

CHAPTER II

REVIEW OF RELATED LITERATURE

The researcher has gone through various databases to locate literature related to this study. The relevant studies found from various sources, which the researcher has come across, are cited below.

Douglas and Douglas (1984)¹ analyzed the food practices and nutrition knowledge of high school athletes participating in interscholastic sports and evaluated differences in terms of selected sports variables. The data for the study were obtained by a questionnaire administered to a sample of 943 athletes from randomly selected high schools in Connecticut. The stated hypotheses were tested statistically using analysis of variance, t-tests, and Pearson correlation coefficients where appropriate. The results of the study indicated that the female athletes had better knowledge of nutrition but poorer food practices than the male athletes. There were also significant relationships between sport forms, seasons, and nutrition knowledge and food practices. High school athletes perceived their best source of nutrition knowledge to be their parents. Results on the nutrition knowledge component of the instrument showed that out of 48 possible answers, the mean correct was 26.4, while out of a possible score of 5, the mean score for food practices was 2.2. Because a positive relationship existed between the number of sport seasons and nutrition knowledge and food practice scores, sport participation may be a catalyst for learning about nutrition.

¹ P. D. Douglas, and J. G. Douglas, "Nutrition knowledge and food practices of high school athletes." J Am Diet Assoc., 84, 10, 1984, pp.1198-1202.

Cupisti *et al.*, (2002)² conducted a study with the aim to investigate dietary composition and nutrition knowledge of 60 athlete and 59 non-athlete adolescent females (age, 14-18 years), using a 3-day food recall and a questionnaire on nutrition. The reported daily energy intake was similar in athletes and non-athletes, but less than the recommended and the estimated requirements. In the athletes, the energy supply from breakfast was higher than in the non-athletes (18.5 +/- 6.6 vs. 15.0 +/- 8.2%, $p < .005$). Energy intake from carbohydrates was higher (53.6 +/- 6.2 vs. 49.8 +/- 6.3%, $p < .05$) and that from lipids was lower (30.4 +/- 5.5 vs. 34.2 +/- 5.2%, $p < .001$) in athletes than in non-athletes. Athletes also showed higher fiber (20.0 +/- 5.8 vs. 14.1 +/- 4.3 g/day, $p < .001$), iron (10.6 +/- 5.1 vs. 7.5 +/- 2.1 mg/day, $p < .001$) and vitamin A (804 +/- 500 vs. 612 +/- 456 micrograms/day, $p < .05$) reported intake than non-athletes. Calcium, iron, and zinc intake were less than 100% RDA in both groups. Athletes gave a slightly higher rate of correct answers on the nutrition knowledge questionnaire (77.6 vs. 71.6%, $p < .01$) than non-athletes. In conclusion, the overall recalled dietary intake and nutrition knowledge of the studied adolescent females show some misconceptions and nutrient deficiencies, but the results in athletes are quite better than in non-athletes, suggesting a favorable role of sport practice on dietary habits and nutrition knowledge.

Perron and Endres (1985)³ studied the relationship between the nutrition knowledge and attitudes and dietary practices of adolescent female athletes, using a 24-hour recall and a 48-hour food record with a modified version of the self-administered knowledge and attitude questionnaire of Werblow *et al.* Analysis indicated that the diets were similar to those of other teenage girls in

² A. Cupisti, C. D'Alessandro, S. Castrogiovanni, A. Barale, and E. Morelli, "Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes." *Int J Sport Nutr Exerc Metab.*, **12**, 2, 2002, pp.207-219.

³ M. Perron, and J. Endres, "Knowledge, attitudes, and dietary practices of female athletes." *J Am Diet Assoc.*, **85**, 5, 1985, pp.573-576.

the United States. The calculated mean values for vitamins A and C were more than 100% of the RDAs, while those for calcium and iron were less than 67% of the allowances. The mean energy value was less than recommended and may have been inadequate for the active subjects. Food consumption analysis showed that of total servings, the milk and meat groups accounted for only about 10% each and that more than 30% came from the "others" group. Although the subjects had some common misconceptions about nutrition, they were generally knowledgeable as well as positive in their attitudes toward nutrition. Nutrition knowledge and attitudes were positively correlated, indicating that the more nutrition knowledge a subject had, the more positive was the attitude toward nutrition, and vice versa. However, no significant correlation was found between nutrition knowledge or attitudes and dietary intake, suggesting that factors other than nutrition knowledge and attitudes, such as a concern for weight and a dependence on others for food selection, played a role in determining the food practices of the subjects.

Factors influencing nutritional supplement use by high school students were assessed by Massad *et al.*, (1995)⁴. Comparisons were made between various groups of sports participants and non-sports participants. The Nutritional Supplement Use and Knowledge Scale was administered to 509 students. Mean supplement use score was 10.87 (SEM = 0.50, range 0-57). Mean knowledge score was 13.56 (SEM = 0.16, range 1-21). Significant relationships ($p < .01$) were obtained for supplement knowledge with use, and supplement use with gender. ANOVA found significant differences between supplement use by gender ($p < .01$), supplement use by sports category ($p < .05$), and knowledge scores by sports category ($p < .01$). Discriminate function analysis indicated knowledge, supplement use, and subscores for protein, vitamins/minerals, knowledge,

⁴ S. J. Massad, N. W. Shier, D. M. Koceja, and N. T. Ellis, "High school athletes and nutritional supplements: a study of knowledge and use." *Int J Sport Nutr.*, 5, 3, 1995, pp.232-245.

supplement use, and sub scores for protein, vitamins/minerals, and carbohydrates were best discriminators of sport group membership. Greater knowledge about supplements was associated with less use; hence, education about supplements can be a deterrent to use. This study may help coaches, athletic trainers, athletic directors, teachers, physicians, and parents identify nutritional misconceptions held by adolescents.

Smith-Rockwell *et al.*, (2001)⁵ assessed nutrition knowledge, opinions, and practices of coaches and trainers at a Division I university. Participants (n = 53) completed questionnaires regarding nutrition knowledge, opinions, and practices. Descriptive statistics and analysis of variance were used to analyze data. Overall, participants responded correctly to 67% of nutrition knowledge questions. Participants who coached/trained female athletes tended to score better than respondents who coached/trained male athletes. Strength and conditioning coaches and participants with greater than 15 years of experience scored higher than other participants. Nutrition opinions/practices responses revealed that nutritional supplements were provided for all but 6% of participants' athletes. Participants rated body weight as more important than body composition to athletes' performances. Over 30% of participants perceived at least one case of disordered eating within the past year. Some participants (53%) felt that athletes may consume more nutritious meals on team-sponsored trips if given larger food allowances. Thirty percent of participants reported dietitians were available to them; the same percentage reported utilizing dietitians. Coaches and trainers are knowledgeable about some appropriate nutritional recommendations, but registered dietitians or qualified sports nutrition professionals may complement the nutrition-related education and counseling of athletes (23).

⁵ M. Smith-Rockwell, S. M. Nickols-Richardson, and F. W. Thye, "Nutrition knowledge, opinions, and practices of coaches and athletic trainers at a division 1 university." *Int J Sport Nutr Exerc Metab.*, 11, 2, 2001, pp.174-185.

