DOCUMENT RESUME

ED 095 181 SP 008 362

AUTHOR	Rasch, Philip J.; Kroll, Walter
TITLE	What Research Tells the Coach About Wrestling.
INSTITUTION	American Association for Health, Physical Education, and Recreation, Washington, D.C.
PUB DATE	64
NOTE	62p.
AVAILABLE FROM	AAHPER Publications-Sales, 1201 16th Street, N. W., Washington, D. C. 20036 (No price quoted)
EDRS PRICE	MF-$0.75 HC Not Available from EDRS. PLUS POSTAGE
DESCRIPTORS	*Athletic Coaches; *Athletics; Dietetics; Health; *Physical Activities; Physical Characteristics; Physiology; Psychological Patterns; Safety; Selection; *Teaching Methods; Weight
IDENTIFIERS	Wrestlers; *Wrestling

ABSTRACT

This guide for coaches working in wrestling is intended to provide coaches with an interpretation of the findings of research, to indicate what additional research is needed, and to provide a source of research references. The guide is divided into the following sections: (a) physical characteristics of the amateur wrestler, (b) physiological aspects of wrestling, (c) psychological characteristics of wrestlers, (d) selection of the wrestling team, (e) conditioning of the wrestler, (f) making weight and diet for wrestlers, (g) health and safety in wrestling. References follow each section. (JA)

WHAT RESEARCH TELLS THE COACH ABOUT

WRESTLING

Prepared by

PHILIP J. RASCH
Naval Medical Field Research Laboratory
Camp Lejeune, North Carolina

WALTER KROLL
University of Texas
Austin

In cooperation with the
NCAA Wrestling Coaches and Officials Association
and
National Association of Intercollegiate Athletic Coaches

AMERICAN ASSOCIATION FOR HEALTH, PHYSICAL EDUCATION, AND RECREATION

1201 Sixteenth St., N.W. **Washington, D.C. 20036**

WHAT RESEARCH TELLS THE COACH SERIES

John M. Cooper, Editor
University of Southern California
Los Angeles

What Research Tells the Coach About Wrestling

IN PREPARATION

What Research Tells the Coach About Swimming
What Research Tells the Coach About Nutrition
What Research Tells the Coach About Track and Field

Library of Congress Catalog Card No. 64-8922

CONTENTS

FOREWORD

This is the first in a series of booklets titled "What Research Tells the Coach" about a particular sport, being prepared under the direct supervision of the Research Council of the American Association for Health, Physical Education, and Recreation. The purpose is to make available to coaches an interpretation of the findings of research, to point out areas where research is needed, and to compile a list of research references about a specific sport.

The authors of this booklet, *What Research Tells the Coach About Wrestling*, have been active wrestlers as well as researchers of note. Dr. Kroll is at present a wrestling coach; Dr. Rasch is both author and researcher. We are fortunate that they have consented to combine their talents.

There has been no attempt to do any more than to let the coach know what has been discovered, what is known, and what is not known about a particular aspect. Technical research language is used in many instances. It is believed the up-to-date coach should be familiar with modern research techniques and tools so that he will be able to understand and utilize findings from research studies.

The authors have accomplished a tremendous task in compiling a comprehensive bibliography on wrestling research studies. The list is extensive and will be of value to both the coach and research worker. We commend this publication to all those interested in the sport of wrestling.

JOHN M. COOPER

PREFACE

From time to time it is profitable to examine the developments in a particular area and attempt an integration of the existing and sometimes voluminous accumulation of pertinent data. Several years ago the Research Council of the American Association for Health, Physical Education, and Recreation undertook to prepare a series of booklets which would make available comprehensive summaries of what research has revealed in regard to a number of sports. *What Research Tells the Coach About Wrestling* is one of the titles in this series.

It seems a reasonable hypothesis that wrestling could benefit from such an inventory of its affairs. One historian has suggested that wrestling must be one of the four oldest sports, exceeded in antiquity only by running, jumping, and throwing. It apparently demanded a high level of skill for success as far back as 4,000 years ago, but only in our own day have the various aspects of this and other sports been subjected to systematic study and analysis. A great many of these investigations are to be found in unpublished theses and dissertations. Other reports have been published in professional journals which are seldom available to coaches or trainers, or have been presented in scientific jargon which is often unintelligible to anyone except specialists. The authors of this booklet have endeavored to survey the pertinent research literature, evaluate it, and select from it the information which is most likely to be useful to the coach and trainer.

No effort was made to include all aspects of the sport; for example, the history, body mechanics, or techniques of the sport were not covered.

Neither will the synthesis presented in this booklet solve many of the crucial problems facing the coach or trainer. The answers to a number of important questions are simply not known, nor will many individuals be able to work under the ideal conditions where full advantage may be taken of everything that is known. Coaching and training are and may continue to be more of an art than a science; it is important, however, at least to be aware of what is fact and what is fancy. The materials in this publication may in some measure contribute to separating valid methods from those which are purely traditional. They may also serve to demonstrate how much needs to be done before coaching and training procedures in wrestling may be said to rest on a firm scientific basis.

Grateful acknowledgement is made to the many librarians and other individuals without whose cooperation this project would not have been possible. Appreciation is due to the editors of *Amateur Wrestling News* and of the *Journal of Health, Physical Education, Recreation* for their help in publicizing requests for bibliographic materials. The authors also wish to express their thanks to the American Association for Health, Physical Education, and Recreation for this opportunity to be of some service to a sport to which, for many reasons, they owe a great indebtedness.

PHILIP J. RASCH
WALTER KROLL

1. PHYSICAL CHARACTERISTICS OF THE AMATEUR WRESTLER

Anthropometrists have long recognized that the human physique may be classified into various general types. Particular kinds of body builds and body proportions may constitute important prerequisites for successful participation in many athletic activities. Extreme ectomorphs, for example, are not usually successful in football or weight lifting, while extreme endomorphs are handicapped in distance running. Thus a study of the physical characteristics of amateur wrestlers may provide a basis for describing the physical traits best suited for success in the sport, and may also suggest general performance requirements inherent in the activity itself.

A few decades ago European wrestlers were described as massive types, with great breadth of shoulders and great breadth and depth of chests, similar in appearance to weight throwers and weight lifters. They were said to have short necks, powerful shoulders, wide trunks, short legs, massive muscles, and great muscular strength (1, 2, 3, 13, 33). At least one student theorized that there was a genotype from which the wrestler-type developed by means of training (2). These observations do not appear to apply to the typical American amateur wrestler of today. Possibly the continuous evolution of the rules governing the sport[1] has had a selective effect on the type of physique which charac-

[1] Studies of these changes have been presented in such papers as Allen V. H. Sapora, *The history and development of the rules and techniques of wrestling*, unpublished master's thesis, University of Illinois, 1940; Dean Rockwell, *The historical basis for present-day American style wrestling*, unpublished master's thesis, University of Michigan, 1946; and Dale O. Thomas, *Chronology of changes in college wrestling rules, 1921-1956*, unpublished doctoral dissertation, State University of Iowa, 1956.

terizes the successful competitor at a given period, but the fact that a comparison of two sets of German data taken some years apart showed a tendency for the successful professional wrestlers of that country to change from a pyknic-muscular type to a muscular-athletic type (17) suggests that other factors are also involved. More recently amateur wrestlers have been described as being generally high in mesomorphy and relatively low in ectomorphy (32) and quite similar in appearance to gymnasts or 100 and 200 meter sprinters (6, 31).

The men to whom the earlier anthropometrists referred might have had a somatotype of approximately 361 or 471. Thirty-five present day varsity wrestlers from four Big Ten schools were found to have a mean somatotype approximating 354, a Rees-Eysenck index of 103.6, and a reciprocal ponderal index (RPI) of 12.9, from which it was concluded that they tended toward the agile rather than toward the ponderous type of body build (11). Sheldon (29) poetically describes this somatotype as

> Race horses and thoroughbreds. Longer legged, faster, more lightly built, but still very powerful, noble animals.

The mean RPI for young American males is 13.0. Freshmen wrestlers at the University of Michigan had an RPI of 12.6 (18), which is practically identical with that of 12.57 reported for 50 competitors in the 20th (1950) National Collegiate Athletic Association Wrestling Tournament (4), and only slightly lower than the figure of 12.8 for University of Michigan athletes as a whole. Observations of 70 candidates for the 1956 United States Olympic wrestling team revealed a mean Rees-Eysenck index of 96.8 and an RPI of 12.7. The ponderal index itself, 238 (T Score 59.9), was almost one standard deviation above the mean for college men (21). For the University of Michigan wrestlers it was 233 (T Score 55.5), which is practically identical with the 236 (T Score 58.9) recorded for athletes as a whole. By these indices wrestlers are rated as somewhat more ponderous and lateral in build than the average young American male, but the difference is relatively small.

The calculated specific gravity, lean body mass, and percentage of body fat and body water of a group of American Olympic freestyle wrestlers, Japanese amateur champion wrestlers, and a college varsity wrestling squad did not differ significantly from that of a group of nonwrestlers (24).

It would seem logical that men with different types of build should develop different styles of wrestling in order to make the best use of their natural attributes or overcome their innate disadvantages. General advice to this effect is frequently found in wrestling texts, but actually proving the obvious appears difficult. Bush (4) obtained the standing height, sitting height, weight, arm length, chest girth, and waist girth of a number of experienced intercollegiate wrestlers and endeavored to correlate body indices derived therefrom with the planes in which

escape and reversal maneuvers used by the subjects were initiated. His findings revealed no correlation between the two factors. The scanty evidence available simply confirms the opinion expressed by a board of experts: "There is no standard build that indicates a champion," (35) but this might safely be extended to include the further comment that the extreme mesomorphs so common in professional wrestling, the extreme endomorphs, and the extreme ectomorphs are seldom seen in amateur wrestling. A study of the 1959 and 1962 wrestling squads at the University of California at Los Angeles revealed a mean phenotype of 3½-5-2½ (N = 40) (22). The one thing typical of the general physique of the amateur wrestlers is the fact that it is well balanced between the three components.

The belief that the amateur wrestler is characterized by a huge chest is also a fallacy. The vital capacities of the American 1956 Olympic team wrestlers did not differ significantly from those predicted for normal males by the Pemberton-Flanagan nomogram, and their maximum breathing capacities did not differ significantly from those predicted by the Motley formula. While timed vital capacity data differed from those reported by Gaensler, this may have resulted from the fact that the latter had both sexes among his subjects (23).

It is quite commonly believed that strength is the most important single factor in success in wrestling (16), and traditionally, practice of this sport has been recommended to those wishing to gain muscular strength and hypertrophy (14). Some modern studies lend support to this recommendation; others do not. In one investigation, dynamometers were employed to test the strength of grip, back, chest, neck, and abdomen of 66 freshmen college students in a physical education wrestling class in October and again in December. Significant improvements were found in chest, neck, and abdomen strength. Eleven of the subjects wrestled competitively during the winter quarter. When tested again, only the abdominal muscles showed any significant increase in strength as a result of this additional training (19). A group of college men who participated in wrestling for six weeks showed no increase in grip strength, elbow flexion strength, or neck extension strength, but did show gains in leg extension strength, elbow extension strength, and hip flexion strength (9).

Tomaras (34) concluded that strength is greatly improved by training in wrestling, although he noted that wrestlers do not have strong hand grips, and found that when measured by the Total Proportional Strength test (TPS), outstanding wrestlers were stronger per pound of body weight than were any other group of athletes. Byram (5), however, was unable to substantiate these findings. In his subjects the flexion and extension strengths of six different muscle groups—forearms, lower legs, and trunk—showed no significant changes after five weeks of competitive wrestling. There is some evidence that the arduous training required

of a competitive wrestler results in the development of fatigue to the degree that a measurable decline in strength results (8).

When the TPS test was administered to competitors in the 1960 Amateur Athletic Union championships and to a visiting team of Japanese champions, the recorded scores were decidedly lower than those achieved by Tomaras' subjects. Neither the American nor the Japanese wrestlers were characterized by exceptional strength, and what superiority they did show over nonathletes in these tests may be attributed to greater leg strength scores (25, 26, 27). Identical findings have been reported concerning typical college and high school wrestlers. They were found to rate "very poorly on all mean strength measures," but "scored much higher on the leg strength measures than they did on grip strengths or back lift" (12).

There is, however, a serious question as to the relationship between TPS scores and athletic performance. Competitors in the Amateur Athletic Union 1960 championships recorded a mean of 6.71 per pound of body weight; the 1959 Japanese Amateur Wrestling Association team 6.82 (26); a group of Big Ten wrestlers 7.42 (11); competitors in the 1958 British Empire and Commonwealth Games 8.1 (20), and a wrestling team at the University of Illinois 8.36 (24).

Several studies have shown that it is not necessary to have fast reactions to be a successful wrestler. In 1943 Keller (10) concluded that an individual with a relatively slow total body movement time had a better chance of success in gymnastics, swimming, and wrestling than in baseball, basketball, and football. Only the swimmers were slower than the wrestlers under the conditions of his test. In general, wrestlers do not differ from physical education students in terms of reaction or movement times in response to visual, tactile, or auditory stimuli (30), nor are there differences in the response times of successful and unsuccessful wrestlers (12). When the raw scores are corrected for age, the response time and movement time of amateur wrestlers do not differ from those of nonwrestlers; the same is probably true of Japanese wrestlers (28). Contradictory results were reported by Wilkinson (36), who found that wrestlers responded significantly faster to the dropping of the arm from the horizontal position upon release of a supporting apparatus and to a visual signal than did baseball players, football players, basketball players, and nonathletes.

The Cureton tests of gross body movement reveal that wrestlers tend to be less flexible than swimmers but more flexible than college students in general (17). However, the statistical significance of the observed differences was not computed, and it is impossible to tell whether they are real or not. Employing more sophisticated techniques, Leighton (15) determined that significant differences exist in the flexibility of specialized groups of college athletes. This specificity of flexibility is consistent with the fact that the correlations between the items of the

Cureton test are low at best. Wrestlers tend to exceed normal young males in neck flexibility, shoulder adduction-abduction, shoulder rotation, elbow flexion-extension, and hip flexion-extension, and to fall below them in shoulder flexion-extension, wrist flexion-extension, ulnar-radial flexion, hip adduction-abduction, and ankle flexion-extension. In general the wrestlers tended to be less flexible than was true of baseball players, basketball players, swimmers, weight throwers, weight lifters, gymnasts, or the controls.

Summary

Contrary to the general opinion, the successful American amateur wrestler is not characterized by a highly mesomorphic build, a huge chest, and great bodily strength. He differs relatively little in body indices from the average young American male. Body types capable of agility appear to have an advantage over those possessing only brute strength. What superiority in the latter the wrestler does show over the nonathlete is due primarily to greater leg strength. Neither is the wrestler outstanding in respect to speed of reaction and movement; he may be highly successful and still be only average in these respects. Wrestlers are more flexible in certain respects than are nonwrestlers, but the fact that the areas of flexibility concerned tend to be specific for this sport suggests that they result from the practice of wrestling rather than characterize individuals who will become proficient in this sport.

