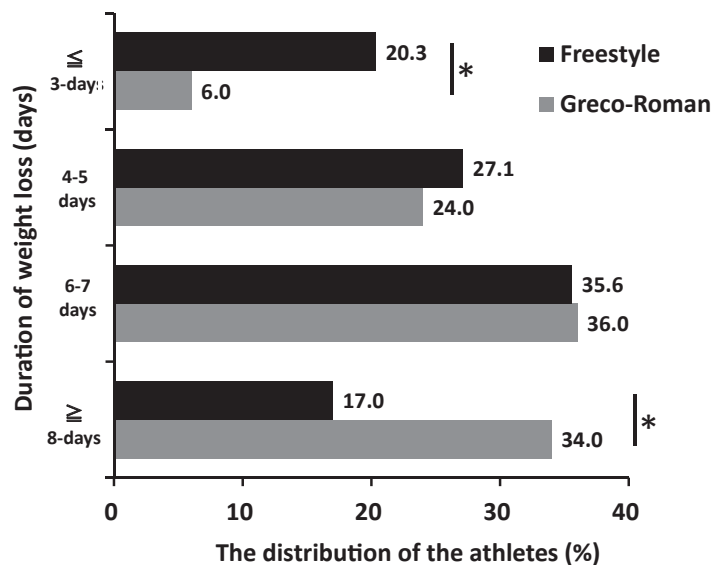


Figure.3 A summary of the duration needed for male wrestlers who weighed more than  $\geq 5\%$  of their weight class to make weight (Freestyle :  $n=59$ , Greco-Roman :  $n=50$ ). \* $P<.05$  between Freestyle vs. Greco-Roman. Woman's Wrestling was excluded from this analysis as the sample size was too small to provide any meaningful data.

classes.

We investigated the relationship between the weight loss methods used and duration of weight loss in male wrestlers with  $\geq 5\%$  EW, as classified according to four categories ( $\geq 8$ -days, 6–7 days, 4–5 days, and

$\leq 3$ -days). Wrestlers who took the longest time to make weight used a greater variety of methods as compared with others. The weight loss methods chosen were found to be significantly associated with the duration of weight loss. Wrestlers who engaged in weight

Table.5 Difference in EW (%), the prevalence of weight loss methods, and number of weight loss methods in male wrestlers (n=109)

	Duration of weight loss				
	Total	≥8-days	6-7 days	4-5 days	≤3-days
	(n=109)	( n=27)	( n=39)	( n=28)	( n=15)
EW (%)					
Average	8.0±2.1	8.5±2.4	8.5±2.3	7.6±2.3	6.7±1.3
(range)	(5.1-13.6)	(5.3-13.6)	(5.1-13.2)	(5.3-11.2)	(5.2-8.8)
Number of weight loss methods selected					
Average	4.1±1.9	5.4±1.7	4.1±1.7*	3.4±1.5*	2.8±1.6*
Methods					
Decreasing in meal frequency	67.0%	74.1%	74.4%	57.1%	53.3%
Increasing in meal frequency	1.8%	0.0%	2.6%	0.0%	6.7%
Decreasing carbohydrate intake	46.8%	70.4%	46.2%	42.9%	13.3%*
Decreasing fat intake	43.1%	77.8%	35.9%*	35.7%*	13.3%*
Decreasing fluid intake	69.7%	74.1%	71.8%	71.4%	53.3%
Increasing fluid intake	16.5%	25.9%	15.4%	14.3%	6.7%
Low-salt diet	25.7%	48.1%	23.1%	14.3%*	13.3%
Increasing volume of exercise (more than usual)	42.2%	59.3%	41.0%	25.0%	46.7%
Saunas and bath	37.6%	51.9%	43.6%	25.0%	20.0%
Training with rubber/plastic suit	55.0%	59.3%	51.6%	57.1%	53.3%

Data is expressed as the percentage of wrestlers who selected methods for each duration of weight loss.

(n) = The number of athletes who weighed more than 5% of their weight class.

\* $P < .05$  between ≥8-days vs. 7-6 days, 5-4 days, ≤3-days.

loss practices over longer durations of weight loss utilized methods that involved dietary changes, such as carbohydrate, fat and salt manipulation. Wrestlers who engaged in weight loss practices over shorter durations primarily utilized methods that involve reductions to body water. These results are similar to previous findings<sup>6)</sup>. Male wrestlers are known to have low levels of body fat, and further reductions to body fat and chronic maintenance of low levels of body fat can be highly stressful to the physical and mental wellbeing of the athlete.