Nutritional knowledge, attitudes, and food patterns of women athletes at the University of Nebraska at Lincoln were studied by Werblow, Fox and Henneman (1978)⁶. Mean test scores for nutritional knowledge were higher for questions relating to "nutrition for the athlete" than to "general nutrition." Attitudes toward nutrition were generally favorable, with a positive correlation between nutritional knowledge and attitudes. Athletes who had received some form of nutrition education had higher nutritional knowledge and attitude scores than those who had not. Respondents were especially concerned with diet as it relates to weight control; those with higher knowledge scores consistently followed food patterns for weight-control diets similar to those used in training and pre-event diets.

The purpose of the study conducted by Jessri *et al.*, (2010)⁷ was to assess the nutrition knowledge and the factors determining this knowledge in Iranian college basketball and football athletes. By highlighting gaps in nutrition knowledge of these athletes, sport nutrition professionals may begin to address these gaps by educating athletes with a view toward minimizing injury and enhancing sport performance. Sixty-six basketball and 141 football players (response rate 78.4%) from 4 medical and 8 nonmedical universities in Tehran agreed to participate in this cross-sectional study. A 2-part questionnaire was used; the first part comprised questions identifying demographic information, and the second part comprised a previously well-validated questionnaire on sport nutrition knowledge. The overall knowledge score was 33.2% (+/- 12.3%). Men scored 28.2% (+/- 12.7%), and women, 38.7% (+/- 14.2%). In both genders, the highest score was obtained for the nutrients subcategory, and the supplements subcategory was the most poorly answered. When compared with

⁶ J. A. Werblow, H. M. Fox, and A. Henneman, "Nutritional knowledge, attitudes, and food patterns of women athletes." *J Am Diet Assoc.*, 73, 3, 1978, pp.242-245.

⁷ M. Jessri, M. Jessri, B. RashidKhani, and C. Zinn, "Evaluation of Iranian college athletes' sport nutrition knowledge." *Int J Sport Nutr Exerc Metab.*, 20, 3, 2010, pp.257-263.

their peers, a significantly higher score was obtained by women ($p < .001$), athletes at medical universities ($p < .001$), and those obtaining nutrition information from reputable sources ($p = .03$). The coach was cited by 89.4% of athletes as their main source of nutrition information. This study showed that the sport nutrition knowledge of these athletes is inadequate. Considering that this substandard level of knowledge may contribute to poor dietary behaviors, these athletes would benefit from nutrition-related training and education.

The objectives of the study conducted by Corley *et al.*, (1990)⁸ were to measure nutrition knowledge of college coaches, to identify educational and demographic factors that affect nutrition knowledge of college coaches, to describe dietary practices recommended by these coaches, and to identify major sources of nutrition information used by coaches. Questionnaires were mailed to 296 coaches of senior and junior colleges in North Carolina using a listing from the National Directory of College Athletics. Coaches of the following sports were included: track and field, cross country, swimming, tennis, basketball, gymnastics, golf, football, and wrestling. The response rate was 36%. Seventy percent of the 15 nutrition knowledge test items were answered correctly; however, only one-third of the coaches indicated a high degree of certainty for the correctness of their responses. There were no significant relationships between nutrition knowledge and sex, age, collegiate conference, course work in nutrition, win/loss record, and years of coaching experience. Major dietary problems of college athletes reported by coaches were consumption of "junk food," poor eating habits, and consumption of an unbalanced diet. The authors recommend an annual workshop for coaches, trainers, and dietitians to develop criteria for nutrition assessment and body composition for college athletes and to

⁸ G. Corley, M. Demarest-Litchford, and T. L. Bazzarre, "Nutrition knowledge and dietary practices of college coaches." *J Am Diet Assoc.*, 90, 5, 1990, pp.705-709.

develop training diets. Special workshops for foodservice personnel are also recommended.

Juzwiak and Ancona-Lopez (2004)⁹ described the dietary practices recommended by coaches working with adolescent athletes and assessed their nutritional knowledge. During a regional competition in the state of Sao Paulo, Brazil, 55 coaches were interviewed. These coaches represented 22 cities with athletes enrolled in Olympic gymnastics, tennis, swimming, and judo events. A 3-section questionnaire was used to obtain data on demographic characteristics, dietary recommendations, and nutrition knowledge. Results showed that all coaches recommended general dietary practices during training, with no specific strategies for pre-, during-, and post-training periods. The main objectives of the recommendations for the training period were weight control and muscle mass gain. Deleterious weight control practices were recommended by 27% of the coaches. Specific dietary practices pre and post competition were recommended by 93% and 46% of the coaches, respectively. Participants responded correctly to 70% (SD = 3.2) of the nutrition knowledge questions, with no significant differences ($p = .61$) between sports. The knowledge test identified a tendency to over-value proteins, excessively low-fat diets, and food myths. These findings indicate the importance of developing strategies that will enhance the nutritional training of coaches.

Recent research suggests that the adolescent athlete is neither aware of nor prepared for the dual demands of sound nutritional practices in general and those demanded by his or her chosen sport activities. The dietary practices of young athletes fail to meet the energy requirements for high performance and may also threaten their well-being. To ascertain the dietary practices and beliefs

⁹ C. R. Juzwiak, and F. Ancona-Lopez, "Evaluation of nutrition knowledge and dietary recommendations by coaches of adolescent Brazilian athletes." *Int J Sport Nutr Exerc Metab.*, 14, 2, 2004, pp.222-235.

of an adolescent athlete population, a survey was conducted by Schmalz (1993)¹⁰ among high school students who were engaged in at least one sport. The results show that students were consuming excessive fats and sugars, and failed to recognize nutritional practices critical to the demands of athletics.

Gacek (2007)¹¹ analyzed customary nutritional behaviours in conditions of intensive physical effort among the secondary school youth sports at School of Sports Championship in Cracov. The subject of the evaluation was also the level of knowledge about basic principles in nutrition of sportsmen among the youth. The anonymous research was conducted in the years 2005-2006 among the youths aged 16-18 in 88 school-boys and 82 school-girls in classes I-III at School of Sports Championship in Cracov. It was carried out by means of a specially prepared author's questionnaire survey. The youth practicing sports at School of Sports Championship utilizes principles of correct nourishment in the limited scale. For example consuming 4-5 meals daily (over 33% girls and 14.7% boys), low preference towards whole meal bread consumption (over 40% girls and 20% boys), extremely low everyday milk drinking (17.1% girls, 34.1% boys) and consumption of dairy products (nearly 44% of the tested persons), small percentage of people who include several portions of vegetables in a daily diet (24.4% girls and 18.2% boys) and also limited consumption of several portions of fruit daily (every second girl and every third boy on average). Inaccuracies connected with nourishment during intensive physical effort first of all apply to: the lack of differentiated diet depending on the sort of practice (about 60% of the tested persons), drinking of sparkling mineral water before and during training or competitions (17% girls and 20% boys), incorrect way of refilling liquids after the effort (about 20% of the whole group), too late consumption of the main meal

¹⁰ K. Schmalz, "Nutritional beliefs and practices of adolescent athletes." *J Sch Nurs.*, 9, 2, 1993, pp. 18-22.