REFERENCES

1. Arnold, A. *Körper-Entwicklung und Leibesübungen für Schul- und Sportärzte sowie Turn- und Sportlehrer.* Leipzig, J. A. Barth, 1931. Cited in Thomas K. Cureton, Jr., and others, *Physical fitness appraisal and guidance.* St. Louis: C. V. Mosby Co., 1947, p. 98.
2. Bach, F. *Anthrop. ang.* 1:200, 1924. Cited in Antti Telkion, Soini Pere, and Mikko Kunnas, *Anthropometric studies of Finnish athletes and wrestlers.* Helsinki: University of Helsinki, 1951.
3. Boardman, Robert. World's champions run to types. *J. Hlth. & phys. Educ.* 4:32 *et seq.*, 1933.
4. Bush, Russell L. *A study of the relationships between anthropometric measurements and wrestling maneuvers.* Unpublished master's thesis, Purdue University, 1950.
5. Byram, Howard M. *Effects of weight reduction on strength and on muscular endurance.* Unpublished master's thesis, State University of Iowa, 1953.
6. Cureton, Thomas K. Jr., and others. *Physical fitness appraisal and guidance.* St. Louis: C. V. Mosby Co., 1947, p. 40.
7. Fisher, John C. *Flexibility as a factor in body mechanics and athletic efficiency.* Unpublished master's thesis, Springfield College, 1938.
8. Hassman, Ralph P. *Changes in the physical status of varsity and freshmen wrestlers at the University of Oregon following a six week cessation of organized team practice and competition.* Unpublished doctoral dissertation, University of Oregon, 1960.
9. Johnson, Neil R. *The effectiveness of wrestling compared to standard weight training procedures for the development of strength.* Unpublished master's thesis, Pennsylvania State University, 1960.
10. Keller, Louis F. The relation of 'quickness of bodily movement' to success in athletics. *Res. Quart.* 13:146-55, 1942.
11. Kroll, Walter. An anthropometrical study of some Big Ten varsity wrestlers. *Res. Quart.* 25:307-12, 1954.
12. ———. Selected factors associated with wrestling success. *Res. Quart.* 29:396-406, 1958.
13. Kohlrausch, W. Zusammenhänge von Körperform und Leistung. Ergebnisse der anthropometrischen Messungen an den Athleten der Amsterdamer Olympiade, 1929. *Arbeitsphysiol.* 2:187-204, 1929. Cited in Thomas K. Cureton, Jr., and others, *Physical fitness appraisal and guidance.* St. Louis: C. V. Mosby Co., 1947, p. 95.
14. LaGrande, Fernand. *Physiology of bodily exercise.* New York: D. Appleton and Co., 1907, p. 248.
15. Leighton, Jack R. Flexibility characteristics of three specialized skill groups of champion athletes. *Arch. phys. Med.* 38:580-83, 1957.
16. Lynch, John J. *A survey study of the problems of weight-reduction in S.S.C.I.F. wrestling.* Unpublished master's thesis, San Diego State College, 1960.
17. Meister, W., and Kowalzig, G. Konstitutions- und Kreislaufuntersuchungen an Berufsringern. *Arbeitsphysiol.* 10:233-50, 1938. Summarized in *Biol. Abstr.* 14:438, No. 4663, 1940.

18. Meyer, Herbert H. *Anthropometry of athletes.* Unpublished master's thesis, University of Michigan, 1945.
19. Mooney, B. F. *The effect of wrestling on muscular strengths.* Unpublished master's thesis, International YMCA College, 1931.
20. Orban, William A. R. Dynamometer strength tests and performance of weight lifters in international competition. *J. sports Med.*, 2:12-16, 1962.
21. Rasch, Philip J. Indices of body build of United States freestyle wrestlers. *J. Assoc. phys. & ment. Rehabilit.* 12:91-94, 1958.
22. ——. Unpublished data.
23. ——, and Brant, John W. A. Measurements of pulmonary function in United States Olympic freestyle wrestlers. *Res. Quart.* 28:279-87, 1957.
24. ——, and Hunt, M. Briggs. A study of the calculated body composition of amateur wrestlers. *J. Assoc. phys. & ment. Rehabilit.* 13:90-93, 1959.
25. ——, and others. A study of the total proportional strength of young adult males. *Rev. Canad. Biol.* 19:369-76, 1960.
26. ——, and others. Effect of training for amateur wrestling on total proportional strength scores. *Res. Quart.* 32:201-207, 1961.
27. ——, and others. Norms for the total proportional strength test. *J. Assoc. phys. & ment. Rehabilit.* 14:67-68, 1960.
28. ——, and others. The response time of amateur wrestlers. *Res. Quart.* 32:416-18, 1961.
29. Sheldon, William H. *Atlas of men.* New York: Harper & Brothers, 1954, p. 173.
30. Smith, Glen R. *Comparison and relationship between reaction time, performance time, and balance among wrestlers and physical education students in college.* Unpublished master's thesis, South Dakota State College, 1960.
31. Tanner, J. M. Shaping up for athletic success. *Fam doc.* pp. 554-55, 1961.
32. ——; Israelsohn, W. J.; and Whitehouse, R. N. Physique and body composition as factors affecting success in different athletic events. *Med. sport* XIV:397-411, 1960.
33. Telkion, Antti; Pere, Soini; and Kunnas, Mikko. *Anthropometric studies of Finnish athletes and wrestlers.* Helsinki: University of Helsinki, 1951.
34. Tomaras, William A. *The effect of wrestling upon physical fitness.* Unpublished master's thesis, University of Illinois, 1948.
35. Umbach, Arnold W., and Johnson, Warren C. *Successful wrestling.* Dubuque: Wm. C. Brown Co., 1960, p. 80.
36. Wilkinson, James J. *A study of the reaction-time measures to a kinesthetic and a visual stimulus for selected groups of athletes and non-athletes.* Unpublished doctoral dissertation, Indiana University, 1958.

2. PHYSIOLOGICAL ASPECTS OF WRESTLING

Amateur wrestling is an extremely vigorous activity. As a result, participants in this sport have been the subjects of extensive studies by researchers interested in the effects of physiological stress on the human body. For convenience their findings as set forth below have been grouped together under the various areas covered.

Energy Cost

One investigator (12) has estimated that wrestling costs about 790 calories per hour; another (8) sets the figure at 4.2 calories per minute (252 calories per hour), with short spurts rising as high as 13 calories per minute. Two European studies (15, 22) agree in establishing the expenditure of energy in wrestling at about twelve times the resting rate.

Heart Size

Perhaps the first question to be considered is whether such exertion has an undesirable effect on the heart. So far as heart size is concerned, the evidence is highly contradictory. Albu (2) reported that at the end of one minute of wrestling there was no change in heart size; at the end of five minutes the heart was smaller; at the end of ten minutes it was larger. He considered this enlargement to be purely physiological. Perhaps this time factor explains why one German investigator (3) reported that there was a decrease in the size of the heart in wrestlers, whereas another (27) found that there was a physiological dilatation. Jokl (18) states unequivocally that the hearts of athletes become enlarged during training, whereas Krestovnikov (22) found only an "insignificant" in-

crease in the heart diameter of wrestlers, which was not attended by injury to health or work capacity. The transverse diameters of the hearts of Turkish wrestlers were at the upper limits of normal values (1). When the heart volume of athletes is expressed as milliliters per square meters of body surface, wrestlers (525 ml M^2BSA) are exceeded by distance runners, rowers and canoeists, swimmers, and skiers (21).

Wilce (44) has made the following statement:

> It is apparently "normal" for the hearts of successful American Olympic team wrestlers and their alternates to average 26 percent plus in cardiac area two days after successful final tryouts. Ten of the thirteen hearts were increased in size. All but one had potential heart disease factors, and one had right-sided cardiac dilatation. The cardiac enlargement may have resulted partially from heavy fluid intake after temporarily breaking training, with its excessive dehydration incident to reducing to lower weights.

In spite of the ominous sound of this to the lay reader, he (44) concludes:

> "Nonorganic cardiac enlargement" is probably of little clinical significance, and should be considered normal for athletes.

ECG Records

The ECG waves in the giant Japanese wrestlers are somewhat larger than in normal individuals, their amplitude being proportional to the individual's weight (29). A negative T_3 at rest has been found in professional wrestlers and is considered normal for these athletes (27).

Rasch and others (34, 35) recorded ECGs of 74 candidates for the 1956 United States Olympic wrestling team and carefully followed a number of these individuals through the tournament designed to select the team. They found that in general the ECGs of the wrestlers did not differ strikingly from those reported in the literature for healthy non-wrestlers of similar age, that there was no evidence that arduous training and competitive wrestling produced pathologic changes in the normal heart, and that there is a tendency for the amplitude of P_2 to increase, and for T_2 and T_{V5} and the Q-T interval to decrease after a competitive bout. Consistent changes were not observed in the measurements of R_2, S_2, P-R interval, and the duration of the QRS complex. The finding that wrestling has no deleterious effect on the heart was to be anticipated, since previous studies (16, 43) of groups of athletes which included wrestlers had concluded that the changes which take place as a result of exertion are not peculiar to the trained person and are not indicative of myocardial injury.

In a follow-up of the foregoing study (17) it was observed that the electrocardiograms of championship level amateur wrestlers demonstrated "notching" and/or "shouldering" more frequently than did those of nonwrestlers. It has been speculated that these represent "less synchronous contraction of the muscle fibers of one ventricle and are an advantage to the athlete by improving the efficiency of the emptying of the heart," (42) but it seems doubtful that any definite statement can be made at this time. Until longitudinal studies are completed, it will not be clear whether this condition predisposes a man to success in athletics, whether it results from arduous training, or whether it has no connection with his athletic career.

Ballistocardiographic Records

An experimental ballistocardiographic study has been reported, but it was found that the instrument is not sufficiently sensitive to reflect differences in circulatory fitness between trained wrestlers and individuals assumed to be in poor condition (18).

Pulse Rate and Blood Pressure

Typically, the resting pulse rate of well conditioned wrestlers averages 60 to 65 beats per minute at rest (1, 22, 33, 40). As with any vigorous activity, participation in the sport causes rises in pulse rate, systolic blood pressure, diastolic blood pressure, and pulse pressure. In one case, after eight minutes of wrestling the systolic blood pressure of both men rose 40 mm Hg. The diastolic pressure of one rose 25 mm Hg.; that of the other, 15 mm Hg. Pulse pressure rose 15 mm Hg. in the first case and 25 mm Hg. in the second. Pulse rate increased 65 beats per minute in one individual and 80 in the other. Systolic pressure returned to normal in 2 hours 40 minutes and in 3 hours 5 minutes respectively. Diastolic pressure became normal in 1 hour 12 minutes for the first man and in two hours for the second (24). Soviet sources (22) report that after a contest the pulse of wrestlers averages 130 to 160 beats per minute, sometimes reaching 200 beats, and the arterial blood pressure is about 140 mm Hg., although it has been observed as high as 230 mm Hg. Figures quite comparable to these have been recorded on American collegiate competitors. Maluke (25), for example, found that the mean pulse rate of members of a college team after matches was 146, and the mean systolic blood pressure was 153 mm.

It has been declared that the resting systolic blood pressures of athletes are lower and the diastolic pressures significantly higher than in untrained subjects, so that the pulse pressures of athletes are significantly reduced. This is interpreted as indicating a low stroke volume and cardiac output, an increase in total peripheral resistance, and a lessening of elastic resistance. These features are considered "typical of the

superior circulatory status of the athlete" (28). They do not appear characteristic of wrestlers. The normal values for males 20 years old are given as 120/80 mm Hg., or a pulse pressure of 40 mm (5). In Maluke's subjects the mean blood pressures were 121 75, for a pulse pressure of 46. In a different group (11) both blood pressures were slightly lower than the norms—118/76—so that the mean pulse pressure was 42. A third sample (40) showed resting (sitting) pressures of 118/72, for a pulse pressure of 46. The mean figures for a group of Turkish champions were 109/73 as compared with 103/65 for their controls, or mean pulse pressures of 36 versus 38 (1). Tests of 38 American college wrestlers showed mean horizontal systolic blood pressures of 122.4 at the start of the training season and 121.0 at the end of the season, five months later. The standing systolic pressures were 128.0 and 124.0 (36).

No statistical evaluations were employed in any of these studies, but the data strongly suggest that the differences were within the limits of the experimental error and that training for wrestling has little or no chronic effect on the systolic blood pressure. They also suggest that the evaluation of blood pressure measures and pulse pressure as "altogether useless in distinguishing between healthy young adults who obviously differ in physical fitness" (37) is probably correct.

A wrestler may take advantage of the Valsalva maneuver by applying pressure to the chest and abdomen of an opponent who is in a static position of strain. First there is a brief rise in blood pressure as the blood is squeezed out of the viscera. This is followed by a precipitous fall, as the compression interferes with the venous return and prevents a new supply of blood from reaching the heart. If skillfully done, the victim may become dizzy and "black out." Under less extreme conditions the use of an "expiratory grunt" may serve to increase intra-abdominal pressure, raise the venous pressure, and assist the venous return (26).

In connection with this subject it should be noted that wrestlers should not engage in strenuous training shortly after acting as blood donors, since giving blood unfavorably affects athletic performance. Near-collapse has been observed in individuals who engaged in competition shortly after blood donation (20).

Blood Chemistry

Considerable evidence is available describing the effect of wrestling on the biochemistry of the body. During a bout the lactic acid content has been found to increase from 9.4-13.7 mg. percent to 18.9-51.4 mg. percent; the sugar content increases from 97-111 mg. percent to 141-165 mg. percent. The quantity of chlorides in the blood increases after a short bout but diminishes after a prolonged bout. The quantity of hemoglobin increases about 4 percent (22).

Changes in the blood pyruvate level may be of importance in assessing carbohydrate metabolism. Ten minutes after a step test the mean blood pyruvate levels of a mixed group of wrestlers and track men showed significant increases. This general picture persisted at the end of 60 minutes. There were individual differences in each group, and there is a possibility that such changes could be used as a practical criterion of physical fitness (45).

The effect of wrestling on the white blood corpuscles has been studied by Karpovich (19). Samples of blood taken from varsity wrestlers showed that matches of two to four minutes produced a lymphocytic reaction, characterized by an increase in lymphocytes, and that matches over four minutes generally produced a neutrophilic reaction, characterized by an increase in neutrophiles. Karpovich concluded that these changes are mostly mechanical. An increased circulation washes out some of these cells. The longer the exercise, the more uniform the extraction of all kinds of corpuscles from the storage places. The possibility that these changes could be used as a measure of conditioning has been considered but is of doubtful feasibility.