A combination of gradual and acute weight making strategies is needed for successful weight management

in wrestlers. Gradual weight making involves muscle and body fat reduction, which requires chronic manipulation of energy balance. As fat is energy dense, adopting a low fat diet is useful to achieve this through energy intake reduction and is used by almost half (43.1%) of the male wrestlers who required RWL.

Carbohydrate is stored in the body in the form of glycogen in the liver and muscles. As each gram of glycogen is bound to approximately three to four grams of water<sup>24)</sup>, reduction of glycogen-bound water with the use of a low carbohydrate diet and appropriate glycogen-depleting training can be effective RWL strategies. However, less than half of the male



Table.6 Difference in EW (%), the prevalence of weight loss methods, and number of weight loss methods in female wrestlers (n=16)

	Total ( n=16 )	Duration of weight loss			
		≥ 8-days ( n=3 )	6-7 days ( n=11 )	4-5 days ( n=1 )	≤ 3-days ( n=1 )
EW (%)					
Average	6.9±1.3	6.5±1.1	6.7±1.1		
(range)	( 5.4-10.4 )	( 5.7-7.3 )	( 5.0-8.3 )	-	-
Number of weight loss methods selected					
Average	3.9±1.5	4.0±1.0	3.8±1.7	4	5
Methods					
Decreasing in meal frequency	56.3%	33.3%	54.5%	100.0%	100.0%
Increasing in meal frequency	0.0%	0.0%	0.0%	0.0%	0.0%
Decreasing carbohydrate intake	62.5%	66.7%	63.6%	0.0%	100.0%
Decreasing fat intake	62.5%	100.0%	54.5%	0.0%	100.0%
Decreasing fluid intake	81.3%	33.3%	90.9%	100.0%	100.0%
Increasing fluid intake	6.3%	0.0%	9.1%	0.0%	0.0%
Low-salt diet	12.5%	0.0%	9.1%	0.0%	100.0%
Increasing volume of exercise (more than usual)	31.3%	33.3%	27.3%	100.0%	0.0%
Saunas and bath	31.3%	66.7%	27.3%	0.0%	0.0%
Training with rubber/plastic suit	50.0%	66.7%	45.5%	100.0%	0.0%

Data is expressed as the percentage of wrestlers who selected methods for each duration of weight loss.

(n) = The number of athletes who weighed more than 5% of their weight class.

wrestlers (46.8%) in this study who required RWL utilized this method. Necessary considerations for the effectiveness of this method include the athlete's original glycogen status, degree of carbohydrate restriction, and training demands. As wrestling training is highly glycolytic, a relatively high carbohydrate intake is necessary <sup>7)</sup>. Adopting a low carbohydrate diet to achieve RWL may be counterproductive to sustain quality training, which may possibly explain why many wrestlers do not utilize this method to achieve RWL. More can be done to educate wrestlers on RWL strategies and how to appropriately periodize this weight loss method within the training and competition program. Mouth-rinsing with carbohydrate- based solutions can

also be used to mitigate the effects of low carbohydrate availability through stimulation of the central nervous system <sup>8), 28)</sup>.

Low salt diets are commonly used by athletes in weight-classified sports to create a temporary reduction in fluid retention and water weight. Reduced salt intake has been shown to improve blood pressure in individuals with hypertension, and would theoretically induce a similar but smaller reduction in intravascular fluid retention in healthy individuals <sup>12), 27)</sup>. It is one of many methods that can be used for weight cutting in the days leading up to the weigh-in. However, this method does not seem to be popular amongst Japanese wrestlers as only 25.7 % of male wrestlers who

required RWL in this study utilized this method. It is notable that the greatest proportion of male wrestlers used this as a method for weight loss over  $\geq 8$  days (48.1%), and fewer wrestlers used this method for shorter durations of RWL (6–7 days 23.1%, 4–5 days 14.3%,  $\leq 3$  days 6.7%). While we did not establish how the low salt diets were used in this study, we speculate that it was one of the methods used to induce dehydration during the early phase of the weight loss, or the other reason. It is also noted that it may be counterproductive to undergo long periods of sodium restriction. Prolonged sodium restriction stimulates greater aldosterone secretion as the body attempts to promote sodium resorption<sup>29)</sup>, which results in increased water resorption. Instead, it will be more effective to limit sodium restriction to only 2–3 days. We recognize that appropriate use of low salt diets can be a useful strategy for weight cutting and but necessary education is needed to be done in wrestlers to optimize this method as a viable weight loss strategy.