¹¹ M. Gacek, "Knowledge and nutritional behaviours among youth practising sports at school of sports championship in Cracov." *Rocz Panstw Zakl Hig.*, 58, 4, 2007, pp.641-648.

before competitions or intensive training (37% girls and 43% boys). The youths of School Sports Championship have limited knowledge on the principles of nourishment for sportsmen; the average percentage of the correct answers in the knowledge test is 46.2% among the girls and 52.9% among the boys and confirms the need of nutritional education between the youth practicing sports.

The sports nutrition knowledge questionnaires have inadequate psychometric validation, and few are up to date in a rapidly changing discipline. Therefore, the purpose of the study conducted by Zinn, Schofield and Wall (2005)¹² was to design a sports nutrition questionnaire that satisfied acceptable psychometric criteria of validity (content and construct) and reliability (test-retest). The questionnaire was designed by an expert panel of six sports dietitians and distributed to five groups, selected for their expected variation in sports nutrition knowledge. Dietitians, university business staff and nutrition students received questionnaires via e-mail. The response rates obtained were 21.3% (n = 49), 34.4% (n = 33), and 72.0% (n = 18), respectively. University business and fitness students completed questionnaires during class time. Response rates were 52.3% (n = 23) and 75.4% (n = 49), respectively. The questionnaire was administered a second time to the business staff and the dietitians to assess test-retest reliability. Two methods were used: 1, Pearson's product-moment correlation; and 2, a percentage calculation of questions answered in an identical manner on both test occasions. Reliability was acceptable with Method 1 yielding acceptable values ($r = 0.74-0.93$), aside from the fluid sub-category ($r = 0.52$). Method 2 showed good test-retest concordance with 81.2% duplication of responses of all questions. Construct validity was high, as indicated by significant mean knowledge score differences between the groups ($p = 0.0001$). Dietitians and nutrition students achieved significantly greater mean scores than the remaining groups. The

¹² C. Zinn, G. Schofield, and C. Wall, "Development of a psychometrically valid and reliable sports nutrition knowledge questionnaire." *J Sci Med Sport.*, **8**, 3, 2005, pp.346-351.

findings of this study indicate that the questionnaire is suitably valid and reliable to be used in research and practice to determine sports nutrition knowledge.

Nutritional needs for peak athletic performance include sufficient calorie intake, adequate hydration, and attention to timing of meals. Student athletes and their advisors often are misinformed or have misconceptions about sports nutrition. This paper by Cotunga, Vickery and McBee (2005)¹³ identifies nutritional needs of young athletes, reviews common misconceptions, and examines the nutrition knowledge of athletes and their sources of nutrition information. Topics covered include energy, carbohydrate, protein, fat and micronutrient needs, hydration requirements, timing of meals, and issues related to age, gender, and specific sports. Other issues addressed include "making weight" and ergogenic aids. Proper nutrition for young athletes is critical not only to their athletic success, but more importantly to their growth, development, and overall health. Nutritional recommendations should be based on the most current scientific data; we provide information about appropriate resources for the school nurse when advising student athletes and their coaches and parents.

Food behaviour is acquired in childhood and is very difficult to be changed latterly in adulthood. The aim of the study conducted by Montero *et al.*, (2006)¹⁴ was to evaluate if food behaviour and other health habits were in accordance with the nutrition knowledge of a sample of University students from different Health Sciences Careers. The investigators studied 105 students (aged 21 +/- 2 years) from San Pablo-CEU University (Madrid); 21 where studying Nursing (N), 32 Pharmacy (Ph); 34 Nutrition and dietetics (ND) and 18 were students of

¹³ N. Cotunga, C. E. Vickery, and S. McBee, "Sports nutrition for young athletes." *J Sch Nurs.*, 21, 6, 2005, pp.323-328.

¹⁴ A. Montero Bravo, N. Ubeda Martín, and A. García González, "Evaluation of dietary habits of a population of university students in relation with their nutritional knowledge." *Nutr Hosp.*, 21, 4, 2006, pp. 466-473.

Podology (P), all of them had been studying Nutrition as subject during 2003-2004 academic year. All the students filled a questionnaire about health habits and some body image perceptions; diet was evaluated by a 3 day diet record and nutrition knowledge by a 20 questions test. Height and weight were measured using standard procedures. ND students believed they had a medium-high level of nutrition knowledge while Pharmacy and nursing students believed they had a medium-low level and the podology ones had the perception to have a low level of knowledge in the subject. Results of test were in accordance with those perceptions as highest records were obtained by the Nutrition students. Nevertheless very few differences were found in the diet of the four populations. Mean energy intake was similar in the four groups, deficiencies (<80% RDA) were observed in fibre, magnesium, folic acid and vitamin E. About body image, 67% of total population had a BMI of 19-25, no differences were appreciated between groups. Male self-reported weight and height were closer to real than those from women, who underestimated weight ($p < 0.05$) and overestimated height. No differences were observed between healthy living habits (tobacco, alcohol and physical activity) in the four populations. Even if N students believed and showed to have a better nutrition knowledge, no changes in food behaviour or other health habits were found. Improving knowledge does not necessary imply change in food habits.

Little is known about if and how team coaches disseminate nutrition information to athletes. Hence, Zinn, Schofield and Wall (2006)¹⁵ conducted a census survey on New Zealand premier rugby coaches (n = 168). All of them completed a psychometrically validated questionnaire, received by either Internet or standard mail (response rate, 46%), identifying their nutrition advice dissemination practices to players, their level of nutrition knowledge, and the factors

¹⁵ C. Zinn, G. Schofield, and C. Wall, "Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches." *Int J Sport Nutr Exerc Metab.*, 16, 2, 2006, pp.214-225.

determining this level of knowledge. The majority of coaches provided advice to their players (83.8%). Coaches responded correctly to 55.6% of all knowledge questions. An independent t-test showed coaches who imparted nutrition advice obtained a significantly greater score, 56.8%, than those not imparting advice, 48.4% ($P = 0.008$). One-way ANOVA showed significant relationships between total knowledge score of all coaches and qualifications [$F(1,166) = 5.28, P = 0.001$], own knowledge rating [$F(3,164) = 6.88, P = 0.001$] and nutrition training [$F(1,166) = 9.83, P = 0.002$]. We conclude that these rugby coaches were inadequately prepared to impart nutrition advice to athletes and could benefit from further nutrition training.