A much more extensive investigation of this topic was undertaken by Farris (13), who made over 300 blood counts on wrestlers, tennis players, track men, baseball players, basketball players, golfers, crewmen, and football players before and after contests. He reported that the men fell into two groups: Basketball, football, and baseball players were characterized by a neutrophilia (polynucleosis), whereas the greatest increases in wrestling and track were due to lymphocytosis. Playing time was not a factor. The individual blood counts in wrestlers indicated that the best athletes had the greatest average increase in lymphocyte absolute values as determined by counts taken before and after competition. The author concedes that this is in contradiction to Karpovich's statement and attributes the difference to the small series utilized by the latter. The increase in leucocytes resulting from any game appears to depend upon the intensity of play rather than its duration. The blood picture of wrestlers was strikingly different from that of football players. The former showed an increase in lymphocytosis, while the latter showed a decrease. This was attributed to greater anxiety during an individual combat sport than during a team game. A definite relationship was found between playing time and erythrocyte changes, however. This increased up to 25 minutes of play, and thereafter decreased. Activity of lesser intensity was accompanied by a greater decrease in erythrocytes (13).

Both short bouts of exercise, such as wrestling for 15 minutes, and conditioning over a period of time increase the normal catalase content of the blood. This is interpreted to indicate an improvement in the oxidative process (6).

Kidney Function

After wrestling, albumin, sugar, hyaline, and granular cylinders may appear in the urine. The specific gravity of the urine is increased; the acidity of the urine and the number of phosphoric combinations are increased, and the quantity of chlorides is reduced (22, 25, 33). The increased acidity of the urine, the increase in the number of casts, the appearance of red blood cells, and the appearance of sugar has been observed to return to precompetition levels after a 40-hour postcompetition period, and after one study (33) it was concluded that "None of the transient symbols of renal trauma appeared with sufficient severity or duration to signify that permanent injury to the kidneys may result from wrestling conducted under intercollegiate or freestyle rules."

Physical Fitness

There are two major factors which comprise the general quality known as physical fitness: muscular strength and cardiorespiratory efficiency. Either of these is difficult to measure, since motivation plays such a large part in an individual's willingness to continue tests which are uncomfortable or boring or both.

The Schneider Index is now rather old, but is still considered one of the better tests for determining circulatory efficiency by the use of mild exercise. However, it is not adequate to discriminate between athletes (8). While various investigators (11, 40) have reported that wrestlers have a Schneider Index significantly higher than the controls, this is probably of little physiological significance.

Similarly, although it has been found that wrestlers have significantly higher scores in the McCurdy-Larson Organic Efficiency Index than do untrained men (11), it is doubtful whether this test is valuable as an index of general condition (8).

Tomaras (40) has shown that a season of training for wrestling results in an improvement in the five-minute step test significant at the 2 percent level. Opinions of this test vary widely. It includes both muscular and cardiovascular factors, and it is questionable whether these are properly weighted in the scoring system. One investigator (30) has reported that it "is not very closely related to one's ability to carry on . . . short extensive exercise of approximately one to six or eight minutes duration." However, the Army Medical Laboratory (10) concluded, "the test is a useful one and serves to give an approximate overall evaluation of the fitness of a group of men."

Wrestlers did not differ significantly from control groups in respect to vital capacity (11, 32, 40), but in any event this factor appears to have little significance as a measure of functional ability. Measurements of mean vital capacity are available in the literature, but these are of little practical use. Vital capacity is related to body weight and body

surface area, and there is such a range in the size of wrestlers that the comparison of mean figures of anthropometric measurements is not very meaningful unless a matched control group is used. So far this has not been done, although a variation of this approach was used in one study (32).

Disagreement in fact exists over the effects of wrestling on the thorax. It has been stated that wrestlers may be "stiff-chested with low expansion," (9) but it has also been claimed that wrestling increases the dimensions and mobility of the thorax (14).

The flarimeter test is related to the Valsalva maneuver in that the positive intrapleural pressure generated by blowing against the resistance offered by a column of mercury interferes with the venous return. It reflects the ability of the body both to withstand carbonic and lactic acid and to effect venous return under conditions of high intrathoracic pressure. It has been used as a physical fitness test, but there appears to be no data correlating scores on this test with athletic performance. Wrestlers do not appear to differ from other athletes in their performance on this test (40).

Freshmen numeral winners in wrestling do not have a higher physical efficiency as measured by the Tuttle pulse ratio test than do students in a physical education class in wrestling (7).

Students who participate in wrestling classes have been found to make greater gains in physical fitness as measured by the Armed Forces Physical Fitness Test (15 item battery) than do those who participate in swimming, but lesser gains than do those participating in tumbling, gymnastics, or conditioning programs (23).

As a test of all-around muscular endurance, Berrafato employed a battery consisting of (1) chinning, (2) push-ups, (3) sitting tucks, and (4) hops to test students in various physical education service courses before and after 15 weeks of participation. The wrestlers improved more than did the volleyball players, but less than did the weight lifters and the boxers. The gains observed for the wrestlers were almost entirely confined to push-ups (4).

One difficulty in evaluating findings such as the foregoing is that the investigators do not specify how much time the individuals being tested actually devoted to an activity. Under the overcrowded conditions characteristic of wrestling classes, a boy may actually wrestle for only a few minutes, whereas the man in the conditioning or gymnastics class may be busy for the entire period. Unless the time actually spent exercising is equated, findings such as the above must be accepted with considerable reserve.

A second problem lies in the fact that it has not been demonstrated that any of these tests actually measure the type of fitness required for success in wrestling. While there may be some overlap from one sport to another similar in nature, it is generally agreed that training is highly

specific. A boy may be in excellent shape for endurance swimming but in extremely poor condition for basketball. Until it is demonstrated that any given test of physical fitness correlates highly with the type of fitness required for success in wrestling, the significance of findings from the administration of such tests remains in doubt.

Balance

The problem of determining the relationship between wrestling and balance is complicated by the possibility that static equilibrium and dynamic equilibrium are unrelated. According to Travis (41), height, weight, and foot length are of considerable importance in dynamic equilibrium but have no effect on static equilibrium.

Schultz (38) administered the Bass Stick Test of Static Balance and the Bass Test of Dynamic Balance (Bass Stepping Stone Test) to 15 members of a college wrestling team and to 66 students in physical education classes. The wrestlers and the controls were then equated on the basis of McCloy's Classification Index II. The wrestlers were tested on three separate occasions with approximately a month's interval between testing, and the students on four occasions at approximately the same interval. All groups tended to show a significant gain in both dynamic and static balance, with no significant differences between the improvement of the wrestlers and that of the nonwrestlers.

When another investigator (39) administered the same tests to 26 college wrestlers and to 85 students in physical education classes, with no attempt made to classify the subjects, he observed some indication that wrestling improved static but not dynamic balance. Tomaras found no indication that wrestling improved balance as measured by walking the balance beam.

Krestovnikov states that "proprioceptive sensibility has a great significance in the case of wrestlers," but this is not demonstrable from the data which he adduces. While there is a suggestion that ability to maintain constant muscular pressure under changing dynamic conditions may be related to wrestling ability, balance and balance-learning tests employing a highly sensitive stabilometer, ability to maintain a constant arm position against a constantly changing force, and ability to discriminate changes in skin pressure are not so related (31).

Summary

The energy expenditure in wrestling is about twelve times that of the resting state. There may be a physiological enlargement of the heart as a result of training, and the electrocardiograms of wrestlers often exhibit certain anomalies. The pulse rate of a well conditioned

wrestler is about 60 to 65 beats per minute, and the blood pressures are within the normal range. Wrestlers should not act as blood donors shortly before engaging in competition.

The effects of wrestling on the biochemistry of the body are generally similar to that for any other form of strenuous work. However, there may be a decrease rather than the more common increase in lymphocytosis. This is attributed to the high anxiety factor present in individual combative sports. There is nothing to indicate that the effects of this sport on the kidneys are severe or lasting enough to indicate any trauma.

A number of studies have been reported in which one test or another was employed to measure the physical fitness of wrestlers. For the most part the findings are inconclusive. In many cases the subjects were in badly overcrowded classes and actually did comparatively little wrestling. It has yet to be demonstrated that the tests used actually measure the type of physical fitness requisite for success in wrestling, and their use in evaluating changes in condition as a result of training is a highly questionable procedure.

Insofar as the evidence reveals, good wrestlers are not characterized by high scores in the balance tests employed to date, and there is no evidence that balance is improved by wrestling to an extent greater than is true of other sports.

REFERENCES

1. Akgun, Necati, and Ustun, Emin. Teleroentgenologic investigations of champion Turkish wrestlers. *Res. Quart.* 31:547-52, 1960.
2. Albu, A. Die Wirkung körperlicher Überanstrengung beim Radfahren. *Berl. klin. Wohnschr.* 34:202, 1897. Cited in Aaron E. Parsonnet and Arthur Bernstein, Heart strain: a critical review; the development of physiologic concept. *Ann. intern. Med.* 16:1123-36, 1942.
3. Berger, W., and Olloz, M. Untersuchungen zum Studium des Trainiertseins. III, Herzgrösse und Herzschlagvolum. *Arbeitsphysiol.* 7:18-43, 1933. In *Biol. Abstr.* 9: No. 11517, 1935.
4. Berrafato, Peter R. *The effect of various physical education service courses on the all-around muscular endurance of university students.* Unpublished master's thesis, University of Illinois, 1949.
5. Best, Charles H., and Taylor, Norman B. *Physiological basis of medical practice.* Baltimore: Williams & Wilkins Co., 1961, p. 275.
6. Burge, W. E. The effect of gymnasium exercises and athletic contests on the blood catalase. *Amer. J. Physiol.* 63:431-32, 1923.
7. Carpenter, Kenneth E. *A study of the physical efficiency of freshmen wrestlers as measured by the Tuttle pulse-ratio test.* Unpublished master's thesis, Ohio State University, 1937.
8. Cureton, Thomas K. Jr., and others. *Physical fitness appraisal and guidance.* St. Louis: C. V. Mosby Co., 1947, pp. 299-300.
9. Dawson, Percy M. *The physiology of physical education.* Baltimore: Williams & Wilkins Co., 1935.
10. Dean, W. B., and others. *A critique of physical fitness tests.* Report No. 3. Army Medical Research Laboratory. Fort Knox, Ky., February 19, 1947, p. 11. Mimeographed.
11. Dening, Kenneth A. *Circulatory-respiratory characteristics of men in training for wrestling.* Unpublished master's thesis, Springfield College, 1952.
12. Dupain, George Z. *Exercise and physical fitness.* Sydney: Shakespeare Head Press Pty. Ltd., 1948, p. 80.
13. Farris, Edmond J. The blood picture of athletes as affected by intercollegiate sports. *Amer. J. Anat.* 23:223-57, 1943.
14. Gladishev, A. A. In Functional morphology of the motor apparatus. *Theor. & Pract. phys. Cul.* 22:76-78, 1959. (Translated by Michael Yessis.)
15. Gullichsen, R., and Soisalon-Soininen, J. L. Über die Kohlenstoffabgabe des Menschen beim Fechten und Ringen. *Skandinav. Arch. f. Physiol.* 41:188, 1921. Cited in Peter V. Karpovich, *Physiology of muscular activity.* (5th ed.) Philadelphia: W. B. Saunders Co., 1959, p. 115.
16. Hoogerwerf, S. Elektrokardiographische Untersuchungen der Amsterdamer Olympiadekämpfer. *Arbeitsphysiol.*, 2:61-75, 1929.
17. Isaacs, Mervyn; Brubaker, Merlin; and Rasch, Philip J. Electrocardiographic "notching" and "shouldering" in athletes and untrained men. *Cardiologia* 41:121-26, 1962.
18. Jokl, Ernst. Effect of sports and athletics on the cardiovascular system. Reprinted from *Cardiology* 5:25-30/25-75, 1961.

19. Karpovich, Peter V. The effect of basketball, wrestling, and swimming upon the white blood corpuscles. *Res. Quart.* Supplement No. 2 to Volume 6:42-48, 1935.
20. ———, and Millman, Nathan. Athletes as blood donors. *Res. Quart.* 13:166-68, 1942.
21. Karvonen, M. J. Problems of training of the cardiovascular system. *Ergonomics* 2:207-15, 1959.
22. Krestovnikov, A. N. *Studies in the physiology of physical exercise.* Moscow: State Publishing House.
23. Landiss, Carl W. *Relative influence of various physical education activities on motor ability and physical fitness of male college freshmen.* Unpublished doctoral dissertation, Pennsylvania State College, 1951.
24. Lowsley, Oswald S. The effects of various forms of exercise on systolic, diastolic, and pulse pressures and pulse rates. *Amer. J. Physiol.* XXVII: 446-66, 1911.
25. Maluke, Andrew W. *An investigation of some physiological results of wrestling.* Unpublished master's thesis, Kent State University, 1949.
26. McCurdy, James H., and Larson, Leonard A. *The physiology of exercise.* (3rd ed.) Philadelphia: Lea & Febiger, 1939, p. 82.
27. Meister, W., and Kowalzig, G. Konstitutions- und Kreislaufuntersuchungen an Berufsringern. *Arbeitsphysiol.* 10:233-50, 1938. In *Biol. Abstr.* 14:438, No. 4663, 1940.
28. Mellerowicz, H. Vergleichende Untersuchungen über das Ökonomieprinzip in Arbeit und Leistung des trainierten Kreislaufs und seine Bedeutung für die präventive und rehabilitative Medizin. *Arch. Kreislauff.* 24:70, 1956. Cited in Ernst Jokl, Effect of sports and athletics on the cardiovascular system. Reprinted from *Cardiology* V, 1961.
29. Miyama, Akira, and others. Studies on the functioning of the circulatory system in Japanese Rikishi (giant wrestler). *Acta Sch. Med. Univ. Kioto.* 14:117-26, 1931. In *Biol. Abstr.* 7: No. 3358, 1933.
30. Montoye, Henry J. The "Harvard Step Test" and work capacity. *Rev. Canad. Biol.* 11:491-99, 1953.
31. Mumby, H. Hugh. Kinesthetic acuity and balance as related to wrestling ability. *Res. Quart.* 24:327-34, 1953.
32. Rasch, Philip J., and Brandt, John W. A. Measurements of pulmonary function in United States Olympic freestyle wrestlers. *Res. Quart.* 28:279-87, 1957.
33. Rasch, Philip J.; Faires, Lucius B.; and Hunt, M. Briggs. Effects of a combative sport (amateur wrestling) on the kidneys. *Res. Quart.* 28: 54-59, 1958.
34. Rasch, Philip J., and others. An electrocardiographic study of United States Olympic freestyle wrestlers. *Res. Quart.* 29:46-53, 1958.
35. ———, and others. Effects of tournament stress on electrocardiograms of United States Olympic freestyle wrestlers. *Res. Quart.* 29:193-99, 1958.
36. Sargeant, Bliss P. *Effect of wrestling on systolic blood pressure.* Unpublished master's thesis, Springfield College, 1934.
37. Salit, Elizabeth P., and Tuttle, W. W. The validity of heart rate and blood pressure determinations as measures of physical fitness. *Res. Quart.* 15:252-57, 1944.

