

Wrestling Weight Classes – Providing a Scientific Rationale

Wrestling is one of several sports employing weight classes for competition. Recently, the international governing body of wrestling (FILA) has been under pressure from the International Olympic Committee to reduce the number of classes. The number of classes was reduced in 1997 from 10 to 8, with a further reduction to 7 in 2001. This paper will review the history of weight classes in the sport, and attempt to put forth a rationale means for the establishment of a weight class model for the future. Weight classes are used in several sports. These include the combat sports of wrestling, boxing, judo, taekwondo, and also weight lifting and rowing. They are used to provide athletes fair competition, opportunity for athletes of various sizes, and safety. The following section lists these sports and the weight classes currently used in competition.

Rowing (2 weight classes) The Olympic rowing program underwent a change beginning at the 1996 Olympics, with the introduction of lightweight events. The men's events include e lightweight double sculls and lightweight coxless fours and the women's events have lightweight double sculls. The weight limits for lightweight events are as follows: individual women must not weigh more than 59 kg, with the average crew weight no more than 57 kg; individual men must not weigh more than 72.5 kg, with the average crew weight being no more than 70 kg.

Table 1: Olympic Combative Sports, plus Weightlifting that Utilize Weight Classes (all weights in kg)

Boxing	
Men only (12)	48, 51, 54, 57, 60, 63.5, 67, 71, 75, 81, 91, +91
Judo	
Men (7)	60, 66, 73, 81, 90, 100, +100
Women (7)	48, 52, 57, 63, 70, 78, +78
Taekwondo	
Men (4)	58, 68, 80, +80
Women (4)	49, 57, 67, +67
Weightlifting	
Men (8)	56, 62, 69, 77, 85, 94, 105, +105
Women (7)	48, 53, 58, 63, 69, 75, +75
Wrestling	
Men (7)	55, 60, 66, 74, 84, 96, 120
Women (7)	48, 51, 55*, 59, 63*, 67*, 72*

The next chart shows the evolution of weight classes used since the first organized world championships in Greco-Roman wrestling in 1904. In the first modern Olympics held in Athens in 1896, there was only a single class, without limits. The number of classes grew incrementally, reaching a high of 10 classes in 1969. Wrestling is the only sport that imposes a limit on the highest weight class. It was first imposed in 1985 with a limit of 130 kg. It has further been reduced to 120 kg in 2002. The number of classes remained at 10 until 1997, when the classes were reduced to 8. This was further reduced to 7 classes in 2002. The impetus for this reduction has come from the IOC in an effort to stem the growth of the Olympic Games. During this time period, women's wrestling has been recognized, with the first FILA sponsored World Championships held in 1987. Women's wrestling will be included in the Olympics for the first time in Athens, 2004.

The reduction in the number of weight classes has been met with concern within the wrestling community and has focused attention on the rationale behind the changes, and ultimately in this paper, the identification of a scientific rationale for the establishment of a weight class system.

The use of weight classes is based on an assumption that differences in body weight can create an unfair advantage for the larger wrestler, and therefore the establishment of weight classes is a rationale solution to this inequity created by differences in size. In order to address the problem from a scientific standpoint, it seems that the establishment of weight classes for world class competition for mature men and women requires two sets of information. These were distilled from comments requested from several experts in the field of wrestling and body composition and anthropometry. There are two major approaches: (1) Use population distributions to ensure fairness of access; and 2) Determine a means of scaling the effects of differences in body weight to equilibrate these effects in a competitive situation. This second approach is not easily defined.