Whati *et al.*, (2005)¹⁶ conducted a study with a purpose to develop a valid and reliable nutritional knowledge test for urban South African adolescents who were participating in the Birth-to-Twenty cohort study. The questionnaire was intended for use every second year, from ages 13 to 14 y until age 20 y. The initial steps involved the development of a conceptual framework and identification of nutritional concepts in collaboration with nutritional experts, and this defined the construct of the questionnaire. The South African national teaching curriculum objectives for nutritional education and other relevant issues were selected as the desired concepts, and most items were phrased in accordance with the recently developed South African Food-Based Dietary Guidelines. Thereafter, 140 items (questions) were developed and in turn assessed by an expert panel, and the result was that only 88 items remained. This was done to ensure content and face validity of the items. The 88 items were constructed into a questionnaire and piloted for appropriateness and understanding by adolescents, ages 13 to 14 y, as a means of assessing face validity by non-experts. The edited preliminary questionnaire (still with 88 items) was administered to a

¹⁶ L. H. Whati, M. Senekal, N. P. Steyn, J. H. Nel, C. Lombard, and S. Norris, "Development of a reliable and valid nutritional knowledge questionnaire for urban South African adolescents." *Nutrition*, 21, 1, 2005, pp.76-85.

nutrition expert group (n = 71) versus a non-expert group (n = 82), referred to as sample 1, for the purposes of performing item analysis and assessing construct validity of the questionnaire. The result of the analysis, a 63-item questionnaire, was administered to adolescents at three school grade levels, 8 (n = 128), 10 (n = 143), and 12 (n = 98), referred to as sample 2, which was representative of the grades in which the Birth-to-Twenty group will be in when the questionnaire is administered. The questionnaire was administered to the sample to assess its content validity and internal consistency reliability. The final questionnaire had 60 items, and its construct, content, and internal consistency reliability were reassessed. The final 60-item questionnaire displayed a significant difference ($P < 0.0001$) in the mean scores of the expert and non-expert groups tested. It had internal consistencies (Cronbach's alpha) of 0.71, 0.79, and 0.82 for grades 8, 10, and 12 respectively, and an overall value of 0.77 for all groups combined. However, it was less than 0.7 for most grade 8 pupils and for all grades at a historically disadvantaged school. A nutritional knowledge questionnaire with construct, face, and content validities and internal consistency was developed for use in South African adolescents to evaluate their nutritional knowledge. Internal consistency was low in children at a disadvantaged school and those in grade 8 compared with multiracial groups at a multiracial school. It is recommended that pupils at disadvantaged schools be assisted by trained interviewers when taking the test.

Burke (1995)¹⁷ explored practical issues in nutrition for athletes. The investigator observed that many athletes do not achieve sound nutritional practices to optimize their sports performance. Factors include poor nutrition knowledge, dietary extremism, poor practical skills in choosing or preparing meals, and reduced access to food due to a busy lifestyle and frequent travel. Education in nutrition for the athlete needs to be practical, so as to address eating strategies

¹⁷ L. Burke, "Practical issues in nutrition for athletes." *J Sports Sci.*, 13, 1999, pp.83-90.

and key food and fluid choices that will help to achieve the goals of sound nutrition. Strategies that can achieve a number of nutritional goals simultaneously are most useful, since athletes often find it difficult to integrate separate issues. Athletes with extreme nutrient requirements, or with nutritional problems, should seek individual assessment and counselling from a sports nutrition expert.

O'Brien and Davies (2007)¹⁸ investigated the relationship between nutrition knowledge and body mass index (BMI). The General Nutrition Questionnaire was distributed to 500 individuals on the database of a large general practice. Results demonstrated that there was no significant correlation between levels of nutrition knowledge and BMI; however, a high level of nutrition knowledge was found among the sample. This suggests that a knowledge deficit may not be the most significant factor preventing overweight individuals from adopting a healthier diet and questions the utility of purely educational approaches to dietary behaviour change. Evidence-based health behaviour change techniques are discussed.

Wrestlers often engage in unhealthy practices to achieve a low body weight for competition. Therefore, Marquart and Sobal (1994)¹⁹ examined beliefs, practices, and potential support systems to promote safe weight loss among scholastic wrestlers. A written questionnaire was developed and administered to all nine high school wrestling teams in one rural county. Responses were obtained from 197 wrestlers. Most wrestlers reported that "making weight" was very important. Increased activity and decreased food intake were the most frequent weight loss methods. Unsafe methods such as vomiting and use of laxatives were

¹⁸ G. O'Brien, and M. Davies, "Nutrition knowledge and body mass index." *Health Educ Res.*, 22, 4, 2007, pp.571-575.

¹⁹ L. F. Marquart, and J. Sobal, "Weight loss beliefs, practices and support systems for high school wrestlers." *Journal of Adolescent Health*, 15, 5, 1994, pp.410-415.

sometimes used, even though many wrestlers recognized these practices were unhealthy and decreased performance. Personal desire to win, coaches, and teammates were reported to be the greatest influences on weight loss efforts. Wrestlers believed that coaches and physicians were the most accurate sources of weight loss information. Nutrition counseling which goes beyond simply providing information about the risk of rapid weight loss among adolescent wrestlers is needed. Emphasis on motivating wrestlers to adopt healthy weight management strategies is important. Wrestlers perceive physicians as credible sources of information, and physicians should become more actively involved in educating both coaches and athletes about safe weight management.

Wrestlers lose weight frequently, using rapid weight reduction methods in order to qualify for a certain weight classification. Under these conditions, the potential for developing eating disorders seems apparent. Hence, Lakin *et al.*, (1990)²⁰ used a questionnaire to evaluate binge eating and bulimic behaviors, nutrition practices, and weight loss methods in 716 wrestlers: Subjects lost 4.0 kg, on average, to certify, and cycled (lost and regained) 2.3 kg weekly. Two-thirds gained weight in the postseason. The most frequently used weight loss methods included increased exercise, food restriction, gradual dieting, and heated wrestling rooms. Subjects relied primarily on coaches and fellow wrestlers for sources of weight management. Using symptom severity levels by Hawkins and Clement (1980) and the Diagnostic and Statistical Manual of Mental Disorders (3rd ed.; DSM-III; American Psychiatric Association, 1980) criteria, 2.8% of subjects were classified as bulimic; 1.4% using DSM-III-R (3rd ed.; rev; American Psychiatric Association, 1987); and 1.4070 met both DSM-III and DSM-III-R. There were significant differences between the diagnostic (DG) and nondiagnostic groups (NDG) in weight lost to certify, weekly weight fluctuation,

²⁰ J. A. Lakin, S. N. Steen, and R. A. Oppliger, "Eating behaviors, weight loss methods, and nutrition practices among high school wrestlers." *Journal of Community Health Nursing*, 7, 4, 1990, pp.223-234.

postseason weight gain, and severity of binge eating. The DG used fasting, food and fluid restriction, dehydration methods, and laxatives significantly more often to promote weight loss. They also experienced significantly more negative feelings during and following binging. Implications for nursing research and clinical practice are also discussed.

Kelkar, Subhadra and Chengappa (2006)²¹ selected 78 sportsmen aged 18-25 years by purposive sampling technique. The sportsmen belonged to varied sports disciplines viz. runners (n=21), boxers (n=21), weightlifters (n=21) and wrestlers (n=15). The nutrient intake showed significant variation with respect to sports discipline and body weight. The nutrient intake of the sportsmen was well comparable with recommended daily allowances except for protein and iron. Elite athletes were generally knowledgeable and sophisticated with regard to nutrition and effect on performance. The attitudes reflected the poor information sportsmen had and their practice to copy peers and coaches. The sportsmen took minimum effort to gather information about nutrition. The sportsmen from the weight category sports (boxing, weightlifting, wrestling) reported vague concepts about weight loss. The sportsmen reported supplements were essential to meet increased demands of training and to supplement nutrients lacking in foods. The present study reveals that there is a paucity of nutrition education intervention among Indian sportsmen.