38. Schultz, Alden E. *The effect of a wrestling program on balance in college physical education classes and amongst members of a college wrestling squad.* Unpublished master's thesis, South Dakota State College, 1959.
39. Smith, Glen R. *Comparison and relationship between reaction time, performance time, and balance among wrestlers and physical education students in college.* Unpublished master's thesis, South Dakota State College, 1960.
40. Tomaras, William A. *The effect of wrestling upon physical fitness.* Unpublished master's thesis, University of Illinois, 1948.
41. Travis, Roland C. An experimental analysis of dynamic and static equilibrium. *J. exp. Psychol.* 35:218-34, 1956.
42. Trethewie, E. R. The ECG of world class middle distance athletes. *Cardiologia* 32:245-54, 1958.
43. Tuttle, W. W., and Korns, Horace M. Electrocardiographic observations on athletes before and after a season of physical training. *Amer. Heart J.* 21:104-107, 1941.
44. Wilce, J. W. The range of the normal heart in athletes. *Amer. Heart J.* 25:613-30, 1943.
45. Yanof, Zale A. Effect of exercise on blood pyruvic acid. *Arch. intern. Med.* 72:239-44, 1943.

3. PSYCHOLOGICAL CHARACTERISTICS OF WRESTLERS

The search for definable and measurable psychological characteristics linked to success in athletics has had an unhappy and continuing experience of frustration. Unlike in the physical and physiological areas, psychological researchers are faced with the dilemma of finding reliable tests for psychological traits which are defined in vague and general terms. Indeed, the question of the existence of some defined personality factors is a controversy itself. As a result, many of the available tests are notoriously unreliable, their validity is highly questionable (if considered at all), and their use has produced results that have been frustratingly contradictory.

One outstanding research psychologist (3) contends that prior to about 1950 "neither the physical nor the psychological measures were worth a cent," and that only in the last few years have psychological measures of personality achieved any worthwhile status. No wonder then that one of the more productive psychological researchers in athletics urges extreme caution and the need for conservatism in drawing conclusions from psychological investigations (12).

The problems involved may be illustrated by a study conducted by Ginn (8) who measured five swimmers, two basketball players, and nine track and field men on a battery of eight "quiet tests" believed to be possible indicators of emotional stress. The battery of tests included the brachial pulse wave, skin temperatures, ECG, pupil diameter, heart rate, blood pressure, respiratory rate, and static neuromuscular finger tremor. The tests were administered in an undisturbed state and again a few hours before a competitive event. The results revealed no significant

changes in any of the measures for the two sessions. The response patterns were highly variable, and there was no relationship between emotional response patterns and athletic performance. Even athletes in the same sport displayed divergent response patterns.

Emotional Responses

Johnson (14) used a subjective questionnaire and the physiological tests of pulse rate, blood pressure, and blood sugar level in one of the first attempts to measure the emotional impact of impending athletic competition. The tests were administered to 15 football players and five wrestlers a few days before, a few hours before, just prior to, and immediately after a contest. Johnson's interpretation of the data suggested that the measures were possible indicators of emotional stress and that wrestlers were more affected emotionally than were football players.

Later, Johnson (13) employed a sensitive psychogalvanometer coupled with psychosexual and sports word association tests to assess the reactivity of swimmers, wrestlers, and basketball and hockey players approximately one hour before a contest. The basketball players displayed significant reactivity compared to the other groups. The findings were in conflict with those of his previous study.

In 1955, Husman (11) investigated the effect of college boxing and wrestling upon aggression by means of three projective tests: Rosenzweig P-F Study, Thematic Apperception Test, and the Sentence Completion Test. Using nine varsity cross country runners and 17 nonathletes as control groups, the tests were administered during preseason, precontest, postcontest, and postseason periods. No significant differences were found for any group from one test session to another except for two changes among the control group on P-F factors. This result plus a questionable mass use of multiple t-tests suggests the need for caution in regard to the validity of certain other results.

Interpreting trends of nonsignificant differences, Husman concluded that wrestlers exhibited (1) greater overall aggression than did boxers, (2) a tendency to aggress toward the environment rather than to blame themselves when frustration appeared, (3) a greater need to protect their ego by directing aggression outward than did the boxers, and (4) a possession of more super-ego than did the boxers.

In a similar study Johnson and Hutton (15) arrived at conflicting results. The projective test, Buck's House-Tree-Person, was administered to eight wrestlers, and the results were evaluated by a clinical psychologist. Testing was done three weeks before, four or five hours before, and the morning after a competitive match. The precontest test revealed an increase in aggression directed inward rather than toward the environment, contrary to Husman's conclusion. The postcontest results indicated

a diminished level of aggressive feelings without direction (inward or outward), and a greater self-assurance replaced feelings of inferiority. The winning or losing of the match had no discernible effect on these factors.

Johnson, Hutton, and Johnson (16) also analyzed the results of a Rorschach and the House-Tree-Person projective tests given to a group of twelve outstanding national caliber athletes. The analysis suggested that these athletes were characterized by a high level of self-assurance, extreme aggressiveness, high and generalized anxiety, and the ability to express extreme aggressiveness freely. The sample included two wrestlers, but no detailed analyses of the separate sports were presented. To many of these individuals, being a champion was a matter of psychological necessity.

A study of the psychological effects of weight loss in high school wrestlers by Horowitz (10) suggested that wrestlers might become more docile with losses in weight over 4 percent of body weight. Weight loss was negatively related to extrapunitiveness (aggression expressed overtly and outwardly) and positively related to impunitiveness (aggression evaded or glossed over). Hence as weight loss occurred, wrestlers became less outwardly aggressive and tended to avoid reaction to any frustration.

Paskalides (20) extended Husman's original study of aggression to include consideration of changes in sexual tension after wrestling and boxing contests. Using certain parts of the work by Husman, the data were reexamined for eight wrestlers, eight boxers, and 18 control subjects. No statistically significant differences resulted. In interpreting trends, however, Paskalides concluded there was higher spontaneous verbalization of sex-related responses in athletes compared to the control group. The results did justify the conclusion that combative sports with vigorous physical demands did not lower levels of expressed sexual tension, at least as measured in this study.

Socioeconomic Aspects

One of the nation's outstanding wrestling coaches, E. C. Gallagher (1), believed that having the right father and mother enhanced chances for success in wrestling since the wrestler was thereby "bred right." He believed that the son of a rich man was a poor choice to become a wrestler, and selected only "poor boys who cannot go out in society."

Some support for his contentions is present in studies by Young (27) and Simone (25). Young used the Hat and North scale plus a level of education check list and collected data on Illinois high school state champion wrestlers. He concluded that the champions tended toward possessing lower social class membership. Simone found that after graduation from college, University of Utah wrestlers earned less than

swimmers, basketball and football players, track men, and tennis players. Conversely, Fulton (6) rated wrestlers' fathers at the State University of Iowa with the Goodenough Occupational Classification Scale, and the results indicated no differences between the backgrounds of wrestlers with those of other athletic groups.

Montoye and others (19) reported that the wrestlers studied all expressed a satisfactory economic status after graduation and were all married, findings not true for any other athletic group studied.

Personality Traits

Some studies have shown that wrestlers are not characterized by particular personality traits. Sperling (26), for example, administered a battery of tests to 171 varsity athletes, 138 intramural athletes, and 126 nonathletes at the City College of New York in the early 1940's. He found the 13 wrestlers demonstrated smaller mean differences compared to other athletes on Smith's Behavior Inventory, Guilford's Introversion-Extroversion Scale, Harper's A Social Study, Allport and Vernon's Study of Values, and the Ascendance-Submission Reaction Scale. Using Eysenck's Maudsley Personality Inventory, Rasch (21) found no differences for a group of 85 wrestlers from five different colleges on the factors of psychosis, extroversion-introversion, or neurosis when compared to available norms.

Two studies exist dealing with masculinity-femininity characteristics of wrestlers. As Rasch and Hunt (23) point out, it has been suggested that men might participate in wrestling as a means of gratifying latent homosexual tendencies. These investigators administered Berdie's Femininity Adjective Check List under a disguised test name to fourteen candidates for the 1960 United States Olympic Team. These top-flight wrestlers did not demonstrate test scores similar to avowed homosexual males, but were more like the normal male freshmen criterion group on which the test was standardized. Fulton (6) used the Guilford-Martin Inventory and found wrestlers were higher in masculinity than track men.

Other investigators have been able to demonstrate distinguishing personality traits in wrestlers compared to other groups. Without benefit of statistical tests for significance, Gupton (9) interpreted results from Rosenzweig's P-F test as indicating that better wrestlers submerge feelings of aggression toward the environment by evading or glossing over frustrations as evidenced by low aggression outward and strong impunitive scores. Husman's work (11) conflicts with this finding. Gupton's group of eight college wrestlers also exhibited a high ego-defense score, as did Husman's group, and a slightly low Group Conformity Rating purported to be a measure of social adjustment.

Fowler (5) measured 60 athletes on football, basketball, and wrestling varsity and junior varsity squads with Allport's Study of Values test

immediately after competitive schedules were completed. Ten varsity and ten junior varsity athletes in each sport were selected from universities in the Ontario-Quebec Intercollegiate Athletic Association. No significant differences between athletic groups were revealed, although Fowler interpreted the data as indicating wrestlers to be more aesthetically and socially centered when compared to norms.

Studying leadership characteristics of cadets at the United States Military Academy, Werner's (28) analysis of test results with Cattell's Sixteen Personality Factor Questionnaire indicated entering cadets who lettered in high school wrestling were more sociable, enthusiastic, adventurous, and group dependent than the nonlettermen group. Compared to entering cadet lettermen in other high school sports, wrestlers were significantly more group dependent and initative. This difference held over athletes in football, riflery, soccer, swimming, tennis, and track, but not over athletes in baseball, basketball, or cross country. At graduation, cadet varsity wrestlers were less sophisticated than academy lettermen in tennis and riflery.

In an illuminating study Lakie (17) utilized five scales from the Omnibus Personality Inventory in studying 230 athletes at four separate collegiate institutions. The entire group analysis revealed no significant differences between any of the five sport groups studied (basketball, football, tennis-golf, track, and wrestling). Analysis of sport groups at each of the separate schools showed that the state university wrestlers were different from the tennis-golf group only on the Liberalism scale. Lakie's interpretation of this was that wrestlers were "more flexible and willing to assume risks than the tennis and golf groups."

It is, of course, not to be expected that the average wrestler is concerned with such psychological subtleties or even consciously aware of them. The candidates for the 1960 United States Olympic wrestling team appeared to think of themselves as straightforward, mature, modest, and masculine, determined to accomplish their goals, and confident of their ability to do so (23).

Competitive Spirit

One of the first attempts to measure competitive spirit was made by Sievers (24) in a study to predict potential wrestling ability. Sievers employed a sustained hand grip strength test which McCloy (18) considered a test of competitive spirit. A wrestler was tested for grip strength on a hand dynamometer. He then was timed to see how long he could maintain two-thirds of his maximum grip strength. The measure did make some contribution to the overall prediction of potential wrestling ability.

Booth (1) developed a written test from the Minnesota Multiphasic Personality Inventory said to be capable of discriminating between good and poor competitors. Rasch, Hunt, and Robertson (22) administered Booth's scale to eleven UCLA and 24 University of Oklahoma wrestlers. At the end of the season each of the coaches rated their wrestlers on competitive behavior. The rank order correlations (.50 and .17) were low, and it was concluded that Booth's competitive behavior scale was of little value in predicting coaches' estimates of their wrestlers' competitive spirit.

Brown (2) had coaches and wrestlers rate varsity high school wrestlers on a competitive-aggressiveness scale. The high rank order correlations of .86, .91, and .95 for three separate teams indicated reliable agreement between the ratings by coaches and wrestlers. Using wrestlers rated high and wrestlers rated low on this scale, comparisons were made with a group of nonathletes on factors in the Edwards Personal Preference Schedule. Significant differences indicated that (a) low rated wrestlers were more enduring—hard working and persevering—than nonathletes, (b) high rated wrestlers were more aggressive than low rated wrestlers, and both groups of wrestlers were more aggressive than nonathletes, and (c) wrestlers were more domineering than nonathletes.

One other study might be mentioned in this area, although its intent did not pertain directly to assessment of competitive spirit. Fagan (4) administered twelve physical fitness tests to a group of high school wrestlers. A competitive record index based on team points won and lost and ratings of desirable qualities in wrestlers by the coaches were compared to scores on the physical fitness tests. The results suggested that physical fitness levels correlated better with coaches' ratings than with actual competitive performance. Hence, the coaches were apparently more influenced in their ratings by physical fitness factors than by real wrestling ability as evidenced by competitive performance.

Summary

An overview of the meager state of knowledge concerning psychological characteristics of wrestlers suggests the perplexing presence of contradictory findings. Most of the tests employed were among the best available, but even the best tests carry comments noting that they only suggest guidelines for evaluation and/or are experimental in nature. The poor validity and reliability of such measurement tools casts a question mark over even statistically significant findings. The unqualified acceptance of conclusions drawn from the weak basis of trends deduced by the investigator is not merited. In addition, Lakie's (17) finding that particular athletic groups may possess characteristics more

linked to the particular school attended than representing distinguishing traits of specific sport participants, may be especially pertinent. His work has demonstrated the need for careful consideration of sampling procedures.

However, the intuitive belief of the apparent significance of psychological characteristics important to success in wrestling is compelling. In pioneer work, such as the researching of psychological characteristics represents, the results may be discouraging. The task of probing into such perilous areas fosters many pitfalls. Those who have undertaken the necessary first steps have helped to open up a facet of athletic research that may well prove to be one of the most important ones.