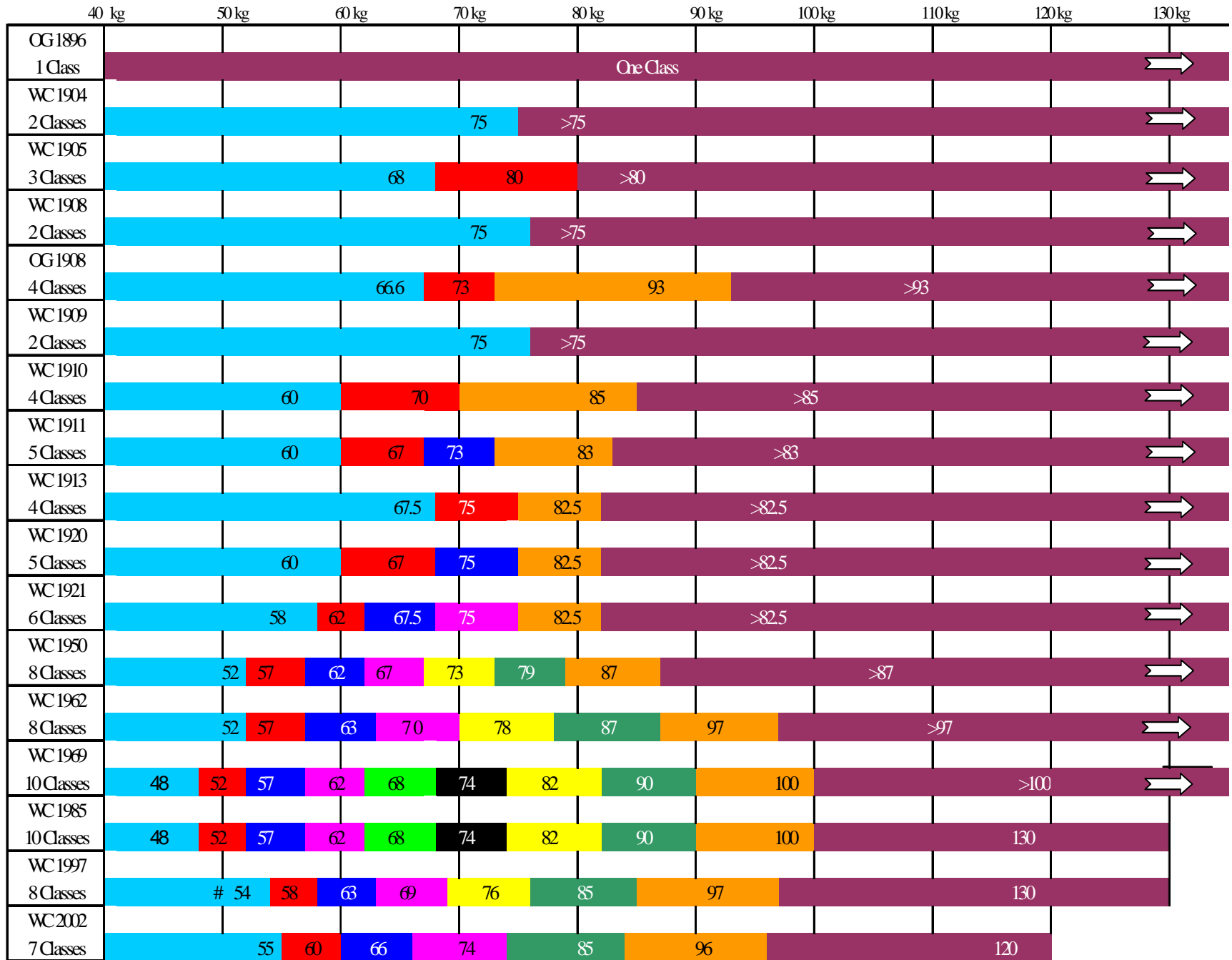
The first modern Olympic wrestling champion was Karl Schumann of Germany. There was only one class. Schumann also won three gold medals in the gymnastics competition.

Heavyweight Limits

Beginning with the 1985 world championships, FILA instituted a maximum weight of 130 kg (286 lbs.) for the highest weight class. A similar limitation was made for U S collegiate wrestlers in 1986, when the NCAA established the 275 lb. class (123.8 kg). Health and safety of the participants was cited by the

NCAA Committee on Competitive Safeguards and Medical Aspects of Sports in the development of this rule change. This entailed concern for the potential mis-matches in size, as well as the health risks present in when an athlete is in the 300-400 pound range. In regard to the former, there was no data cited that documents excessive weight difference causing injuries in the heavyweight class. The concern for the health of the athlete outside of competition centered around the following: 1) encourage the athletes who were obese to move towards a lower, and healthier weight and lifestyle; 2) discourage the practice of artificially inflating the athletes size by way of tremendous caloric intake; and 3) discourage the use of ergogenic aids, such as anabolic steroids, in their quest to become larger. There is no data that has tracked the success of the rule change in achieving the goal in #1. While there are some athletes who have lost weight to wrestle in this class, many of these huge athletes probably just quit the sport. It is not clear how the limit was established by FILA.