Barr (1987)²² conducted a study with objectives to compare the nutrition knowledge, including knowledge about nutrition in relation to physical activity, of female university students and members of varsity athletic teams and to document selected nutrition practices of those groups. Instruments developed

²¹ G. Kelkar, K. Subhadra, and R. K. Chengappa, "Nutrition knowledge, attitude and practices of competitive Indian sportsmen." *Indian Journal of Nutrition and Dietetics*, 43, 7, 2006, pp.293-304.

²² S. I. Barr, "Nutrition knowledge of female varsity athletes and university students." *J Am Diet Assoc.*, 87, 12, 1987, pp.1660-1664.

for the study were completed by varsity athletes (no. = 70) and students not on teams (no. = 129). The two groups were similar in education, but the athletes were younger, taller, and heavier than the students and were considerably more active. The athletes used more nutritional supplements (especially iron) and were less likely to exclude red meat from their diet than were students. Scores on the knowledge test (which had a possible range of - 100% to 100%) averaged 34% for both team members and students. Both groups scored higher on general nutrition questions than on questions about nutrition in relation to activity. Among students, age, education, dietary pattern, total number of nutrition information sources, and length of time an activity program had been maintained were positively associated with nutrition knowledge. Those relationships were not detected among varsity athletes. It was concluded that female varsity athletes had levels of both general and sports-related nutrition knowledge that were similar to those of female students not participating on varsity teams.

Vinci (1998)²³ presented an overview of the Husky Sport Nutrition Program at the University of Washington. This program is a component of the Department of Intercollegiate Athletics Total Student-Athlete Program, an NCAA-sponsored CHAMPS/Life Skills Program that provides life skills assistance to student-athletes. Successful integration of a sport nutrition program requires an understanding of the athletic culture, physiological milestones, and life stressors faced by college athletes. The sport nutritionist functions as an educator, counselor, and administrator. Team presentations and individual nutrition counseling provide athletes with accurate information on healthy eating behaviors for optimal performance. For women's sports, a multidisciplinary team including the sport nutritionist, team physician, clinical psychologist, and

²³ D. M. Vinci, "Effective nutrition support programs for college athletes." *Int J Sport Nutr.*, 8, 3, 1998, pp.308-320.

athletic trainer work to prevent and treat eating disorders. Case studies are presented illustrating the breadth of nutrition-related issues faced by a sport nutritionist working with college athletes.

It is well established in the literature that college students have poor eating habits and that many barriers exist to achieving optimal nutrition for this busy population. Little is known about students' perceptions of this problem or suggestions for improving their dietary habits. Similarly, college health professionals need innovative approaches to nutritional education. In an effort to develop an online nutrition resource specifically geared to college students, Cousineau, Goldstein and Franko (2004)²⁴ assessed the availability of Internet-based nutritional information for this population and conducted focus groups with students and health professionals to identify relevant nutrition concerns. They used concept-mapping techniques to conduct a systematic analysis of the qualitative information generated from their focus group participants. Their findings emphasize the need for targeted resources for college students and the importance of using students' suggestions in developing nutrition programs.

Students entering university often lack knowledge about fats; whether students gain such information during four years at university is unclear. Mazier and McLeod (2007)²⁵ measured and compared students' knowledge of fat in the first and fourth years. The effect of a nutrition course on knowledge was also examined. A total of 215 science students at a small undergraduate university completed a 15-item, closed-ended questionnaire concerning knowledge of fats in the diet. Fourth-year science students have greater nutrition knowledge of fats than do first-year science students ($p < 0.005$). Given that the majority of first-year

²⁴ T. M. Cousineau, M. Goldstein, and D. L. Franko, "A collaborative approach to nutrition education for college students." *J Am Coll Health*, 53, 2, 2004, pp.79-84.

²⁵ M. J. Mazier, and S. L. McLeod, "University science students' knowledge of fats." *Can J Diet Pract Res.*, 68, 3, 2007, pp.154-159.

students reside on campus and the majority of fourth-year students reside off campus, the purchasing of food and preparation of meals may explain the senior students' greater knowledge of fat. Students who have taken a nutrition course know more about fats than do those who have not ($p < 0.001$). The results suggest that taking even one course in nutrition greatly increases nutrition knowledge. Universities could encourage undergraduate students to take a basic nutrition course, which should emphasize the identification and understanding of different types of dietary fats.

The results of study conducted by Pratt and Walberg (1988)²⁶ indicated that most (80%) of the teachers were fairly knowledgeable about the nutrition needs of athletes. However, while many teachers agreed that carbohydrates and fats were the main sources of muscular energy, 35% indicated that protein was the primary source of energy for muscular activity. Also, 12% agreed that the consumption of salt tablets during athletic events prevents muscle cramps. The results suggest nutrition education for HPE teachers is needed. Information provided to HPE teachers should address their three main nutrition concerns, which are a balanced diet for athletes, weight control, and fluid replacement.

Whati *et al.*, (2009)²⁷ conducted a study with the objectives to (i) develop and validate a norm-referenced performance-rating scale to interpret a nutrition knowledge test developed for urban adolescents and (ii) develop a prototype for other researchers to follow when developing nutrition knowledge tests. For norm development the nutrition knowledge test (questionnaire) was administered to a sample representative of the questionnaire target group, referred to as the norm group. These included 512 adolescents in grades 8 (n

²⁶ C. A. Pratt, and J. L. Walberg, "Nutrition knowledge and concerns of health and physical education teachers." *J Am Diet Assoc.*, 88, 7, 1988, pp.840-841.

²⁷ L. Whati, M. Senekal, N. P. Steyn, C. Lombard, and J. Nel, "Development of a performance-rating scale for a nutrition knowledge test developed for adolescents." *Public Health Nutr.*, 12, 10, 2009, pp.1839-1845.

158), 10 (n 149) and 12 (n 205) at three randomly selected schools in Soweto and Johannesburg. The performance scores (in percentages) obtained by the norm group were transformed to Z-scores which were categorised into stanines using established Z-score cut-off points. For validation purposes the questionnaire was completed by 148 volunteers: sixty university dietetics students, nineteen non-nutrition university students and sixty-nine primary-school teachers. As required of an ideal norm group, the Z-scores formed a normal distribution (a bell-shaped curve). To facilitate interpretation of the results, the Z-score cut-off points for these categories were transformed back to performance scores (percentages) so that the performance of a testee could be interpreted directly from his/her performance in percentage. As is recommended, the nine stanine categories were reduced to five: very poor, fair/below average, good/average, very good/above average and excellent. The discriminatory validity of the norms was substantiated by showing that groups with known nutrition knowledge levels were rated appropriately and that the performance ratings of these groups differed significantly, with university dietetics students scoring 98.3%, primary-school teachers 20.3% and non-nutrition university students 31.6%. The norm-referenced performance-rating scale can be used with confidence to interpret the performance score achieved by a testee on the nutrition knowledge test developed for urban adolescents in South Africa. The methodology used in the study serves as a prototype for other researchers who are developing knowledge tests.