REFERENCES

1. Booth, E. G. Personality traits of athletes as measured by the MMPI. *Res. Quart.* 29:127-38, 1958.
2. Brown, Edward A. *Personality characteristics of wrestlers.* Unpublished master's thesis, University of Minnesota, 1958.
3. Cattell, Raymond B. Some psychological correlates of physical fitness and physique. *Exercise and fitness.* Chicago: Athletic Institute, 1960.
4. Fagan, Clifford B. *A further study of the use of psycho-motor tests for the measurement of potential wrestling ability.* Unpublished master's thesis, State University of Iowa, 1940.
5. Fowler, William H. *A comparative study of evaluative attitudes of outstanding varsity athletes and junior varsity athletes.* Unpublished master's thesis, Springfield College, 1961.
6. Fulton, James B. *The relationship between selected personality traits and participation in different forms of athletics and gymnastics.* Unpublished master's thesis, State University of Iowa, 1948.
7. Gallagher, E. C. *Amateur wrestling.* Guthrie, Okla.: Co-operative Publishing Co., 1925.
8. Ginn, Ralph A. *Measurement of pre-competitive emotion.* Unpublished master's thesis, University of Illinois, 1959.
9. Gupton, Oscar W. *Personality characteristics in college wrestlers.* Unpublished master's thesis, University of North Carolina, 1951.
10. Horowitz, Leon D. *Psychological effects of weight loss as measured by the Rosenzweig P-F study.* Unpublished master's thesis, University of Maryland, 1956.
11. Husman, Burris F. Aggression in boxers and wrestlers as measured by projective techniques. *Res. Quart.* 26:421-25, 1955.
12. Johnson, Warren R. Some psychologically oriented research. *Phys. Educr* 10:35-37, 1953.
13. ———. Psychogalvanic and word association studies of athletes. *Res. Quart.* 22:427-33, 1951.
14. ———. A study of emotion revealed in two types of athletic sports contests. *Res. Quart.* 20:72-79, 1949.
15. ———, and Hutton, Daniel C. Effects of combative sports upon personality dynamics as measured by a projective test. *Res. Quart.* 26:49-53, 1955.
16. Johnson, Warren R.; Hutton, Daniel C.; and Johnson, Granville B. Personality traits of some champion athletes as measured by two projective tests: the Rorschach and H-T-P. *Res. Quart.* 25:484-85, 1954.
17. Lakie, William L. Personality characteristics of certain groups of intercollegiate athletes. *Res. Quart.* 33:566-73, 1962.
18. McCloy, Charles H., and Young, Norma Dorothy. *Tests and measurements in health and physical education.* (3rd ed.) New York: Appleton-Century-Crofts, Inc., 1954.
19. Montoye, Henry J., and others. *The longevity and morbidity of college athletes.* Indianapolis: Phi Epsilon Kappa Fraternity, 1957.
20. Paskalides, Thomas. *The effect of a boxing and wrestling contest upon sexual tension as measured by the Thematic Apperception test.* Unpublished master's thesis, University of Maryland, 1958.

21. Rasch, Philip J., and others. Neuroticism and extraversion in United States intercollegiate wrestlers. *J. Assoc. phys. & ment. Rehabilit.* 16: 153-54, 1962.
22. Rasch, Philip J.; Hunt, M. Briggs; and Robertson, Port G. The Booth scale as a predictor of competitive behavior of college wrestlers. *Res. Quart.* 31:117-18, 1960.
23. Rasch, Philip J., and Hunt, M. Briggs. Some personality attributes of champion amateur wrestlers. *J. Assoc. phys. & ment. Rehabilit.* 14:163-64, 1960.
24. Sievers, Harry Leo. *The measurement of potential wrestling ability.* Unpublished master's thesis, State University of Iowa, 1934.
25. Simone, Anthony. *The socio-economic status of intercollegiate athletes.* Unpublished doctoral dissertation, University of Utah, 1953.
26. Sperling, Abraham P. The relationship between personality adjustment and achievement in physical education activities. *Res. Quart.* 13:351-63, 1942.
27. Young, William. *The social stratification of the Illinois state high school wrestling and swimming champions, 1959-60.* Unpublished master's thesis, Northern Illinois University, 1960.
28. Werner, Alfred C. *Physical education and the development of leadership characteristics at the United States Military Academy.* Unpublished doctoral dissertation, Springfield College, 1960.

4. SELECTION OF THE WRESTLING TEAM

Research investigations, such as have been reviewed in previous chapters of this monograph, may be viewed as falling into particular categories common to all sport research. Such an approach could consider one category as indicating characteristics possessed by successful performers, and a second category of characteristics developed by participation in the particular activity. Logically, our confidence in the meaningfulness of the measures used would be enhanced if there was reasonable agreement between the two categories.

The next step would be to develop prognostic tests capable of predicting the likelihood of success for new groups on the basis of factors known to be both possessed by successful performers and also developed by participation in the activity. That is, we would have confidence in our knowledge of what it takes to be a successful performer and be reasonably well equipped to develop tests capable of identifying such talent in new groups.

Unfortunately, research conclusions indicate few distinguishing characteristics possessed by successful wrestlers and considerable disagreement over what is even developed by participation in wrestling. No wonder the situation is somewhat bewildering when one compares the two categories against each other. For example, a careful review of the preceding chapters would offer some support to each of the following self-contradictory statements. Wrestlers are extreme mesomorphs with massive, broad bodies, and they are not. Wrestling both requires and develops strength and endurance, and it does not. Wrestlers are mobile and quick-reacting, and they are not. Wrestling requires and develops balance, and it does not. Wrestlers are aggressive, and they are not.

Wrestlers have poor socioeconomic status, and they do not. Wrestlers are characterized by particular personality traits, and they are not.

The problem is not necessarily limited to wrestling alone. During the 1920's and 1930's the physical education field produced numerous sports skills tests, a movement still in progress today. Such tests were meant to be useful for grading or classification purposes, and hence could be considered to be indicators of successful performance in the particular activity being studied. These tests have had only mild success. A great many of the earlier ones were subjectively designed and their external validity never established. Few, if any, of all the tests available have been extensively cross-validated to show their predictive value in new groups, a critical test for the worth of any such device. On the other hand, several of the skill tests report validity coefficients as good or better than some well accepted psychological tests.

The few studies done on wrestling have concerned themselves chiefly with the prediction of potential wrestling ability utilizing test items which measure innate characteristics rather than being tests of wrestling ability per se. Test makers in sports such as basketball have followed the common practice of defining and then measuring basic skill components such as dribbling, passing, and shooting in an attempt to predict all-around basketball ability. Studies on wrestling, conversely, have assessed overall wrestling ability either by subjective ratings or by actual competitive success and then sought to find correlates with the basic components of physical fitness, body types, speed of movement, motor educability, psychological characteristics, and so on.

The earliest and thus far most successful study was done by Sievers (8) in 1934 in an effort to measure potential wrestling ability using a group of 30 high school wrestlers. He concluded that the Sargeant Jump, breath holding, the apparatus to test applied forces, and the "switch" tests were of little value in estimating wrestling ability. Three tests, however—the Athletic Index, Sustained Grip test, and the Front and Back Leaning Rest test—gave a creditable estimate of wrestling ability as assessed by subjective ratings. He developed a multiple regression equation with subjectively rated wrestling ability being equal to .4594 Athletic Index plus .3105 Sustained Grip plus .2402 Front and Back Leaning Rest. The reported correlation, an incredible .972, has never been duplicated since. His conclusions about explosive strength were supported by Burley and Anderson (1) who found that wrestlers were inferior to track athletes, swimmers, basketball players, and football players in this respect.

A few years later Fagan (3) attempted a study along similar lines. Two separate criteria of wrestling ability were established, and a battery of physical fitness tests were then given to 52 varsity high school wrestlers. A competitive record criterion based on season won-and-loss performances showed a moderate correlation of .64 with the second

criterion based upon each coach rating wrestlers on ten desirable abilities. Intercorrelations revealed that the physical fitness tests correlated higher with the coaches' ratings than with the competitive record. A multiple correlation value of .475 was found in predicting coaches' ratings using the Johnson Motor Educability test, the Burpee test, and the Physical Fitness Index. The actual competitive record criterion correlated with the Johnson test .23, the Burpee test .17, and the Physical Fitness Index .11. None of the latter correlations are significantly different from zero. All correlations as well as the multiple correlation formula were considered too low by Fagan to be of much value in predicting potential wrestling ability.

The results also suggest (although not cited in the study itself) that the coaches tended to rate the wrestlers more on the basis of possession of certain physical attributes than on the wrestlers' actual competitive ability. That is, coaches' ratings were apparently highly influenced by qualities of physical fitness conceived to be important, and, as it turned out, did a relatively poorer job as far as being able to predict actual competitive success.

In comparison, the studies by Sievers and Fagan display some conflicting results. Whereas Sievers found the Front and Back Leaning Rest test to contribute to the prediction of subjectively rated wrestling ability, Fagan found it to correlate negatively ($-.10$) with his own competitive record. Siever's highly weighted Athletic Index correlated only .06 (nonsignificant) when Fagan compared it with his competitive record. Thus, some of the positive relationships found in each of the separate studies are apparently contradicted when compared against one another.

Mumby (6) measured 21 students from intermediate and advanced wrestling classes on apparatus designed to assess the ability to maintain (a) constant pressure, and (b) constant position under changing test conditions. A skin pressure sensitivity test as well as a balance test in the referee's position were also included. Scores were compared with ratings made by two coaches. These ratings, it should be noted, were not of wrestling ability in the usual sense but were ratings of the wrestlers on "such things as ability to notice change of force, awareness of relative body positions, and overall balance." The group was divided into good wrestlers and poor wrestlers on the basis of ratings with significant differences being demonstrated on the constant pressure and balance tests. However, when balance and balance learning were correlated with the coaches' ratings, no significant correlations resulted. The tests were considered to be of little value for the use intended.

Gross, Griesel, and Stull (4) studied the relation between the Iowa Revision of the Brace, Metheney's revision of the Johnson test (both classified as motor educability tests), and McCloy's Strength test and subjectively assessed wrestling ability after eight weeks of instruction.

The unique feature of the study was that none of the 56 college students studied had ever had any wrestling experience. The highest correlation found was .498 between McCloy's General Strength Quotient and the ability to learn wrestling. A multiple correlation of .602 was found, using the two motor educability tests plus the strength index in predicting rated wrestling ability. The authors concluded the results to be impractical for predicting wrestling ability in college men.

It should be noted, however, that this multiple correlation was higher than the one found by Fagan (R=.475) based upon the Johnson test, a Burpee test, and the Physical Fitness Index. Since the number of subjects used was quite similar (52 and 56), the studies suggest the possibility that there is a slightly better chance of predicting wrestling ability in unskilled groups than in skilled groups, which is usually the case if reliable tests are used. Fagan's Physical Fitness Index correlated .22 with coach-rated wrestling ability while Gross, Griesel, and Stull found a correlation of .498 between McCloy's Strength Quotient and subjectively rated wrestling ability. This may indicate that strength is more important for beginning wrestlers than for advanced wrestlers. Fagan, it must be remembered, also found that his measures correlated more poorly with an actual competitive record criterion. It is likely that the values reported by Gross, Griesel, and Stull would be lower for the prediction of actual competitive wrestling success.

Also of interest is the similar value the Johnson Motor Educability test had in predicting subjectively rated wrestling ability. The two values, .368 and .331, suggest that motor educability is an important factor related to wrestling success. Although physical education researchers tend to refute the worthwhileness of such low predictive measures, it would be well to remember that some of the commonly used tests to predict college academic achievement possess validity coefficients in the order of .3 to .6. Such predictive efficiency is acclaimed by psychological test makers while physical education researchers tend to deride such results as too low to be of practical value. Indeed, it is of value, but apparently the predictive power we seek may be quite unrealistic.

It seems likely that the reason such tests are not more successful in predicting wrestling ability is that the most important single factor in a wrestler's success may be motivation. A man with a flaming desire to win may, and often does, triumph over opponents who seemingly surpass him in ability and every possible natural advantage.

One point that might also be mentioned in connection with the prediction of wrestling ability is the common result found by Kroll (5), Romanowski (7), and Yahr (9) concerning take down performances and overall wrestling success. In his study of offensive maneuvers used by Wisconsin wrestlers in 40 high school championship bouts, Yahr found that the wrestler who secured the first take down won 76 percent of the

bouts. Kroll analyzed the results of 1,029 individual matches for 90 high school wrestlers and found that successful wrestlers (defined as ones who placed in a sectional or state tournament) secured the initial take down 70 percent of the time and lost it only 9 percent of the time. In the remaining 21 percent, no take down occurred. The unsuccessful wrestlers, on the other hand, secured and lost the initial take down about the same percentage of the time (38 and 37 percent respectively). In addition, initial take down performance was unrelated to measures of strength and speed of movement. Romanowski studied 288 wrestlers in high school, college conference, and national tournaments and found that wrestlers who won their bouts outscored losers three to one on take down points. Bush (2) found no relationship between maneuvers employed and various anthropometric measures in his study.

Rightly or wrongly, take down ability suggests itself as the most important single skill in amateur wrestling as conducted under the rules in vogue. Unfortunately, take down ability as a predictive test may be inappropriate as a measure to assess wrestling potential in unskilled groups. Take down ability seems unrelated to speed of movement, static strength, and certain anthropometric measurements. It also seems unlikely that it could be related to cardiovascular condition, since initial take downs occur within the first two or three minutes of a match. These studies, which have pointed up the lack of relationship between take down ability and certain traits, are similar to the studies which have been unable to define distinguishing characteristics in a number of groups of successful wrestlers.

Summary

There appears to be no outstanding test or group of tests which will successfully select the best potential wrestlers. Although certain tests of strength, endurance, psychological characteristics, motor educability, balance, body type, and body proportions suggest the need for certain minimum levels of quality in such respects, they represent a poor basis for selection. Whatever the qualities are that are necessary for wrestling success, no adequate artificial tests are available to measure them. Indeed, one might suggest that wrestling skill is an independent, pure factor.

Hence, the best technique for team selection continues to be actual competitive matches. Wrestling enjoys an advantage over some other sports in which the best performers may have to be picked primarily on the subjective appraisal of the coach. In some respects these results may be taken to be a compliment to the sport of wrestling since there appears to be no inherited characteristics that are prerequisites for wrestling success.

REFERENCES

1. Burley, Lloyd R., and Anderson, Roy L. Relation of jump and reach measures of power to intelligence scores and athletic performance. *Res. Quart.* 26:28-35, 1955.
2. Bush, Russell Lee. *A study of the relationships between anthropometric measurements and wrestling maneuvers.* Unpublished master's thesis, Purdue University, 1950.
3. Fagan, Clifford B. *A further study of the use of psycho-motor tests for the measurement of potential wrestling ability.* Unpublished master's thesis, State University of Iowa, 1940.
4. Gross, Elmer A.; Griesel, Donald C.; and Stull, Alan. Relationship between two motor educability tests, a strength test, and wrestling ability after eight weeks' instruction. *Res. Quart.* 27:395-402, 1956.
5. Kroll, Walter. Selected factors associated with wrestling success. *Res. Quart.* 29:396-406, 1958.
6. Mumby, H. Hugh. Kinesthetic acuity and balance related to wrestling ability. *Res. Quart.* 24:327-34, 1953.
7. Romanowski, Walter V. *A comparative study of the effectiveness in the neutral standing position versus working on the mat in terms of points scored in amateur wrestling.* Unpublished master's thesis, Purdue University, 1952.
8. Sievers, Harry Leo. *The measurement of potential wrestling ability.* Unpublished master's thesis, State University of Iowa, 1934.
9. Yahr, Donald E. *A study of offensive wrestling maneuvers used by high school champions in the state of Wisconsin.* Unpublished master's thesis, University of Wisconsin, 1959.