Chart 1: Evolution of Weight Classes Used in Olympics (OG) and World Championships (WC)¹



¹Weight Classes from FILA Database Provided by IAT, Leipzig

Use of Population Distributions to Create Fair Access to the Sport

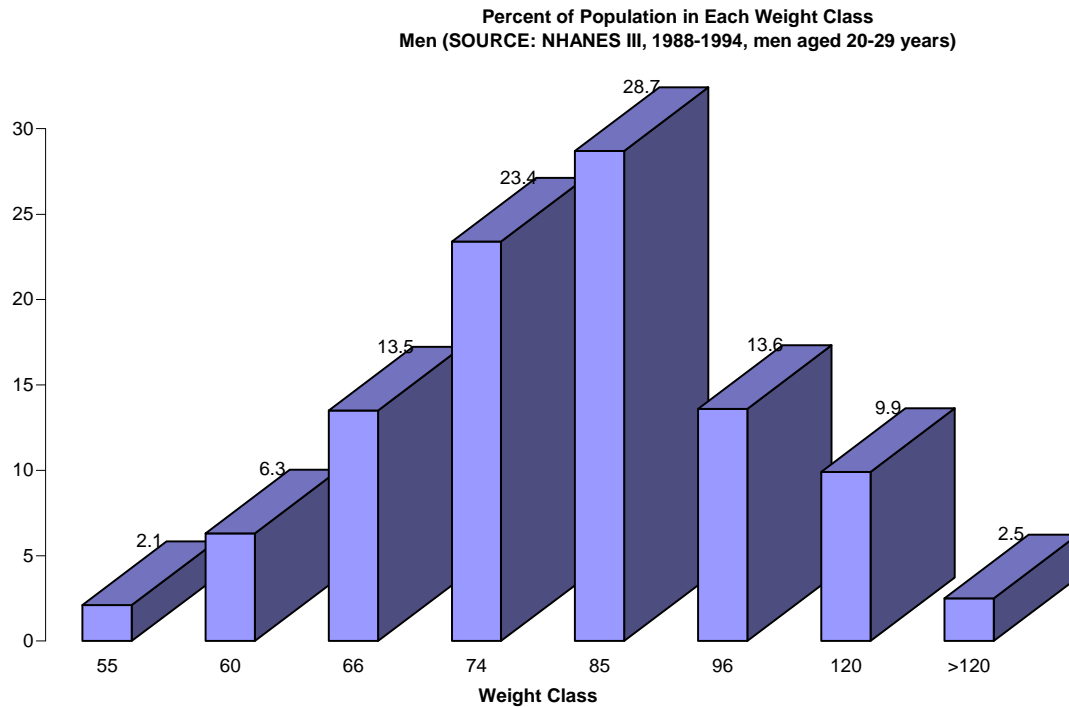
Statistics from the NHANES III 1994 Survey are available for the United States. The National Health and Nutrition Examination Survey (NHANES) is a survey conducted by the National Center for Health Statistics (NCHS). Data listing the distribution of body mass (weight) for the age range of the competitors was studied. Since the mean age of the wrestling champions in the 2000 Olympic Games

was 25.5 (FS) and 26 (GR), the range of data selected was for the span of 20-29 years of age and is listed in Table 2. One can then examine the current weight classes and see the percentage of the population that falls in each weight class. This was done using the current FILA weight classes for senior competition. The results are shown in Charts 2 and 3 for men and women, respectively.