Long (1989)²⁸ determined the nutrition knowledge of sports physical therapists. A Nutrition Knowledge Test was designed and mailed to 1000 members of the Sports Section of the American Physical Therapy Association. The 498 therapists who returned completed questionnaires achieved an overall mean knowledge score of 71.63%. Women scored significantly better than men; therapists in the

²⁸ D. L. Long, "Nutrition knowledge of sports physical therapists." *J Orthop Sports Phys Ther.*, 10, 7, 1989, pp.257-263.

16+ years of experience and the 50+ years age groups scored less well. While there was a positive attitude toward nutrition, no correlation was found between attitude and nutrition knowledge. Thirty percent of the therapists reported receiving nutrition education in their physical therapy program. Thirty-two percent received nutrition information through continuing education. Those therapists with continuing education achieved significantly higher knowledge scores, particularly on the sports-related questions. The results of this study indicate that the nutrition knowledge of sports physical therapists can be increased with nutrition education provided through continuing education.

Wrestlers are known for their extreme weight-cutting practices including fasting, food and fluid restriction, and dehydration. Using a stratified statewide survey, this investigation by Oppliger *et al.*, (1993)²⁹ elucidated weight loss practices, nutritional knowledge, and bulimic behaviors among 713 high school wrestlers in Wisconsin. Results showed that 1.7% of the wrestlers answered questions consistent with all five criteria for bulimia nervosa, a rate higher than expected for adolescent males. An additional 43% exhibited weight-cutting practices similar to those of the wrestlers who met all bulimia nervosa criteria. The average wrestler lost 3.2 kg to compete, cycled 1.8 kg weekly, and fasted 20 hours prior to weigh-in. More extreme behaviors occurred among the 45% who met two or more bulimia nervosa criteria on their questionnaire; 19% frequently fasted, 25% restricted fluids, 34% used rubber suits, and 8% vomited. These results are comparable with data published over the past 20 years. Efforts to curtail these behaviors through regulations restricting weight loss coupled with sound nutritional information are warranted. Physicians and health professionals should be alert to potential eating disorders within this population.

²⁹ R. A. Oppliger, G. L. Landry, S. W. Foster, and A. C. Lambrecht, "Bulimic behaviors among interscholastic wrestlers: a statewide survey." *Pediatrics*, 91, 4, 1993, pp.826-831.

Oppliger, Steen and Scott (2003)³⁰ examined the weight management (WM) behaviors of collegiate wrestlers after the implementation of the NCAA's weight control rules. In the fall of 1999, a survey was distributed to 47 college wrestling teams stratified by collegiate division (i.e., I, II, III) and competitive quality. Forty-three teams returned surveys for a total of 741 responses. Comparisons were made using the collegiate division, weight class, and the wrestler's competitive winning percentage. The most weight lost during the season was 5.3 kg +/- 2.8 kg (mean +/- SD) or 6.9% +/- 4.7% of the wrestler's weight; weekly weight lost averaged 2.9 kg +/- 1.3 kg or 4.3% +/- 2.3% of the wrestler's weight; post-season, the average wrestler regained 5.5 kg +/- 3.6 kg or 8.6% +/- 5.4% of their weight. Coaches and fellow wrestlers were the primary influence on weight loss methods; however, 40.2% indicated that the new NCAA rules deterred extreme weight loss behaviors. The primary methods of weight loss reported were gradual dieting (79.4%) and increased exercise (75.2%). However, 54.8% fasted, 27.6% used saunas, and 26.7% used rubber/plastic suits at least once a month. Cathartics and vomiting were seldom used to lose weight, and only 5 met three or more of the criteria for bulimia nervosa. WM behaviors were more extreme among freshmen, lighter weight classes, and Division II wrestlers. Compared to previous surveys of high school wrestlers, this cohort of wrestlers reported more extreme WM behaviors. However, compared to college wrestlers in the 1980s, weight loss behaviors were less extreme. The WM practices of college wrestlers appeared to have improved compared to wrestlers sampled previously. Forty percent of the wrestlers were influenced by the new NCAA rules and curbed their weight loss practices. Education is still needed, as some wrestlers are still engaging in dangerous WM methods.

³⁰ R. A. Oppliger, S. A. Steen, and J. R. Scott, "Weight loss practices of college wrestlers." *Int J Sport Nutr Exerc Metab.*, 13, 1, 2003, pp.29-46.

Kiningham and Gorenflo (2001)³¹ assessed the weight loss practices of Michigan high school wrestlers at all levels of competition. A two-page survey was designed to assess weight loss behaviors of high school wrestlers. It was mailed by the Michigan High School Athletic Association (MHSAA) midway through the wrestling season to all Michigan high schools participating in interscholastic wrestling. Completed surveys were received from 2532 wrestlers. Wrestlers lost an average of 6 pounds during the season. Over 50% of wrestlers lost more than 5 pounds; 27% of wrestlers lost at least 10 pounds; 72% of wrestlers engaged in at least one potentially harmful weight loss method each week of the wrestling season; 52% used at least two methods each week; 12% used at least five methods each week. Weekly use of laxatives, diet pill, or diuretics was reported by 2% of wrestlers. Vomiting to lose weight was done at least weekly by 2% of wrestlers. Wrestlers who engaged in at least one rapid weight loss method per week lost more weight, began wrestling at an earlier age, and reported more binge eating compared with wrestlers who did not report weekly rapid weight loss. From the results it was concluded that majority of Michigan high school wrestlers engaged in at least one potentially harmful weight loss method each week of the wrestling season. Fasting and various methods of dehydration were the primary methods of rapid weight loss. Wrestlers who lost weight each week were more likely to binge eat. Potentially harmful weight loss practices were found to be common at all grades and success levels.

Several recent studies have pointed out that the weight loss techniques used by wrestlers to make weight are similar to the behavior of bulimics. Therefore, the purpose of the study conducted by Dale and Landers (1999)³² was to determine

³¹ R. B. Kiningham, D. W. Gorenflo, "Weight loss methods of high school wrestlers." Med Sci Sports Exerc., 33, 5, 2001, pp.810-813.

³² K. S. Dale, and D. M. Landers, "Weight control in wrestling: eating disorders or disordered eating?" Med Sci Sports Exerc., 31, 10, 1999, pp.1382-1389.

whether an increased risk of bulimia nervosa existed for a group of junior high and high school wrestlers. Wrestlers (N = 85) completed the Eating Disorder Inventory (EDI) once during the season, and once during the off-season. A comparison group of nonwrestlers (N = 75) also completed the questionnaire. No significant differences were found between the number of in-season wrestlers and nonwrestlers classified as "at risk" for bulimia nervosa. Significant differences were revealed, however, between in-season wrestlers and nonwrestlers, and between in-season wrestlers and off-season wrestlers, on the Drive for Thinness subscale. In both cases, significantly more in-season wrestlers scored above the "at risk" cutoff on the subscale. These results indicate that although in-season wrestlers are more weight conscious than nonwrestlers, these feelings and attitudes are transient. All subjects classified as "at risk" also participated in an interview which followed the format of the Eating Disorder Examination. Interviews with in-season wrestlers revealed that their concerns with weight were due entirely to the demands of wrestling, and did not meet the severity level required for a diagnosis of bulimia nervosa.