5. CONDITIONING THE WRESTLER

Almost every textbook or article written about wrestling cites the need for wrestlers to possess outstanding levels of physical fitness. The disappointing performance of United States wrestlers at the World's Championships at Toledo in 1962, for example, was blamed in part on the lack of time for training and conditioning (6). Few of the investigations studying levels of physical fitness in wrestlers, however, have corroborated such beliefs. As was discussed in Chapter I, the typical amateur wrestler is not characterized by great strength, and it is difficult to say to what extent increasing this factor improves wrestling performance. Thus, just as in the selection of wrestlers, the lack of definite evidence that specific traits are important to successful wrestling complicates the planning of conditioning programs. The failure to stringently identify factors essential to wrestling success means that the planning of conditioning programs must be done without sound scientific basis.

Fortunately, however, there are some better guidelines than a statement once made by a physical education writer that "Wrestling does not develop extra lung cells. . . ." In fact, it is encouraging to see that wrestling is making use of some of the general principles of athletic training being developed in the field as a whole. Material found in preceding chapters has pertinence to the problem of conditioning; that presented in this chapter, however, will consider only those studies directly pertaining to conditioning.

The first systematic study of conditioning practices apparently was conducted by Carter (4) in a 1941 survey of the kinds and amounts of conditioning practices used by 25 high school and 25 college coaches. One of the major differences found was that high school coaches stressed strength training while college coaches put more emphasis on general condition and endurance. The types of conditioning activities

used and the purposes of such activities were quite similar, the difference being in time spent on activities and the number of different activities used. All coaches used wrestling as a general conditioner, but fewer high school coaches used running for this purpose than did college coaches. Only four high school and one college coach used weight training as an activity to develop strength.

High school preseason conditioning programs lasted almost five weeks, while the college program was over seven weeks in length. College coaches stressed wrestling and running sooner and more often in their program than did the high school coaches. The most used conditioning practices, and the number of coaches using each activity were as follows:

High School		*College*	
wrestling	(25)	wrestling	(24)
bridging	(22)	running	(21)
push-ups	(18)	bridging	(12)
running	(18)	push-ups	(11)
leg raising	(15)	rope skipping	(11)
knee bends	(9)	rope climbing	(11)
rope skipping	(9)	fundamentals	(6)
rope climbing	(7)	chins	(4)
standing wrestling	(7)		
sit-ups	(6)		
chins	(5)		
rocker	(5)		
bicycling	(4)		
barbells	(4)		

Since Carter's study, athletic conditioning practices have undergone a radical change in many sports due to systematic and scientific investigation. Of particular interest is the study by Funston (7) who polled 154 out of 192 wrestlers at the Illinois state high school tournament in 1960-61. Carter's study showed that only a few of the coaches used weight training, but Funston's results showed that almost half (47.7 percent) of the wrestlers had utilized weight training, and over three-fourths (76.7 percent) of the coaches encouraged such training. However, only about 45 percent of the coaches actually conducted a weight training program before or after school hours. It was not revealed how many coaches incorporated weight training as a part of the regularly scheduled practice periods.

The most popular routines included the military press, two-hand curl, bench press, full squats, prone pull-overs, press behind neck, and the upright rowing motion. Less popular exercises, used by less than half of the group, included the weighted sit-up, stiff-legged dead lift, weighted bridging, reverse curl, bent rowing motion, shoulder shrugs, and side bends. Of these exercises, some question might be raised about the suitability of the full squat exercise (8, 10). The use of weights

in a training program, however, is certainly to be recommended if efficient development of strength is desired (3); for instance, while the Soviets are notoriously secretive about their training programs, there is evidence that the use of barbells is incorporated in them (1).

Other investigators have sought to assess the relative effects of different kinds of training programs in relation to wrestling. Johnson (9) studied the effects of six weeks of wrestling compared to six weeks of weight training on the amount of strength developed in 45 wrestlers, 31 weight trainers, and a control group of 29 men. The weight trainers exercised three times weekly doing presses, curls, squats, neck raises, and hip flexions with iron boots, and squeezing tennis balls. It was found that neither wrestling nor weight training programs of the duration studied developed grip strength, elbow flexion strength, or neck extension strength. The two programs were of comparable value in significantly developing leg extension, elbow extension, and hip flexion strength.

In an earlier study, Berndt (2) divided 30 high school wrestlers into three matched groups. One group followed a conditioning program utilizing only wrestling maneuvers and similar activities. The second group followed normal wrestling practice and in addition trained daily with setting-up and running exercises that included push-ups, sit-ups, leg lifts, rope climbing, running in place or mile run or rope skipping, deep knee bends, and high bridges. The third group followed again the normal wrestling practice but also included a daily weight training program of military presses, curls, bent rowing motion, stiff-legged dead lifts, prone pull-overs, weighted sit-ups, and weighted deep knee bends. The weight training as well as the calisthenics program increased in intensity progressively throughout the season.

After six weeks of training the groups were compared on preconditioning and postconditioning scores made on the Roger's Physical Fitness Index Test (right and left grip strength, leg lift, back lift, pull-ups, push-ups, and lung capacity). The results showed that the wrestling-only group did not improve significantly, but that the other two groups did. Both the calisthenics group and the weight training group were superior to the wrestling-only group, but were not significantly different from each other.[2]

Although Johnson could demonstrate no conditioning differences between wrestling and weight training, Berndt showed that weight training added to a wrestling program did make a difference on improvement in the Physical Fitness Index. It seems likely that the intensity of wrestling itself as conducted in these studies was not sufficient to produce maximum training effects as far as the physical fitness measures utilized were concerned.

[2] The statistical analysis actually made in the study was in error. Some of the conclusions in the study were then incorrect. The data have been recalculated properly, and the corrected results and conclusions are presented here.

Several articles (11, 12) have forwarded the idea of achieving conditioning through the teaching of fundamental skills. Admittedly, this is not a new concept, since Carter showed that six of his college coaches recommended and used it as a conditioning activity. The contention in these articles was that time should not be spent on calisthenic-type activities when more effective results might be achieved through skill practice sessions alone. The basis for one of these articles was evidently the work of Berndt. Unfortunately, the correct analysis of Berndt's data does not support the contention that wrestling alone is more effective than wrestling coupled with calisthenics or with weight training as supplementary conditioning activities. Indeed, it is not even as effective, and in Berndt's study it was shown not effective at all.

In view of the general similarity of wrestling and judo, the training program used at the Kodokan is of interest. This emphasizes the use of dumbbells and would certainly require the addition of bridging to be suitable for wrestlers. It incorporates the squat, straight arm pull-over, heel raise, bench press, flying motion, high pull-ups, curl, standing triceps curl, seated press behind neck, and sit-ups (5).

The conclusion to be drawn is not as simple as it might seem. The studies that exist certainly indicate that wrestling alone is not as effective as wrestling coupled with other activities in achieving physical fitness; in fact, this is probably true for many sports, as suggested by Campbell's work (3). What clouds such a straightforward conclusion are the questions of what kind of wrestling, what amount, under what conditions, and the like. No definitive studies exist at the present time to shed much light on this problem.

It should also be mentioned that a number of studies have shown significant improvement in physical fitness measures due to a season of wrestling. These studies were reviewed in the chapter on physiological characteristics. The difficulty in applying these results to the problem of planning conditioning practices is that many of these studies apparently utilized not only wrestling as an activity but many other conditioning activities as well.

Only one other study directly pertaining to conditioning need be mentioned. Vohaska (13) was unable to show any added improvement in cardiovascular measures during a four-week training period due to the addition of wheat germ oil feeding. The problem of diet is considered carefully in another chapter and so is not discussed here.

Summary

The problem of conditioning for wrestling is plagued by lack of knowledge of what is necessary for success, a problem not unique to conditioning alone. Even so, there does exist a rather common ground of

agreement among coaches as to what types of conditioning activities should be employed. This agreement does not, however, find its correlate with the few studies done to demonstrate what traits are linked to wrestling success.

It appears that coaches must define the fitness traits they deem essential and then select the most appropriate activities to develop such qualities. Little criticism or little encouragement can be possible based upon the studies available in the wrestling literature.

REFERENCES

1. Anonymous. Soviet wrestlers train much like Americans. *Scope Weekly*, May 7, 1958, p. 15.
2. Berndt, Donald William. *A comparatice study of conditioning programs for use in amateur wrestling.* Unpublished master's thesis, Springfield College, 1955.
3. Campbell, Robert L. Effects of supplemental weight training on the physical fitness of athletic squads. *Res. Quart.* 33:343-48, 1962.
4. Carter, Norvin Pryor. *The status of practices in conditioning high school and college wrestlers.* Unpublished master's thesis, Kent State University, 1941.
5. Draeger, D. Weight training for judo. *Strgth & Hlth*, June 1960, pp. 16 *et seq.*
6. Editorial. *Amatr. Wrestling News* 7:2, July 11, 1962.
7. Funston, Robert G. *A survey to ascertain the kind and amount of weight training used by participants in the 1960-61 Illinois state wrestling tournament.* Unpublished master's thesis, Northern Illinois University, 1961.
8. Helfet, Arthur J. Mechanism of derangement of the medial semilunar cartilage and their management. *J. bone & joint Surg.* 41B: 319-36, 1959.
9. Johnson, Neil Ralph. *The effectiveness of wrestling compared to standard weight training procedures for the development of strength.* Unpublished master's thesis, Pennsylvania State University, 1960.
10. Klein, Karl K. The deep squat exercise as utilized in weight training for athletics and its effect on the ligaments of the knee. *J. Assoc. phys. & ment. Rehabilit.* 15:6 et. seq., 1961.
11. Ream, Charles. Conditioning without calisthenics in wrestling. *Athl. J.* 39:35-36, 1958.
12. Sparks, Raymond E. Conditioning for effective wrestling. *J. Hlth., phys. Educ., Rec.* 26:42 *et. seq.*, 1955.
13. Vohaska, William John. *The effects of wheat germ oil on the cardiovascular fitness of varsity wrestlers.* Unpublished master's thesis, University of Illinois, 1954.

6. MAKING WEIGHT AND DIET FOR WRESTLERS

"Making weight" and its ramifications present one of the thorniest problems in the conditioning of athletes. In theory, coaches and authors of texts on wrestling are quite generally agreed that a man should compete as close to his normal weight as is possible, partly, perhaps, because of a general belief that men making weight tend to "go stale" more quickly than do those who are not. In practice, however, these same individuals may have their wrestlers do something quite different. There can be no question but that Ekfelt (18) is correct in stating that excessive weight reduction is one of the chief targets of critics of amateur wrestling, and that this has been cited by school authorities as an effective argument against the introduction of the sport into scholastic and collegiate institutions. At the 1961 convention of the American Association for Health, Physical Education, and Recreation, the conferees on wrestling agreed that this is one of the most serious difficulties confronting those interested in promoting the sport.

Some impartial observers (15, 27) view making weight as little more than a subterfuge whereby one wrestler is able to secure over another unfair advantages in height, reach, and leverage. Coaches (21), physicians (37), and professional groups (5) unite in strongly condemning excesses in the practice. Certainly most wrestlers heartily dislike the process but appear quite willing to utilize it in order to secure the advantages which it may give them or to protect themselves against opponents who seek such advantages. To the spectator the gaunt, desiccated wrestler probably looks more like a refugee from a concentration camp than a highly conditioned athlete—an impression which must certainly create an unfavorable image in the public mind. To the medical doctor the whole process "is just not good medical sense," (43)

and it has been said that in making weight the man shifts his position in the actuarial tables "a little bit in the direction of being a worse 'risk' than before" (15). A number of states have adopted plans designed to control the practice.

Actually, convincing scientific evidence of the harmful effects of making weight to the extent customary among interscholastic and intercollegiate wrestlers seems scarce, although the medical literature contains at least one report (26) of a case of acute pancreatitis developing as a result of this procedure. Nelson's study (29) of tenth, eleventh, and twelfth grade wrestlers showed no distinct developmental differences between those who made weight and those who did not, although there was an indication that the latter tended to make a slightly greater gain in height. Similarly, Alitz (3) reported that both wrestlers who made weight and those who did not achieved normal gains in weight and strength during the period extending from the beginning of the wrestling season to three months after its close. The main complaint heard from the wrestlers themselves is that they seem to catch cold more easily when making weight.

Weight losses of up to 5 percent appear to have no detrimental effects on the neuromuscular, cardiovascular, and respiratory systems, or on oxygen requirements (39). Strength measurements and maximal oxygen intake per kilogram of body weight, in fact, show no decreases up to a loss of 10 percent in body weight (38). When high school wrestlers who lost 4.4 percent to 6.9 percent of their body weight (mean seven pounds) were compared with those who did not make weight, no significant differences in pulse rates, systolic blood pressures, diastolic blood pressures, or scores on the Carlson Fatigue-curve Test were found (20). College wrestlers losing a rather similar amount of weight did not display any decrease in physical efficiency as measured by an adapted Harvard Step Test (19). Study of a group of wrestlers who lost an overall average of 10.29 pounds, or 6.78 percent of their body weight, with a maximum of 11.11 percent, revealed that weight loss within these limits did not materially affect a wrestler's strength, slow his reaction time, affect his balance in motion, reduce his endurance, nor hinder his development of power (30).

Byram (12) measured the muscular-endurance (ability to repeatedly flex a segment of the body against a resistance) and circulatory-respiratory endurance (Carlson Fatigue-curve Test) of a group of wrestlers before and after making weight and compared them with a control group who did not make weight. The experimental group lost weight equal to 11.04 percent of their body weight, but no statistically significant differences were observed in the parameters tested. Schuster (35) also studied the effects of rapid weight reduction on endurance. One half of his subjects were required to lose approximately ten pounds per man in a seven-day period, the other half serving as controls. Criteria

were the number of push-ups and squat-thrusts the subjects could perform and the number of miles they could ride on an ergocycle. There were no significant differences in performance before and after reducing, and in the opinion of the judges, the loss of weight had no effect on the men's wrestling ability. However, at least partially contradictory observations were reported by Edwards (17), who recorded the number of push-ups, number of pull-ups, right and left hand grips, maximum time of running on a treadmill, heart rate, blood pressure, and blood lactate level of only four subjects. Three of these lost a mean of 6.37 percent of their body weight during a seven-day period, while the other served as the control. No significant changes were noted in the strength tests, but the subjects making weight decreased an average of 30 percent in the time of the treadmill run. Physiological findings were inconsistent and inconclusive. The small sample and the short time involved in the study make the findings difficult to evaluate.