Table 2: Weight (kg) at each centile for U.S. men and women aged 20-29 years

Centile	Men	Women	Centile	Men	Women	Centile	Men	Women
1	52.95	42.40	34	69.95	56.30	67	82.05	66.45
2	54.95	44.05	35	70.25	56.45	68	82.35	67.23
3	55.95	45.00	36	70.50	56.65	69	82.80	67.70
4	57.20	45.95	37	71.10	57.05	70	83.05	68.05
5	57.70	46.65	38	71.45	57.30	71	83.80	68.45
6	58.50	47.25	39	71.81	57.55	72	84.05	69.25
7	59.40	47.80	40	72.15	57.65	73	84.35	69.65
8	59.90	48.10	41	72.40	57.85	74	84.90	70.70
9	60.35	48.55	42	72.65	57.90	75	85.60	71.55
10	60.95	49.10	43	73.20	58.35	76	86.30	72.30
11	61.80	49.55	44	73.60	58.60	77	86.70	72.90
12	62.00	49.75	45	73.90	58.85	78	87.45	73.65
13	62.40	49.80	46	74.15	59.15	79	88.35	74.60
14	62.75	50.45	47	74.25	59.45	80	89.60	75.20
15	63.10	50.55	48	74.65	59.75	81	90.25	75.95
16	63.85	50.80	49	74.85	59.85	82	90.75	76.50
17	64.15	51.20	50	75.35	60.50	83	91.90	77.75
18	64.70	51.55	51	75.70	60.80	84	92.50	78.50
19	65.00	52.10	52	76.15	61.10	85	93.65	79.85
20	65.50	52.35	53	76.60	61.65	86	94.45	80.45
21	65.70	52.45	54	76.95	62.00	87	95.45	81.05
22	66.05	52.75	55	77.25	62.65	88	96.60	82.90
23	66.40	53.20	56	77.60	63.05	89	98.05	84.35
24	66.80	53.40	57	77.90	63.30	90	99.40	86.60
25	67.10	53.60	58	78.05	63.55	91	101.10	88.65
26	67.50	53.90	59	78.45	63.80	92	102.85	90.65
27	67.75	54.30	60	79.05	64.15	93	104.70	91.80
28	67.90	54.75	61	79.60	64.55	94	105.95	94.55
29	68.10	55.05	62	80.00	64.95	95	107.70	99.05
30	68.55	55.25	63	80.35	65.10	96	112.40	100.15
31	69.10	55.50	64	80.75	65.45	97	115.50	102.05
32	69.30	55.75	65	81.05	65.90	98	123.00	105.05
33	69.70	56.15	66	81.30	66.25	99	130.45	114.65

Chart 2: Percentage of U.S. men aged 20-29 years classified by wrestling weight categories



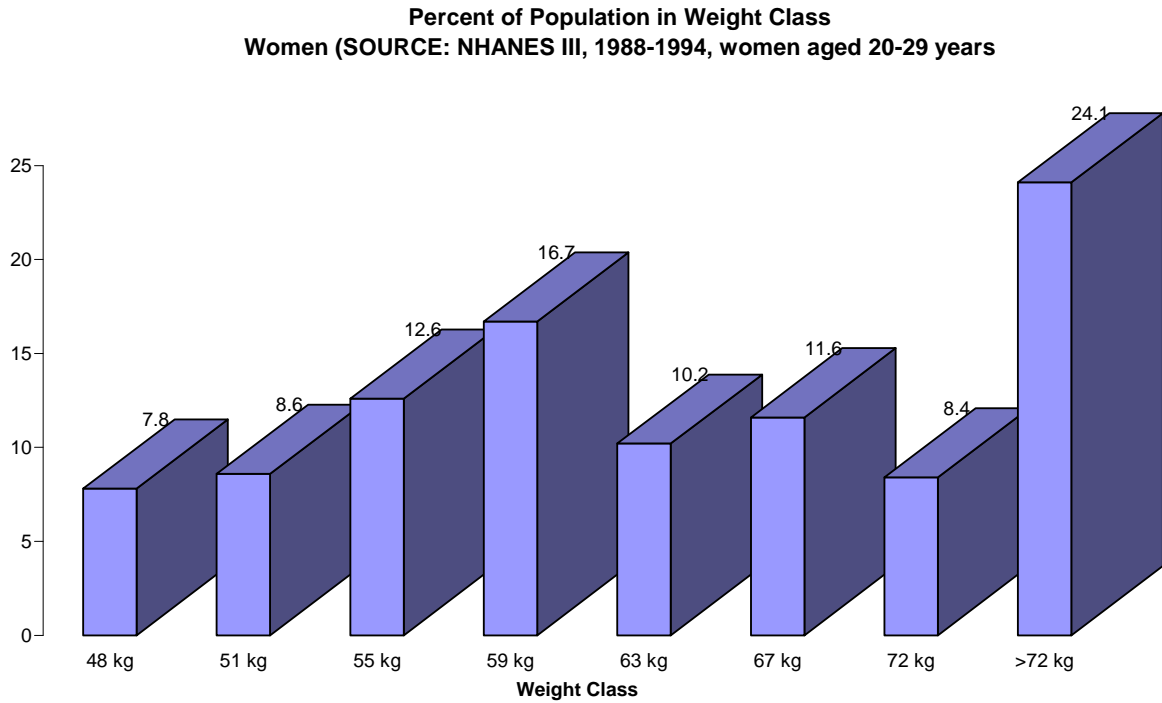
Men's Weight Classes	Percentage of Men
55 kg	2.1
60 kg	6.3
66 kg	13.5
74 kg	23.4
85 kg	28.7
96 kg	13.6
120 kg	9.9
(>120 kg) Outside competition limits	2.5