Compared with a similar study conducted in 2001<sup>17)</sup>, the proportion of male athletes who needed to cut weight in this study (77%) is lower than what was previously found (83%)<sup>20)</sup>. The proportion of female athletes who needed to make weight in this study was also observed to be lower (51% compared with 77% in the previous study)<sup>20)</sup>. There are two possible reasons for this. Firstly, in 2013 there was a rule change that increased the number of weight classes from 7 to 8. As a result, wrestlers were able to participate in a more suitable weight class which inevitably reduced the need for drastic weight cuts. Secondly, to prevent unsafe weight making practices, the Japan Wrestling Federation Medical Science Committee created education programs for junior wrestlers to build an awareness on the dangers of RWL in 2007. Guidelines and programs for safe weight loss were also introduced. Collectively, these measures have been found to improve unsafe weight loss practices in Japanese wrestlers<sup>1)</sup>. Despite this, it is still concerning that a large number of top

Japanese wrestlers in this study were still found to engage in RWL practices.

It was observed that Freestyle wrestlers tended to make weight within a shorter time frame ( $\leq 3$  days) compared with Greco-Roman wrestlers ( $\geq 8$  days). Many previous studies have suggested that the physical and technical-tactical characteristics of Freestyle and Greco-Roman wrestlers are different. There are major differences between Freestyle and Greco-Roman wrestling. Freestyle wrestling allows actions of both the upper and lower body<sup>11)</sup> and require leg attacks<sup>14)</sup>. On the other hand, holds below the waist is forbidden in Greco-Roman wrestling. Instead, this wrestling style emphasizes dynamic moves (e.g., lifting, throwing, and resisting opponents). These differences contribute towards wrestling style-specific physical and technical-tactical characteristics<sup>11), 14)</sup>. It is beyond the scope of this study to determine how the different wrestling styles affect the duration of weight loss. Further studies in this area are warranted and the information will be useful to establish individualized safe weight loss recommendations.

Female wrestlers in this study began wrestling at a younger age as compared with male wrestlers and began weight cutting practices at a significantly younger age. This means that they were likely to be exposed to unsafe weight loss practices and its associated risks at an earlier age, and are likely to continue these practices late into their careers<sup>25)</sup>. Athletes accustomed to regular weight cutting at an early age are also known to use harsher methods for weight loss<sup>3)</sup>. The prevalence of disordered eating in competitive youth sports is high compared to non-athletic youths and early weight cycling practices can exacerbate the development of the Relative Energy Deficiency in Sport (RED-S)<sup>21)</sup>. It is particularly concerning that weight cutting practices in this group would likely to have coincided with puberty. This exposes them to low energy availability, both contributed by energy restriction to achieve the weight cut and increased energy requirements to support rapid

growth and development. As a result, they are vulnerable to the multiple health risks of low energy availability including endocrine dysfunction, impaired bone health and psychological issues<sup>21), 23)</sup>. It is crucial to consider the energy requirements to support the growth and developmental needs of youth athletes and those entering puberty. Studies to investigate the relationship between early weight cutting practices and subsequent weight cycling in wrestlers are warranted.

Wrestling rules were revised in 2017 to prevent RWL and its associated health risks. Instead of weigh-ins the day before the competition, this new rule requires weigh-ins to be conducted on the morning of the competition. Weigh-ins are also conducted on the morning of the second day if a competition is held over two days. The present rule effectively reduces the recovery period between the time of weigh-in and the competition from 15 hours to 2 hours. Studies to investigate the implications of this rule change on RWL and recovery practices in wrestlers is recommended.

This study has provided us with extensive data to better understand the general weight making practices of wrestlers in the week leading up to a competition. However, specific details of the weight making process (i.e., extent of carbohydrate or fluid restriction) are not investigated in this study. Another limitation of this study is the reliance on self-reported data, although it is assumed that wrestlers tend to be well aware of their body composition and weight making requirements.