Making weight may involve exercise, use of sweat baths, and restriction of food and water intake. So far as strength tests or cardiac response to work are concerned, it appears to make little difference whether the wrestler reduces by running or by use of the sweat bath, although the running does give additional cardiorespiratory training. Wrestlers themselves generally prefer making weight over a period of several days rather than by "crash" methods, and there is some evidence that the latter may result in a deterioration of cardiovascular efficiency (2). Making weight by restriction of caloric intake raises the problem of whether the athlete is ingesting a sufficient amount of vitamins and minerals. The evidence is admittedly contradictory, but Bourne (10) has questioned whether an athlete in training can fulfill his increased vitamin and mineral needs from the foods he normally eats. This problem becomes much more severe when a man is in hard training on a greatly restricted diet, and indicates the necessity for the coach or trainer to satisfy himself that the diet is balanced even though limited.

While making weight by semistarvation embodies certain long-range dietary hazards, systems which employ the ingestion of extra quantities of salt to secure dehydration are undeniably dangerous. Needed fluid may be drained from the body and the fluid balance upset. If there is any tendency toward incipient kidney disease, the results may be serious. Use of this method, therefore, must be totally condemned.

There is, in fact, evidence that the effect of water restriction in making weight is much more serious than is the reduction in food intake. Fatigue is the first symptom of dehydration, and a significant reduction in work performance has been observed to accompany dehydration of the magnitude of 3 percent of body weight (9). Animal experiments have shown that water supplementation during running produces a marked improvement in endurance, which is believed to be related to the maintenance of normal hydration, improvements in temperature

regulation, and in the beneficial effect of water on carbohydrate metabolism (6). Perhaps once the wrestler has "weighed in" it is even more important to replenish his depleted water supply than it is to furnish him with food. Edwards mentions that his "subjects did not seem to suffer too much from hunger, but there were frequent complaints of thirst." It would seem possible that the differences between his results and those of Schuster might reflect differences in water deprivation undergone by the two groups of subjects. This would be consistent with the fact that physiologists have demonstrated that even moderate water deficits cause an increase in pulse rate, rectal temperature, and ventilation rate, and a reduction in circulating blood plasma volume, with eventual exhaustion as a consequence of circulatory inadequacy. There is evidence that men in good physical condition show a lesser cardiovascular strain from dehydration than do untrained men (11), but even so, "drying out" must be classed as a dangerous practice (34). Semistarvation, on the other hand, results in a reduction of the heart rate, a decline in blood pressure, and a decrease in the total metabolism. It seems likely that some of the differences reported in results of research on the effects of making weight are attributable to the relative amounts of fasting and dehydration sustained by the subjects.

Other physiological problems are also involved. For instance, when rabbits were deprived of water for 48 hours, a significant rise in the serum cholesterol resulted. This increase was greater than the increases in red blood cells or hematocrit (4). In the case of obese human subjects it has been demonstrated that serum cholesterol is related to caloric intake. When the caloric intake is curbed, the serum cholesterol decreases; when it is uninhibited, the serum cholesterol increases, even if the subject is kept on a low fat-low cholesterol diet (42). The effect of making weight on the serum cholesterol of healthy human males does not appear to have been investigated, but the foregoing suggests that contradictory processes may be involved and that the subject may be a complex one.

Once the wrestler has weighed in, it would appear important to allow him an ample quantity of water. The nature of the sport suggests that there may be possible mechanical disadvantages to entering a bout with a stomach full of water, and, too, it is often said that drinking prior to a contest interferes with an athlete's performance. The scientific studies which have been reported in the literature afford, however, no support to this opinion, as least insofar as noncontact activities are concerned (8, 23).

Overuse of laxatives is also fairly common among men making weight. This has been cited as a cause of potassium depletion (36).

Some objection has been raised to the use of various methods of "sweating off" weight (steam room, rubber suit, etc.) on the grounds that this causes a loss in body salt, as well as a disturbance of the body

fluid balance, possibly resulting in muscle cramps, weakness, and exhaustion. Just how serious this possibility actually is does not appear clear. The writers have found no reports in medical literature of the collapse of wrestlers due to salt depletion, but the benefits of increasing the salt intake during periods of hot weather appear well established. Interestingly enough, even after "fatigue" of the sweat glands has been induced by means of heat, heavy exercise will still stimulate copious sweating, and the concentration of sodium chloride remains essentially unchanged. It is not clear whether the heat does not actually exhaust the glands or whether they recover very rapidly (1).

It must be emphasized that the papers cited in this chapter have dealt almost exclusively with the acute effects of making weight; whether there are chronic disadvantages to this practice cannot be determined from the evidence now available. It is unfortunate that, apparently, no longitudinal studies of the health and fitness of jockeys have been reported in the literature. Although Nelson and Alitz have shed some light on the subject, there is much yet to be learned about the extent to which making weight may interrupt the growth cycle of the adolescent. It would be injudicious to ignore Peckos' (31) warning that children cannot afford a drastic reduction in calories and still maintain proper growth and development.

As a result of such considerations as have been set forth above, the Nebraska plan and a number of others designed to safeguard interscholastic wrestlers in particular against the possibly deleterious effects of excessive reduction in body weight have been proposed. Unfortunately, discussions of this project are seldom characterized by scientific detachment, and none of the proposed solutions to the problem have met with general favor. The present rules for interscholastic wrestling contain a recommendation by the Rules Committee that the family and/or school physicians be consulted and that they determine the lowest weight class in which a boy may compete. This has the advantage of shifting the responsibility from the shoulders of the coach to those of the physician, but all too often the latter is without qualifications in sports medicine and knows less about conditioning athletes than does the average competent trainer. The result is that the physician tends to be ultraconservative in his judgments. It is probably for this reason that Southern California wrestling coaches have expressed their preference for a plan by which a wrestler may not compete in a class lighter than the one in which he wrestles during the first meet of the season (24).

The trained wrestler is said to produce about 4 calories of energy per minute and to develop three times this amount for short spurts (33). Obviously this energy expenditure is dependent upon the food intake. Disregarding any considerations of making weight, there is little that can be said about the diet of wrestlers other than that it should be well balanced, varied, and adequate. Racial and religious dietary practices

and individual idiosyncrasies make it impossible to provide a table of recommended menus. "The general rule for all athletes is that the food intake must maintain the athlete at the optimal body weight for maximal performance, and must furnish the calories, amino acids, vitamins, and minerals necessary for growth, development, and function" (28). This does not necessarily require a large caloric intake; the biggest problem at most training tables is to prevent undesirable weight gains (40). At the 1928 Olympic Games it was observed that the average daily intake of 28 male competitors was 3,350 calories—about the amount required by any young male of average size who is fairly active physically—comprised of 139 g. protein, 390 g. carbohydrate, and 137 g. fat. This showed no distinct variations with event or climate of home country. Most of the athletes stressed their need for generous helpings of meat, eggs, and milk (7).

This emphasis on animal proteins is common among the vast majority of athletes and may be due not only to the biological value of proteins of this type, which is higher than in vegetable proteins but also to the vitamins and minerals contained in these foods, to certain combinations of amino acids or other nutrients not found in proteins of vegetable origin, or to the fact that the average utilization of animal proteins in the body is 9 percent higher than that of vegetable protein (22). Nevertheless, the high levels of athletic performance occasionally shown by vegetarians demonstrate that animal proteins are not essential.

The necessity for, or value of, protein dietary supplements for the athlete has yet to be demonstrated. One drawback to their use, or to a high protein meal, shortly before competition lies in the fact that proteins have an acid residue which must be excreted via the kidneys. Effective renal action ceases during heavy exercise, and the protein residue increases the metabolic acidosis which occurs normally. The requirement for protein in the diet is not significantly increased by exercise unless growth in muscle mass is taking place (41).

Several students have reported that there is a small increase in muscular efficiency when the diet is relatively high in carbohydrates. Since it takes time to fill up the glycogen stores of the body, long-continued, strenuous work should be preceded by a lay-off from heavy work of about two days (13, 14). The same results cannot be achieved by increasing the carbohydrate intake shortly before beginning competition. As carbohydrate stores are reduced, the body may utilize fat as fuel for exercise, and athletic training appears to increase the ability of the body to derive energy from this source. However, as fat is believed to be about 5 percent less efficient as a source of energy than carbohydrate and delays gastric emptying, athletic trainers generally discourage its consumption. Fat does represent a more concentrated source of food energy than do other types of food, and the consumption of fat tends to be higher in those working under severe environmental conditions.

It is of interest in this connection that calories derived from fat have been observed to form about 45 percent of the total intake of Finnish professional wrestlers (13).

Studies of the effects of severe training on the need for vitamins are contradictory. There is no question but that certain levels of vitamin intake are essential for high levels of athletic performance, but there is considerable argument over whether these levels are met by the normal diet. Bourne strongly believes that they are not. It is certainly possible that "supplementation could affect to a limited degree the efficiency of energy-releasing reactions," (25) but Upjohn and cooperating authors (40) class it as "an unnecessary expenditure." Soviet physiologists working with athletes lay great stress upon vitamin supplementation and have prepared elaborate schedules for the administration of varying quantities at each stage of the training program. The generally unsatisfactory nature of their published reports, however, makes it practically impossible to evaluate the worth of their procedures. The available evidence does not permit a forthright answer to questions regarding the value of vitamin and mineral supplementations during periods of arduous physical work.

During tournaments wrestlers may be observed partaking of honey, chocolate, oranges, and other "quick energy" foods. It seems unlikely that, except in such prolonged events as channel swimming and marathon running, there is any possibility of the body's energy stores being exhausted. It is therefore improbable that there is any physiological need for resorting to sugar supplementation during wrestling meets or that such supplements will actually be utilized by the body during the competition, but there is no reason to forbid their use if the wrestler desires them. As was mentioned earlier, the intake of some fluid at the same time is highly desirable.

Summary

Making weight is an undesirable practice for the adolescent. The older individual in good training may take off up to approximately 10 percent of his normal body weight for brief periods without adversely affecting his strength, endurance, reaction time, fatigue rate, or blood pressure. Reducing weight by restriction of caloric intake over long periods of time involves the risk of vitamin and mineral deficiency. Reducing by restricting water intake may result in fatigue. The physiological effects of dehydration are apparently more severe than those of semistarvation. There is no miracle diet for the wrestler; it need be only sufficient, well balanced, and nutritious. The evidence indicates that there are advantages in a diet relatively high in carbohydrate.

REFERENCES

1. Ahlman, K., and Karvonen, M. J. Stimulation of sweating by exercise after heat-induced "fatigue" of the sweating mechanism. *Acta Physiol. Scandinavica* 53:381-86, 1961.
2. ———. Weight reduction by sweating in wrestlers, and its effect on physical fitness. *J. sport Med.* 1:58-62, 1961.
3. Alitz, LeRoy A. *The effect of participation in a high school wrestling program upon physical status.* Unpublished master's thesis, State University of Iowa, 1959.
4. Altschul, Rudolf, and Smart, Terry A. Influence of water deprivation on serum cholesterol in rabbits. *Geriatrics* 14:461-64, 1959.
5. American Medical Association Committee on Injury in Sports and the National Federation of State High School Athletic Associations joint statement, December 31, 1958.
6. Anonymous. Restriction of food or water and work capacity. *Nutr. Rev.* 19:23-25, 1961.
7. Berry, W. T. C., and others. The diet, haemoglobin values, and blood pressures of Olympic athletes. *Brit. Med. J.* 4598:300-304, 1949.
8. Blank, Lane B. An experimental study of the effect of water ingestion upon athletic performance. *Res. Quart.* 30:131-35, 1959.
9. Blyth, Carl S., and Burt, John J. Effect of water balance on ability to perform in high ambient temperatures. *Res. Quart.* 32:301-307, 1961.
10. Bourne, G. H. Vitamins and muscular exercise. *Brit. J. Nutr.* 2:261-63, 1948.
11. Buskirk, E. R.; Iampietro, P. F.; and Bass, David E. Work performance after dehydration: effects of physical conditioning and heat acclimatization. *J. appl. Physiol.* 12:189-96, 1958.
12. Byram, Howard M. *Effects of weight reduction on strength and on muscular endurance.* Unpublished master's thesis, State University of Iowa, 1953.
13. Cathcart, E. P. The physiological approach to fitness. *Brit. Med. J.* 4048:273-76, 1938.
14. Christensen, E. Hohwu; Krogh, A.; and Lundhard, J. Investigations on heavy muscular work. *Quart. Bull. Hlth. Organ. Leag. Nat.* III:388-417, 1934.
15. Dawson, Percy M. *The physiology of physical education.* Baltimore: Williams & Wilkins Co., 1935, pp. 175-76.
16. Doscher, Nathan. The effect of rapid weight loss upon the performance of wrestlers and boxers, and upon the physical proficiency of college students. *Res. Quart.* 15:317-24, 1944.
17. Edwards, Jennings B. *A study of the effect of semi-starvation and dehydration on strength and endurance with reference to college wrestling.* Unpublished master's thesis, University of North Carolina, 1951.
18. Ekfelt, Vernon. Eliminating the criticisms of high school wrestling. *Athl. J.* XXXVII:10-11, 1956.
19. Englund, John H. *A comparative study of cardiovascular adjustment to rapid and extreme weight reduction in college wrestling.* Unpublished research study, Colorado State College, 1962.