SOURCE: NHANES III, 1988-1994, men aged 20-29 years (n = 1,639)

One can see that the potential number of athletes is much higher in the middle weights. The 85 kg class has the highest potential with almost 29% of the population. The heavyweight limit theoretically eliminates 2.5% of the population. More weight classes in this region is called for to make the access to competition more equitable. While there are only 2.1% of this population in the lowest weight class,

one must remember that this is U.S. data. Other data sets need to be investigated. It is likely that some countries have body mass distributions that have smaller people. For instance, athletes from the Peoples Republic of Korea won the FS 48 kg weight class in the 1986 and 1987 World Championships, and also the 1992 and 1996 Olympic Games.

Chart 3: Percentage of U.S. women aged 20-29 years classified by wrestling weight categories



Women's Weight Classes	Percentage of Women
48 kg	7.8
51 kg	8.6
55 kg	12.6
59 kg	16.7
63 kg	10.2
67 kg	11.6
72 kg	8.4
>72 kg (outside competition limits)	24.1

SOURCE: NHANES III, 1988-1994, women aged 20-29 years, excluding those who were pregnant and/or lactating at examination (n = 1,625)

There is a better dispersion of athletes in women's wrestling. It is interesting to note that the largest proportion of women in this population fall outside of the competitive limits of 72 kg. Discussion needs to be focused on the question of whether the population data is truly representative of the pool of potential athletes. If the people above 72 kg are not likely to be athletes, it would not be appropriate to add an additional weight class.

Prior to the contraction of weight classes, the weight classes at the extremes, while having fewer entrants, were still represented with seemingly sufficient

number of competitors (see Table 5). These competitors have distinguished themselves in the annals of wrestling lore-Issaev (Bul), Javadi (IRI), Dimitriev and Kornilaev (URS), Kim (PRK) and Berceanu (Rom) all at 48 kg. It is worth noting that the highest points per match in the 1995 WC were from the 48 kg weight class. There is a world-wide secular trend towards larger people. However, many athletes may be lost to the sport of wrestling because of the elimination of the 48 kg weight class and this is an area that deserves additional research. Further study should include population data from other countries.



A great 48 kg wrestler from Bulgaria: Hasan Isaev Olympic Games champion in Montreal, 1976. Two time world champion - in Istanbul, 1974 and Minsk, 1975. Silver medal winner at the 1973 World Championship in Teheran.

Table 5: Participation rates per weight class in 1993 FS and GR World Championships

Weight Class Kg	# GR Athletes	# FS Athletes
48	24	22
52	25	23
57	34	26
62	33	29
68	29	33
74	31	28
82	30	31
90	27	25
100	23	19
130	19	17

Another use of these data is to create a model based on an equal distribution of the population within the weight class system. This approach would be an attempt to address the issue of fairness. If one were to create a fair system, a first approach could be to divide the population into the number of classes deemed necessary. For this hypothetical model, ten weight classes were developed. The procedure was to divide the distribution into eight classes (each class containing approximately 12% of the distribution) and also add a class at each tail of the distribution. The results of this model are shown in table 6.

Table 6: Weight Class Model Built on Equality of the Distribution of Population

Percentile	Men	Women
2	55	44
12	62	50
24	67	53.5
36	70.5	56.5
48	74.5	60
60	79	64
72	84	69
84	92.5	78.5
96	112	100
98	123	105

Use of Performance Factors: At what point does a difference in weight make a difference in the competitive outcome?

If one looks at the span from one weight class to the next, it can be expressed in absolute terms (kg), or as a percentage of the preceding weight class. The absolute difference between classes continually increases as one moves from lower to higher weight classes.