## V. Conclusions

In this study, we profiled all wrestlers who competed at the 2016 Japanese Wrestling Championship one week before their weigh-ins and evaluated the relationship between the duration of methods used for RWL by male wrestlers with  $\geq 5$  % EW. Wrestlers in the lighter weight categories tend to have greater EW than those in heavier weight categories. We found that wrestlers who cut weight over a longer duration utilized a greater variety of weight loss methods, while

those who cut weight over a shorter period utilized methods that actively and passively modified water weight. We have also identified trends in the use of low carbohydrate and low salt diets for RWL, and suggest for wrestlers to be educated to further improve the effectiveness of these methods. Future studies to investigate the early weight cutting practices and subsequent weight cycling in wrestlers are needed. Studies to investigate the revision of the new weigh-in rule are recommended to better understand the implications of the rule change on RWL and recovery practices in wrestlers.

**Acknowledgments:** We thank the subjects, parents, and wrestling coaches for participation and cooperation. We thank Dr. Katsuji Aizawa, Dr. Hiroshi Arakawa and Mr. Kotaro Fujiyama for helpful insights and contributions to the data interpretation and discussion.

**Conflicts of Interest:** The authors declare no conflict of interest.

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**体重階級制競技の計量に向けた減量と計量後の食事に関するアンケート**

本調査は選手が減量後に最適な栄養摂取を行うための指標を作成することと、減量と怪我の関連を調べることを目的としています。

私は同意説明文書（別紙）をよく読み、個人情報取り扱い等、内容を理解しましたので、下記の質問に記入します。

氏名： \_\_\_\_\_ 年齢： \_\_\_\_\_ （未成年者の場合）代表責任者： \_\_\_\_\_

本調査の結果を希望される方に、全体の傾向とご自身の結果を返却いたします。

◆本調査の結果の返却を希望されますか。当てはまるほうに○をつけてください。

(1) はい (2) いいえ

※「はい」に○をされた方には結果をご本人にご返却致します。ご希望の返却先をご記入ください。

返却先：郵送（郵送先住所）： \_\_\_\_\_

1、今大会の試合までの体重、食事量、水分量、減量方法等についてお聞きします。

① 以下のそれぞれの時期の体重を <b>小数点第1位まで</b> ご記入ください。						
② いつもの食事量を100%としたときに、各時期の食事量は何%であったかをご記入ください。						
③ いつもの水分量を100%としたときに、各時期の水分量は何%であったかをご記入ください						
時期	計量 1か月前	計量 1週間前	計量 3日前	計量 前日	計量日 朝	計量直前
(1) 体重	_____ kg	_____ kg	_____ kg	_____ kg	_____ kg	_____ kg
(2) 食事量	_____ %	_____ %	_____ %	_____ %	_____ %	_____ %
(3) 水分量	_____ %	_____ %	_____ %	_____ %	_____ %	_____ %
④ 今大会に向けて行った体重調整は何日前から開始しましたか。						_____ 日前
⑤ 今大会に向けて行った体重調整は100点満点中、何点だと思いますか。						_____ 点
その点数だと思った理由（ _____ ）						
⑥ 今大会に向けて減量を行いましたか。「はい」に○された方は⑦をお答え下さい。						(1) はい (2) いいえ
⑦ 今大会に向けて行った減量方法を、以下の選択肢の中から当てはまるもの全てに○をつけてください。						
(1) 食事回数を減らす	(2) 食事回数を増やす	(3) 炭水化物（糖質）を減らす	(4) 脂質を減らす			
(4) 水分量を減らす	(5) 水分量を増やす	(6) 塩分量を減らす	(10) その他			
(7) 運動量を増やす	(8) サウナ・湯船に入る	(9) サウナスーツを着て運動する	( _____ )			