Many wrestlers engage in chronic dieting and rapid "weight cutting" throughout the year to compete in a category below their natural weight. Such weight-management practices have a negative influence on their health and nutritional status, so the National Wrestling Coaches Association implemented a new weight-management program for high school wrestlers in 2006. The purpose of this study conducted by Shriver, Betts and Payton (2009)³³ was to determine whether seasonal changes in weight, body fat, and eating attitudes occur among high school wrestlers after the implementation of the new weight-management rule. Fifteen high school wrestlers participated in the study. Their weight, body composition, and eating attitudes were measured preseason, in-season, and off-

³³ L. H. Shriver, N. M. Betts, and M. E. Payton, "Changes in body weight, body composition, and eating attitudes in high school wrestlers." *Int J Sport Nutr Exerc Metab.*, 19, 4, 2009, pp.424-432.

season. Body fat was assessed using dual-energy X-ray absorptiometry. Attitudes toward dieting, food, and body weight were assessed using the Eating Attitude Test (EAT). No significant changes in body fat were detected from preseason to off-season. Weight increased from preseason to in-season ($p < .05$) and off-season ($p < .05$). Although the EAT score did not change significantly from preseason to off-season, 60% reported "thinking about burning up calories when exercising" during preseason, and only 40% felt that way during the season ($p < .05$) and 47% during, off-season ($p < .05$). The results shows that the wrestlers experienced a significant weight gain from preseason to off-season with no significant changes in body fat. Their eating attitudes did not change significantly from preseason to off-season in this study, but further research using a large sample of high school wrestlers is warranted to confirm these findings.

Severe weight control methods used by high school wrestlers have caused concern about these students' growth and athletic performance. There are minimal prevalence data on a few methods of weight control used by wrestlers and no information on the relationship to body fat measurements. Therefore, Woods, Wilson and Masland (1988)³⁴ compared eight control methods and the percent body fat of wrestlers ($n = 49$) to competitive squash players ($n = 20$) and noncompetitive jogging and fitness students ($n = 38$) at an independent secondary school. Wrestlers used dieting ($p = 0.0002$), bingeing ($p = 0.026$), vomiting ($p = 0.046$), sweating ($p = 0.0001$), and fluid restriction to less than 2 cups/day ($p = 0.0014$) significantly more often than controls (squash players and jogging/fitness students). There was no difference between the wrestlers' and controls' use of fasting ($p = 0.5$) or exercising ($p = 0.1$). Neither group reported using a diuretic or laxative during the sports seasons. Although the wrestlers' percent body fat was lower than controls (mean for wrestlers = $10.3 \pm 3.5\%$,

³⁴ E. R. Woods, C. D. Wilson, and R. P. Masland Jr, "Weight control methods in high school wrestlers." J Adolesc Health Care., 9, 5, 1988, pp.394-397.

mean for controls = 12.4 +/- 3.7%, $p = 0.01$), wrestlers perceived their mean ideal weight to be less than their present weight (wrestlers = -1.56 +/- 6.20 lb, controls = +1.92 +/- 9.49 lb, $p = 0.03$). From the results it was concluded that the methods of weight control practiced could potentially impair an adolescent's growth and development as well as increase the risk of dehydration or electrolyte imbalance during competition.

Utter (2001)³⁵ studied changes in body composition of college-age wrestlers ($N = 21$, 19.0 +/- 0.2 years of age, 8.2 +/- 0.6 years of experience) throughout the season after implementation of the new National Collegiate Athletic Association (NCAA) wrestling weight certification (WWC) program. Wrestlers were divided into 2 groups, starters ($n = 10$) and nonstarters ($n = 11$), based on the number of completed matches during the 1998-1999 season. Body density was measured via hydrostatic weighing, with residual volume determined via the nitrogen washout technique. Hydration was assessed by measuring specific gravity of urine (Usg). For body mass and fat-free mass (FFM), a significant difference in the pattern of change was found ($p < 0.05$), highlighted by a decrease in body mass (-3.0%, -2.5 kg, -5.8 lb) and a maintenance of FFM from preseason to peak season for the starters. The pattern of change over time was significantly different for refractometry Usg ($p < 0.01$) but not for the test strip Usg ($p = 0.54$). No significant interaction effects were seen for percentage of body fat or fat mass. Significant time main effects were found for percentage of body fat, body mass, fat mass, FFM, and refractometry Usg. Taken together, the results of this investigation demonstrate that collegiate wrestlers lose body mass but maintain FFM throughout the season, which may in part be associated with the new NCAA WWC program.

³⁵ A. C. Utter, "The new National Collegiate Athletic Association wrestling weight certification program and sport-seasonal changes in body composition of college wrestlers." *J Strength Cond Res.* 15, 3, 2001, pp.296-301.

Schmidt, Piencikowski and Vandervest (2005)³⁶ investigated the effects of a competitive wrestling season on body composition, muscular strength, and muscular power in National Collegiate Athletic Association (NCAA) Division III college wrestlers. A total of 10 wrestlers were assessed throughout 2 consecutive wrestling seasons in late October, late January (midseason), and late March (postseason). Measurements included body weight, body composition (6-site skinfold), muscular strength (back squats and bench press), and muscular power (e.g., power cleans, vertical jump, seated medicine ball put). A repeated-measures analysis of variance (ANOVA) showed no significant changes in body weight, percentage of body fat, or fat-free mass (FFM) from pre- to mid- to postseason (body weight, 77.9 +/- 12.4, 75.7 +/- 11.0, and 79.9 +/- 12.8 kg; percentage of body fat, 11.6 +/- 3.9, 10.5 +/- 3.0, and 12.0 +/- 3.4; FFM, 68.5 +/- 8.7, 67.5 +/- 8.2, and 70.0 +/- 9.0 kg). A statistically significant main effect of time ($p < 0.01$) was observed for muscular strength, as both the back squat and bench press measures were lower at midseason (back squat, 150.8 +/- 25.2 kg; bench press, 98.3 +/- 25.4 kg) than at pre- and postseason (back squat, 157.9 +/- 25.5 and 161.4 +/- 25.6; bench press, 103.4 +/- 25.5 and 106.4 +/- 26.0). Muscular power did not change significantly throughout the wrestling season. These data indicate that Division III college wrestlers remain relatively weight stable with little change in body composition during a competitive wrestling season. While muscular power is apparently maintained, muscular strength may decline slightly. These findings suggest that these wrestlers benefit from a training program that emphasizes in-season strength maintenance.

³⁶ W. D. Schmidt, C. L. Piencikowski, and R. E. Vandervest, "Effects of a competitive wrestling season on body composition, strength, and power in National Collegiate Athletic Association Division III college wrestlers." *J Strength Cond Res.*, 19, 3, 2005, pp.505-508.