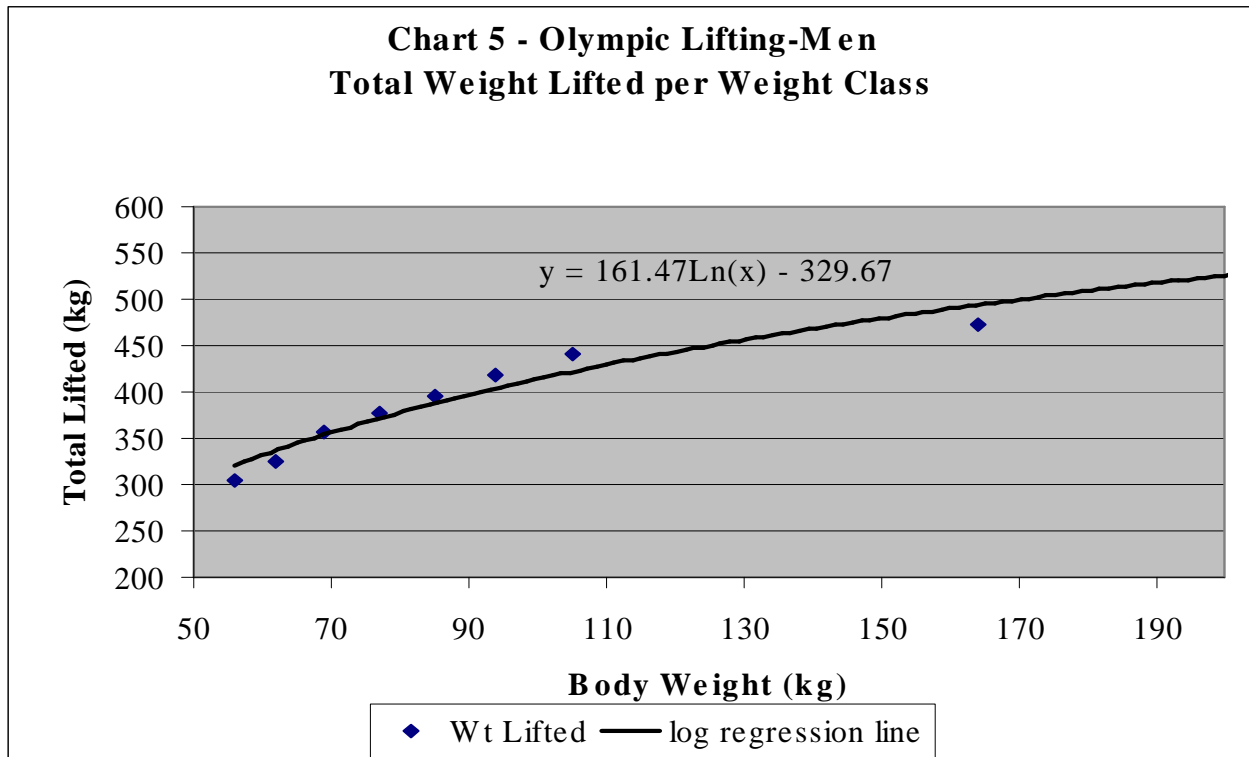
Table 7: Comparison of Weight Class Systems from 1969, 1997, & 2002

Weight Classes 1969	Absolute difference between classes (kg)	Relative difference (% increase)	Weight Classes 1997	Absolute difference between classes (kg)	Relative difference (% increase)	Weight Classes 2001	Absolute difference between classes (kg)	Relative difference (% increase)
48	4	8.3	54	4	7.4	55	5	9.1
52	5	9.6	58	5	8.6	60	6	10.0
57	5	8.8	63	6	9.5	66	8	12.1
62	6	9.7	69	7	10.1	74	11	14.9
68	6	8.8	76	9	11.8	85	11	12.9
74	8	10.8	85	12	14.1	96	24	25.0
82	8	9.8	97	33	34.0	120		
90	10	11.1	130					
100								
>100								
Average	6.5 kg	9.6 %		7.2 kg	10.6 %		8.2 kg	11.8 %

Excluding the highest weight class, the average weight between classes have increased from 6.5 kg in 1996, to the present 8.2 kg. When expressed as a percentage of the preceding weight class, the average increased from 9.6% to 11.8%. What is the role of mass in wrestling? The muscle tissue in the fat-free mass is the source for the generation of force and power to execute holds and overcome the forces and mass of the opponent. What percentage difference creates a competitive advantage? In competitions decided by the narrowest of margins, small differences in strength, power, inertia, and leverage could make difference in the outcome

One focus of attention can be on the relationship between strength and body mass. Studies have shown that the increase in strength as the subject increases in mass is not linear. An increase in size does not allow for the proportional increase in force generation.