2、過去の減量経験についてお聞きします。

① 何歳から競技を始めましたか。 \_\_\_\_\_ 歳 ② 初めて減量をしたのは何歳ですか。 \_\_\_\_\_ 歳

③ 今年1年（2016年1月～12月）に何回くらい減量を行いましたか。 \_\_\_\_\_ 回

3、今日の計量後から明日のウェーシング・アップまでに食べる予定の主な食品、飲料に○をつけてください。

(1) ごはん・おにぎり	(2) パン	(3) 麺類	(4) おかゆ・雑炊
(5) 肉類	(6) 魚・魚介類	(7) 豆腐・納豆	(8) 卵
(9) 野菜・きのこ・海藻	(10) 果物（カットフルーツ、缶詰含む）	(11) 牛乳・乳製品	(12) 水・茶・コーヒー 紅茶・0kcal 飲料
(13) 経口補水液（OS-1 など）	(14) スポーツドリンク (0kcal は含まない)	(15) ジュース	(16) アルコール飲料
(17) 和菓子 (饅頭、せんべいなど)	(18) 洋菓子 (ケーキ、ドーナツ、クッキーなど)	(19) アイスcream	(20) ゼリー飲料
(21) サプリメント（ビタミン、ミネラル、アミノ酸などの粉末・粒など）	(22) 汁物（味噌汁、スープ など）	(23) その他（ _____ ）	

質問は以上です。ご協力ありがとうございました。

### Note

- This is a translated version of a questionnaire. The original version was in Japanese.
- The data highlighted in red was used to answer the research question.

### Questionnaire about pre-competition rapid weight loss

The purpose of this survey is to 1) create guidelines for optimal post weigh-in recovery and 2) investigate the relationship between weight loss and injury risk of the competition.

I confirm that I have read and understood the information sheet for the project and I agree to participate in this study.

Signature : \_\_\_\_\_ Age : \_\_\_\_\_ (If you are under 20) Legal guardian : \_\_\_\_\_

◆ Would you like to return the results of this survey? Please check “Yes” or “No”.

(1) Yes (2) No

※If you check “Yes”, we will return your results and the findings of the survey. Please indicate your address below.

Address : \_\_\_\_\_

### 4、Weight history, diet patterns, and weight loss methods leading up to competition

① Please fill in your body weight <b>(to the nearest decimal place)</b> .						
② Please estimate the amount of food consumed (in percentage), relative to your usual intake.						
③ Please estimate the amount of drink consumed (in percentage), relative to your usual intake.						
Time Period	One month before weigh-in	One week before weigh-in	Three days before weigh-in	One day before weigh-in	Morning of the weigh-in	Just before weigh-in
(1) Body Weight	. kg	. kg	. kg	. kg	. kg	. kg
(2) Amount of food	%	%	%	%	%	%
(3) Amount of drink	%	%	%	%	%	%
④ How many days do you usually take to cut weight for the competition?					Days before	
⑤ On a scale of 1 to 100, how good was your weight-cutting approach?					Points	
The reason ( )						
⑥ Did you lose weight for this competition? If “Yes”, please answer ⑦.					(1) Yes (2) No	
⑦ Please check the weight loss methods utilized for this competition (multiple answers are allowed).						
(1) Decreased meal frequency	(2) Increased meal frequency	(3) Decreased carbohydrate intake			(4) Decreased fat intake	
(4) Decreased fluid intake	(5) Increased fluid intake	(6) Low-salt diet			(10) Others ( )	
(7) Increased volume of exercise (more than usual)	(8) Saunas and bath	(9) Training with rubber/plastic suit				

5、Past experience of weight loss

- ① At what age did you begin to practice wrestling? \_\_\_\_\_ years
- ② At what age did you first cut weight for competition? \_\_\_\_\_ years
- ③ How many times did you cut weight this year? From January to December 2016 \_\_\_\_\_ times

6、Please check the list below for food and drink **you plan to consume after your weigh-in before the competition.**

(1) Rice • Rice bowl	(2) Bread	(3) Noodles	(4) Porridges
(5) Meat	(6) Seafood	(7) Tofu, Natto	(8) Eggs
(9) Vegetables, Mushrooms, Seaweeds	(10) Fruits (Includes pre-cut fruits, canned fruits)	(11) Milk, Dairy products	(12) Water, Tea, Coffee, Non-carbohydrate beverages
(13) Oral Rehydration Solutions (OS-1, etc.)	(14) Sports drinks (Does not include calorie-free beverages)	(15) Juice	(16) Alcohol beverages
(17) Japanese confectioneries (Manju, rice crackers, etc.)	(18) Western confectioneries (Cakes, Donuts, Cookies, etc.)	(19) Ice creams	(20) Jelly drinks
(21) Supplements (Vitamin, minerals, powders, tablets, etc.)	(22) Soup (Miso soup, etc.)	(23) Others ( )	

End of survey. Thank you for your participation!