20. James, Byron D. *The effect of weight reduction on the physical condition of high school wrestlers.* Unpublished master's thesis, State University of Iowa, 1960.
21. Kenney, H. E. The problem of weight making for wrestling meets. *J. Hlth. & phys. Educ.* 1:24 *et seq.*, 1940.
22. Kraut, H.; Bramsel, H.; and Wecker, H. Utilization of vegetable and animal protein in the human digestive tract. *Biochem. Z.* 320:422-30, 1950.
23. Little, C. C.; Strayhorn, H.; and Miller, A. T. Jr. Effect of water ingestion on capacity for exercise. *Res. Quart.* 20:398-401, 1949.
24. Lynch, Joseph J. *A survey study of the problems of weight-reduction in S.S.C.I.F. wrestling.* Unpublished master's thesis, San Diego State College, 1960.
25. Mayer, Jean, and Bullen, Beverly. Nutrition and athletic performance. *Physiol. Rev.* 40:369-97, 1960.
26. McDermott, William V., and others. Acute pancreatitis after prolonged fast and subsequent surfeit. *New Eng. J. Med.* 254:379-80, 1956.
27. Morehouse, Laurence E. Size classification of wrestlers. Unpublished paper delivered before the American College of Sports Medicine, 1961.
28. ———, and Rasch, Philip J. *Sports medicine for trainers.* (2nd ed.) Philadelphia: W. B. Saunders Co., 1963. p. 56.
29. Nelson, William B. *The relationship of weight cutting to certain physical growth factors of selected high school wrestlers in Minnesota.* Unpublished master's thesis, Mankato State College, 1962.
30. Nichols, Harold Jr. *The effect of rapid weight loss on selected physiologic responses of wrestlers.* Unpublished doctoral dissertation, University of Michigan, 1957.
31. Peckos, Penelope S. Caloric intake in relation to physique in children. *Science* 117:631-33, 1953.
32. Rasch, Philip J. Protein and the athlete. *Phys. Educ* XVII:143-44, 1960.
33. Riedman, Sarah R. *The physiology of work and play.* New York: Dryden Press, 1952, p. 117.
34. Rupp, Edward H. Effects of weight loss upon the performance and health of college and varsity wrestlers. *Amer. Wrestling Coaches & Officials Assoc. Bull.*, 1954, pp. 14-18.
35. Schuster, Abraham Z. *The effects of rapid weight reduction on the endurance and performance of wrestlers.* Unpublished master's thesis, Pennsylvania State University, 1954.
36. Schwartz, William B., and Pelman, Arnold S. Metabolic and renal studies in chronic potassium depletion resulting from overuse of laxatives. *J. Clin. Invest.* XXXII: 258-71, 1953.
37. Steinberg, Irving H. In the transcript of the Sixth Annual Meeting of the American College of Sports Medicine, p. 68.
38. Taylor, H. L., and others. Performance capacity and effects of calorie restriction with hard physical work on young men. *J. appl. Physiol.* 10:421-29, 1957.
39. Tuttle, W. W. The effect of weight loss by dehydration and the withholding of food on the physiologic response of wrestlers. *Res. Quart.* 14:158-66, 1943.

40. Upjohn, Harold L., and others. Nutrition of athletes. *J. Amer. Med. Assoc.* 151:818-19, 1953.
41. Van Itallie, Theodore B.; Sinisterra, Leonard; and Stare, Frederick J. Nutrition and athletic performance. *J. Amer. Med. Assoc.* 162:1120-26, 1956.
42. Walker, Weldon J., and others. Effect of weight reduction and caloric balance on serum lipoprotein and cholesterol levels. *Amer. J. Med.* 14:654-64, 1953.
43. Wilce, J. W. Cited in Olden C. Gillum, *The effects of weight reduction on the bodily strength of wrestlers.* Unpublished master's thesis, Ohio State University, 1940.

7. HEALTH AND SAFETY IN WRESTLING

When vigorous young men engage in physical contact sports it is inevitable that some injuries will be incurred. Lloyd, Deaver, and Eastwood (13) rate wrestling as "highly hazardous," ranking fifth in this respect in high schools and exceeded only by polo and football in colleges. They recommend that, "Institutions promoting wrestling among their students should carefully investigate the conditions under which practice and competitions are conducted." Reeck (18) found that approximately 5 percent of the total high school squad enrollment received injuries; the average accident rate per school was 1.9; the average days lost per school were 13.5; the average severity rate per accident was seven days. These data are generally similar to those found in other reports. One (15) showed that 8.8 percent of the total high school wrestling enrollment and 15.8 percent of the college enrollment received injuries, with a severity rate of 5.6 days lost per injury for high school wrestlers and 6.3 days for college wrestlers. Oregon high school wrestlers sustained a higher ratio of injuries (33.65 per 100 participants) than was incurred in basketball (12.7/100), hockey (8.3/100), baseball (7.12/100), or track (5.88/100) (3). Over a period of years at Phillips Academy little difference was observed in the average number of injuries per player in soccer, basketball. hockey, baseball, wrestling. and lacrosse (6). Another investigator (11) found an injury frequency of 6.5/100 among high school wrestlers in the midwest.

Among high school wrestlers the majority of injuries appear to be cauliflower ears, infections, and strains, rather than broken bones or other serious trauma. Nevertheless, when fractures or dislocations do occur, they are relatively serious, and it is not surprising that one of the primary objections to the inclusion of wrestling in high school

physical education programs has been administrative disapproval on the basis that the sport is dangerous (8). One point that clearly emerges from all this is that the wrestler should be covered by *some form of* accident insurance.

Probably the fault lies less with the sport itself than with the conditions under which it is often conducted. In some sections of the country at least, facilities for wrestling practice are generally inadequate (1). The responsibility for the provision of suitable quarters is ordinarily a matter of administrative authority and one over which the coach has little or no control. Moreover, the fact that wrestling is probably the fastest growing interscholastic sport has resulted in a demand for coaches which far exceeds the available supply. In 1960 it was estimated that 60,229 boys participated in interscholastic wrestling, a figure surpassed only by the number of participants in the so-called four major sports (19). Surveys in various sections of the country show that a very large percentage of the coaches have had less than five years of experience and that many of them have never wrestled competitively. Some have not had even so much as a physical education course in the sport (1, 9). The possible importance of this lack of preparation is pointed up by Reeck's contention that coaches with over six years of experience had fewer accidents to their charges, although this has been denied by other investigators (11).

The following suggestions for preserving the health and safety of these athletes are drawn from the personal experience of the writers and from a number of studies which have been concerned with the problem.

1. A dangerous situation exists whenever a coach attempts to handle large numbers of students at once in a limited area, and the potential exposure to injury becomes unacceptably large. One estimate is that each participant requires a space of approximately 50 square feet (5). The number on the mat at any one time may be reduced by having part of the team do road work, calisthenics, or other drills. It must be emphasized that the type of maneuver being practiced will influence the number of men who may safely be on the mat. It cannot be assumed that because a given number is acceptable under certain conditions it is equally acceptable under others. It is, of course, essential that proper discipline be maintained; there is no place for "horse play," practical jokes, or other similar activities in the wrestling area.
2. If the mat is in the open, safety mats should be placed around it so that men thrown or rolled off the wrestling area will not land on a bare floor.
3. If the mat is within a wrestling room, all walls should be padded to a height of approximately five feet.
4. All posts, heaters, and other projecting equipment should be protected by adequate safety guards.

5. No stools, benches, chairs, tables, etc. should be permitted on or at the edge of the wrestling area.
6. The wrestling room should be clean, well lighted, warm, and well ventilated. A temperature of 70 to 80 degrees is generally considered best (2, 9).
7. Gym pads, safety mats, and other equipment used in place of modern foam plastic wrestling mats must be covered with an appropriate material in order to reduce the incidence of mat burns and similar injuries, catching an extremity between two mats, etc. The covers themselves must be kept clean and sanitary preferably by daily disinfecting and cleaning, tight, and in good repair. Injuries may result from catching a foot in a torn cover or in a fold of a loose cover. Canton flannel covers appear to be a fertile source of infection (11).
8. Protective equipment must be supplied to the wrestlers. Probably the most important items in this category are ear protectors. The use of knee and elbow pads varies. Some schools require their use by all members of the team; others issue them only as needed. Uniforms and equipment must be kept clean.
9. Candidates for the wrestling team must be given a physical examination at the start of the season and before returning to training after injury or illness.
10. The wrestler should be required to warm up thoroughly before engaging in competition or a workout. The finding that over a third of the injuries in high school wrestling occur in the first minute (15) suggests a failure to have boys properly warmed up before going onto the mat.
11. A fatigued athlete is much more susceptible to injury than a fresh one. The percentage of injuries incurred in practice tends to increase after the first hour (15). Length and severity of practice periods and of the season should be established with the condition of the wrestlers in mind; a large number of coaches consider one and a half to two and a half hours optimal for practice (2, 9, 11).
12. Participants must be properly conditioned. In one survey (20) it was found that 42 percent of the colleges who abandoned intramural wrestling did so because the conditioning of the contestants was unsatisfactory. The athletic directors questioned set the minimum training period at anywhere from two weeks to ten weeks. However, in intramural competition, consideration may be given to shortening the length of bouts and in other ways compensating for the poorer condition of the participants. Obviously no individual should be permitted to engage in a competitive bout until he has a reasonable knowledge of techniques and rules. This point has become more important with the popularity of television wrestling and the tendency of young boys to experiment with holds displayed

by the professionals. It is to be noted that injuries to wrestlers tend to decrease as experience is gained (11, 15).

13. Officiating must be competent. Concomitant with the need for qualified coaches has arisen a need for qualified officials. Probably every experienced wrestler or coach can recall injuries which could have been prevented by foresight and action on the part of the referee. In the writers' experience, the use of illegal holds or rolling off the mat are the situations most often involved. In many cases it may be necessary to hold officials' clinics prior to the start of the wrestling season in order to ensure a source of satisfactory officials. In both high school and college wrestling approximately 50 percent of the accidents occur during work on the feet (15). This may be another reason for the high incidence of injury during the first minute, and underlines the need for special vigilance by officials at the start of matches and by the coach at the start of practice sessions. Unsupervised practices should be avoided.
14. A first aid kit must be readily available for minor cuts, abrasions, etc. There can be no possible excuse for the use of unclean towels to stanch bleeding, nor for a lack of sanitary drinking fountains and receptacles for expectoration. Competent medical care must be available for infections and the more serious trauma, and the wrestlers must be required to avail themselves of it whenever necessary. If at all possible, a physician should be in attendance during all competitive bouts. Care must be taken that an injured man does not return to the squad too soon, as recurrence of old injuries appears common at the college level. This suggests that the man was permitted to resume practice before the rehabilitation process was complete in the first instance.
15. A daily weight chart provides a useful warning of major changes in the wrestler's physical condition.

If, in spite of all precautions, accidents do occur, what is their nature? Some reports of renal trauma incurred during wrestling have appeared in the literature, but most of these were incurred by professionals (7, 10). Brown states that sprains are reported most frequently, followed by infections, hematoma and hemorrhage, and contusions, in that order. In a Kansas study (4) sprains were found to be the most common injury, with fractures ranked second, followed by contusions, dislocations, and lacerations, all of a similar frequency. Strains and sprains predominated in two other investigations (2, 15). Much the same finding had been reported earlier by Lloyd, Deaver, and Eastwood, who ranked bone injuries third. Konrad (11) lists "cauliflower ear" first, followed by infection, pulled muscles, and injured ribs. In Gallagher's (6) experience, concussion was by far the most common form of injury, followed by sprains. If there is any one form of trauma which might be considered characteristic of the sport, it is probably detachment of

a rib from the anterior portion of the lower thoracic cage, resulting from a violent twisting movement of the trunk in an effort to escape from a hold (12, 16). Although hand injuries receive comparatively little attention in the surveys reviewed for this chapter, they appear relatively common among experienced wrestlers (17). Possibly the incidence of sprains and strains at least could be reduced by the introduction of the progressive resistance exercises into the preseason conditioning program, as is now so widely done in football.

While the possibility of accidents can never be entirely eliminated, their probability can be greatly reduced by unremitting care on the part of all involved. Quigley's "Bill of Rights" provides that the athlete is entitled to good coaching, good equipment, and good medical care, but these rights are valueless if the athletes themselves do not cooperate to make them effective, and careful organization and administration are required to make the Bill's provisions effective (14). To attribute injuries primarily to carelessness on the part of the wrestlers, as do many coaches (8), is at best an admission of poor teaching.

Summary

The possibility of injury is inherent in all physical contact sports, including wrestling. Even if trauma cannot be entirely prevented, the frequency of its occurrence can be reduced by the use of experienced coaches, adequate space, protective mats and personal equipment, hygienic surroundings, avoidance of over-fatigue, proper conditioning, and competent officiating. Particularly careful supervision is required during the first few minutes of practice or competition, when the wrestlers are still on their feet and possibly not thoroughly warmed up, and when they have become fatigued. Practice sessions of over two and a half hours and schedules of over 13 dual meets are apt to be excessive.

When injuries do occur, they are most likely to be sprains or strains, but dislocations, fractures, and concussions may occur, and provision must be made for their prompt treatment. It is desirable that a doctor be at ringside during competition and readily available during practice. First aid treatment should be given to all minor injuries, with special care taken to prevent the onset of infection. Unremitting attention to the prevention of injuries is required on the part of all involved with wrestling.

REFERENCES

1. Bonheim, Robert S. *High school wrestling in Southern California.* Unpublished special study, University of California, Los Angeles, 1961.
2. Bredehoft, Theodore C. *A survey of health and safety practices utilized in selected interscholastic wrestling programs throughout the United States—1958-59.* Unpublished master's thesis, University of Washington, 1959.
3. Brown, Richard G. *Nature and frequency of injuries occurring in Oregon high school interscholastic sports.* Unpublished master's thesis, University of Oregon, 1951.
4. Elbel, Edwin R. Athletic injuries in Kansas high schools. *Bull. Educ.* 5:1-23, 1950.
5. Gallagher, E. C., and Peery, Rex. *Wrestling.* (Rev. ed.) New York: A. S. Barnes Co., 1951, p. 80.
6. Gallagher, J. Roswell. Athletic injuries among adolescents: Their incidence and type in various sports. *Res. Quart.* 19:198-214, 1948.
7. Glenn, James F., and Howard, Marvin. The injured kidney. *J. Amer. Med. Assoc.* 173:1189-95, 1960.
8. Handy, C. W. *A survey of wrestling in the physical education program of California high schools.* Unpublished master's thesis, University of Southern California, 1939.
9. Helmbreck, Earl. *General opinion factors influencing safe weight reduction among high school and college wrestlers.* Mimeographed.
10. Kleiman, A. H. Renal trauma in sports. *Western J. Surg.* 69:331-40, 1961.
11. Konrad, Ignatius J. *A study of wrestling injuries in high schools throughout seven Midwestern states.* Unpublished master's thesis, Michigan State College, 1951.
12. Interview with Vladimir Krutjevsky. *Scope Weekly,* May 7, 1958.
13. Lloyd, Frank S.; Deaver, George G.; and Eastwood, Floyd B. *Safety in athletics.* Philadelphia: W. B. Saunders Co., 1949, pp. 99-104.
14. Morehouse, Laurence E., and Rasch, Philip J. *Sports medicine for trainers.* (2nd ed.) Philadelphia: W. B. Saunders Co., 1963, p. 133.
15. Patacsil, Joseph. *An analytical study of the incidence of injuries sustained in intercollegiate and interscholastic wrestling.* Unpublished master's thesis, Purdue University, 1955.
16. Rachun, Alexius. Mechanics of athletic injury. *New York J. Med.* 61:258-59, 1961.
17. Rasch, Philip J., and others. Effect of training for amateur wrestling on total proportional strength scores. *Res. Quart.* 32:201-207, 1961.
18. Reeck, Claude C. Abstract: A national study of incidence of accidents in high school wrestling, 1937-1938. *Res. Quart.* X:72-73, 1939.
19. Russell, William W. *Interscholastic athletics participation survey, February 1960.* Mimeographed.
20. White, Carlton C. *Study of methods used to protect the health and safety of college intramural participants.* Unpublished master's thesis, University of California, 1942.