A simple examination of the world record totals in Olympic weightlifting (Chart 1) shows a curvilinear relationship, with the strongest athletes, “pound for pound” at the lowest classes. Some of this relationship may be explained by the fact that in weightlifting, as well as in wrestling, one sees progressively higher percentages of body fat as the classes increase in size. This can be used as an argument for larger spans between the upper weight classes.



This suggests that one could employ an approach to the normalization of strength in relation to size. Jaric (2003) in his review of the role of body size in the relation between muscle strength and movement performance, distinguishes between various types of strength and testing modalities, and lists the resulting allometric scaling equations. However, taking the simplest case of strength (S) measured by a dynamometer, the normalized strength (S_n) in relation to body mass (m) is:

$$S_n = S/m^{2/3}$$

This expression can be used to equilibrate span of weight or size, throughout the range of desired weight classes. For example, if one wanted to establish 10 classes that contain equal spans of estimated strength from size, the following steps would be followed:

- 1) Calculate the scaling coefficient for each of the lowest and highest weight classes (for this model the range in place in 1995 is used).
 For 48 kg raised to the 2/3 power the coefficient is 13.21
 For 130 kg raised to the 2/3 power the coefficient is 25.66
- 2) The range defined by these two values is 12.45 scaling units.
- 3) Since 10 weight classes are desired, 12.45 is divided by 9 to obtain the span for each class. This value is 1.38333
- 4) This value is added to the coefficient associated with the lowest weight class to establish the next class (13.2100 plus 1.38333) and so forth for the following classes (1st column).
- 5) These coefficient values are returned to their associated weights by raising to the 3/2 power (2nd column) and are shown in Table 8.

Table 8: Weight Classes from Size and Strength Scaling

Scaling Coefficient	Weight (kg) Associated with Coefficient	Weight Class (kg)
13.21000	48.012	48
14.59333	55.748	56
15.97667	63.860	64
17.36000	72.331	72
18.74333	81.147	81
20.12667	90.294	90
21.51000	99.761	100
22.89333	109.538	110
24.27667	119.614	120
25.66000	129.983	130

Creating a Model from Population Equity and Performance Potential Equity

In the Performance Equity Model, strength to size is the factor being considered. Table 9 contains the set of classes that resulted from each approach.

Table 9: Model Weight Class Systems

Population Model	Performance Model
55	48
62	56
67	64
70.5	72
74.5	81
79	90
84	100
92.5	110
112	120
123	130

A panel of experts could use the above data to most effectively merge the important aspects of each, into one weight class system.

Other Considerations

Lower Weight Classes: It has been known that humans are increasing in size over successive generations. This is called a “secular trend.” Possible reasons include better nutrition, immunization among others. The size of athletes has likewise increased. Some of this may be tied to training, dietary manipulation, rule modifications, and the use of illegal ergogenic aids. The nature of the sport of wrestling offers access to many that may

otherwise be shut out of many other popular sports because of their size. For example, height has been studied as a factor for success in many sports. Khosla and McBroom (1988) studied the finalists in 47 different female events from the 1972 and 1976 Olympics. They found that 23.3% were greater than 175 cm. in height. If one were to use the US as a reference population, there were only 2.4% of females greater than 175 cm in height.

Khosla (1968) also pointed out the advantages posed to countries of differing average stature. The Japanese won 11 gold medals in individual events, 10 of which were in weight-categorized sports-boxing, wrestling, weightlifting, and judo. Elimination of the population at the extreme low-weight tail of the distribution could be viewed as a bias against cultural groups having a smaller mass. One can see that many sports tend to favor the larger competitor. Can/should sport provide opportunities for the entire span of sizes?

Anthropometry and Weight Loss: The general anthropometric characteristics of wrestlers show a high level of mesomorphy. Studies of elite wrestlers have shown the following somatotypes: 2.4 – 6.7 – 1.5 (Carter et al); Cuban freestyle wrestlers 1.8-6.8-1.4, Greco-roman wrestlers 2.0-6.5-1.5 (Betancourt-Leon et al); and greco-roman competitors from the European Championships 2.7 – 6.2 – 1.7 (Charzewski et al). The brachial index (length of the forearm relative to the upper arm as a %) is low for wrestlers and weightlifters where strength and stability is important. A low brachial index provides the biomechanical advantage of short force arms. Most wrestlers seek to compete in a weight class where their strength (power) to size ratio is maximized. Studies on wrestlers yield low body fat values. In his summary of the characteristics of elite wrestlers, Horswill reports a range of 7.6 – 9.8% body fat. This minimization of body fat-high fits the description of Norton and Olds, as most weight category sports, as one where the competitors use “size optimization.” This classification system of sports is based on the size qualities of the athletes the sport attracts. Additionally, wrestlers will intentionally lose weight to compete at a lower weight class using short-term weight loss methods that can prove to be injurious to health. The American College of Sports Medicine (ACSM), in their position statement on weight loss in wrestlers recommended adding additional weight classes, particularly in the lower and middle classes to reduce the need to use artificial or dangerous means to reach a competitive weight.

Changing High School Wrestling Weight Classes in the USA?

Currently, rules from the National Federation of State High School Associations calls for 14 weight classes in high school wrestling.

There have been changes over the years, some very small, some more significant. I have summarized this history into six general eras, or points of significant change. In the 1930's and early 1940's there were 10 weight classes: 95, 105, 115, 123, 135, 145, 155, 165, 175, and heavyweight (unlimited). For most of the 1950's and 60's there were 12 classes: 95, 103, 112, 120, 127, 133, 138, 145, 154, 165, 175, and heavyweight. From 1971 to 1985, the weight classes were 98, 105, 112, 119, 126, 132, 138, 145, 155, 167, 185, and heavyweight. In 1986, the heavyweight, or unlimited class, had a limit imposed to 275. This was adopted, ostensibly, to prevent injuries due to huge mismatches in size.

In 1989, there was an increase in the number of weight classes to 13. The 98 pound class was dropped, and smaller ranges between the middle classes were established (where there are the most wrestlers). The last significant change occurred in 1998, with the addition of a 215 pound class.

Recently, there have been criticisms of the current system with calls to reduce the number of classes, and move up the weight of the lowest class. The concerns voiced by these coaches are time constraints posed by 14 weight classes, the difficulty to fill complete line-ups, and that the lowest weight class is often won by underclassmen who grow out of the class. Jerry Diehl, NFHS assistant director, says that these concerns had been received in coach's surveys and were being reviewed by the wrestling rules committee. Dave Carlsrud, assistant to executive secretary of the North Dakota High School Activities Association and chairperson of the NFHS Wrestling Rules Committee says that his major concern was the length of tournaments created by having more weight classes, along with increased forfeits at both the upper and lower ends of the range of weight classes. He stated, "We do not want to reduce opportunities for participation, especially for the smaller athlete who does not have as many avenues." In order to have concrete data regarding the sizes of our athletes, the committee will use data from the National Wrestling Coaches Association. NWCA Executive Director, Mike Moyer has made available to interested state associations the Optimal Performance Calculator. This data management system provides

the determination and coordination of a minimal wrestling weight as part of a state's weight certification program, mandated by the National Federation. The initial weights of all participants are accessible and should provide a good picture of the athletes who are actually coming to the sport. From this we can see what classes are really needed. Moyer's program is currently utilized by 23 state associations and has a data base extending back several years. The data which can be utilized by the rules committee next April will have been gathered from over 200,000 wrestlers. It will also contain important information on the number of forfeits and match outcomes.

Dave Gannaway, an Assistant Director of the Illinois High School Association, will be the new chair of the national wrestling rules committee. His state is one which has overwhelmingly supported the current weight classes in recent coach surveys. He told me that data from his state's weight certification program will also be pooled with that from the NWCA and is looking forward to using actual numbers, "rather than impressions."

Future Work

- 1) Identify and use additional population studies from other continents, particularly Asia.
- 2) Do these population distributions reflect the true pool of potential athletes for wrestling?
- 3) The performance factor used in this paper only dealt with strength as a function of mass. Is this the best allometric scaling equation for wrestlers? For women? Are there other parameters that would be more useful, such as power?
- 4) There needs to be a discussion among experts, convened for the purpose of establishing a methodology for the "meshing" the population-based model and the performance-based models.

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