The purpose of study conducted by Wroble and Moxley (1998)³⁷ was to: 1) examine the weight loss patterns in a group of high school varsity wrestlers whose teams participated in a body composition measurement & nutrition education program, and 2) test the hypothesis that wrestling at a weight below recommended Minimum Wrestling Weight (MWW) results in decreased wrestling success. For this investigators measured skinfold thickness in 465 wrestlers at 16 schools and, using the Lohman method, determined their percent body fat. An educational program presented at each school explained the results, provided nutritional information regarding proper diet and methods of weight loss, and suggested a voluntary MWW corresponding to 5% body fat. After excluding the heavyweight wrestlers, there were 159 varsity wrestlers. At the end of the season, authors noted their weight class and whether they placed in post-season state championship qualifying tournaments. The result shows that 53 wrestlers (33%) wrestled below MWW. When analyzed by school, wrestlers' non-adherence to MWW ranged from 0% to 56% of all wrestlers. In the lightest four weight classes, 62% wrestled below MWW; in the middle four classes, 29%; and in the heaviest four classes, 6%. Of the 53 wrestlers below MWW, 57% placed and of the 106 above MWW, 33% placed ($P < 0.01$). These results show that a substantial number of wrestlers who participate in a voluntary body fat measurement and diet education program wrestle below recommended MWW. This is particularly true at lower weight classes. Further, wrestling below MWW was associated with greater wrestling success. The current concept of MWW should not be based on wrestling performance effects.

³⁷ R. R. Wroble, and D. P. Moxley, "Weight loss patterns and success rates in high school wrestlers." Med Sci Sports Exerc, 30, 4, 1998, pp.625-628.

Lingor and Olson (2010)³⁸ examined the methods used to meet certification weight for wrestling and to measure the changes in body composition during 1 season for Division III college wrestlers. Nine college wrestlers completed this study. Body composition was analyzed by underwater weighing (UWW) and multifrequency bioelectrical impedance before and throughout the competitive season. Hydration status was measured by urine osmolality (Uosm) and urine specific gravity (Usg). Nutritional intake was measured for 2 1-week periods, once at the beginning and again near the end of the season. Subjects' fat-free mass (FFM) increased an average of 1.8 kg, whereas fat mass (FM) decreased 2.2 kg as indicated by UWW from the beginning to the end of the season. Wrestlers on average cycled their weight 3.4 kg (4.7% of body weight) per week. The majority of wrestlers cut weight by reducing calories and restricting fluids starting 2 days before the competition. Uosm and body weights on Friday suggested that for wrestlers to achieve the necessary weight loss by dehydration to "make weight" for a Saturday meet, wrestlers would approach a 5% level of dehydration. No loss of FFM because of weight cycling (WC) was evident to achieve competitive weight. Most wrestlers significantly restricted fluids and caloric intake in the 48 hours before weigh-in.

Roemmich and Sinning (1997)³⁹ measured adolescent wrestlers (n = 9, 15.4 yr) and recreationally active control adolescent males (n = 7, 15.7 yr) before, at the end (late season), and 3.5-4 month after a wrestling season to assess the influence of dietary restriction on growth, maturation, body composition, protein nutrition, and muscular strength. Controls consumed adequate amounts of energy, carbohydrate (CHO), protein, and fat, and demonstrated normal gains in

³⁸ R. J. Lingor, and A. Olson, "Fluid and diet patterns associated with weight cycling and changes in body composition assessed by continuous monitoring throughout a college wrestling season." J Strength Cond Res, 24, 7, 2010, pp.1763-1772.

³⁹ J. N. Roemmich, and W. E. Sinning, "Weight loss and wrestling training: effects on nutrition, growth, maturation, body composition, and strength." J Appl Physiol, 82, 6, 1997, pp.1751-1759.

weight, fat mass (FM) and fat-free mass (FFM). Wrestlers consumed a high-CHO (61 +/- 2% kcal), low-fat (24 +/- 2% kcal) diet during the season but did not consume adequate energy (24.7 +/- 3.5 kcal.kg⁻¹.day⁻¹) or protein (0.9 g.kg⁻¹.day⁻¹). Deficient dietary intake reduced prealbumin levels (26.0 +/- 1.9 vs. 20.2 +/- 0.9 mg/dl) and slowed the accrual of lean arm and thigh cross-sectional muscle areas (AXSECT, TXSECT, respectively). For wrestlers, dietary deficiency also decreased weight (60.3 +/- 3.5 to 58.0 +/- 3.3 kg), relative fat (9.9 +/- 0.5 to 8.0 +/- 0.7%), and FM (6.0 +/- 0.5 to 4.7 +/- 0.6 kg). Postseason, wrestlers and controls consumed similar diets, and wrestlers had significant increases in prealbumin, AXSECT, and TXSECT. Wrestlers also increased their weight (6.1 +/- 0.6 kg), FFM (3.0 +/- 0.6 kg), and FM (3.2 +/- 0.5 kg) postseason. Rates of bone maturation and segmental growth were not different between the groups. The wrestlers had reductions in elbow and knee strength from preseason to late season but increases postseason. Lean tissue changes were associated with the changes in strength and power ($r = 0.72-0.91$, $P < 0.001$). After covariance for FFM or limb-specific cross section, few significant changes remained. In conclusion, dietary restriction reduced protein nutrition and muscular performance but produced little effect on linear growth and maturation. Prealbumin levels and the rate of lean tissue accrual were positively related ($r = 0.43$, $P < \text{or} = 0.05$).

Steen and Brownell (1990)⁴⁰ assessed weight loss practices in wrestlers. 63 college wrestlers and 368 high school wrestlers completed a questionnaire that examined the frequency and magnitude of weight loss, weight control methods, emotions associated with weight loss, dieting patterns, and preoccupation with food. Clear patterns emerged showing frequent, rapid, and large weight loss and regain cycles. Of the college wrestlers, 41% reported weight fluctuations of 5.0-9.1 kg

⁴⁰ S. N. Steen, and K. D. Brownell, "Patterns of weight loss and regain in wrestlers: has the tradition changed?" *Med Sci Sports Exerc*, 22, 6, 1990, pp.762-768.

each week of the season. For the high school wrestlers, 23% lost 2.7-4.5 kg weekly. In the college cohort, 35% lost 0.5-4.5 kg over 100 times in their life, and 22% had lost 5.0-9.1 kg between 21 and 50 times in their life. Of the high school wrestlers, 42% had already lost 5.0-9.1 kg 1-5 times in their life. A variety of aggressive methods were used to lose weight including dehydration, food restriction, fasting, and, for a few, vomiting, laxatives, and diuretics. "Making weight" was associated with fatigue, anger, and anxiety. Thirty to forty percent of the wrestlers, at both the high school and college level, reported being preoccupied with food and eating out of control after a match. The tradition of "making weight" still appears to be integral to wrestling. The potential physiological, psychological, and health consequences of these practices merit further attention.

The deaths of three intercollegiate wrestlers in 1997 prompted the NCAA and governing bodies that oversee high school sports to adopt new policies prohibiting unsafe weight loss practices. Similar policies have not yet been adopted for international style wrestling, a style that attracts thousands of youth once the regulated scholastic season is over. Therefore, this study conducted by Alderman *et al.*, (2004)⁴¹ examined the rapid weight loss practices in high school wrestlers participating in international style wrestling. To do this, rapid weight gain (RWG), an index that reflects the degree of rapid weight loss (RWL), was examined. Wrestlers (N = 2638) participating in the 1997 and 1998 National wrestling championships were randomly selected to be weighed at mat side with electronic scales. The methods wrestlers used to accomplish weight loss were also assessed in a subsample of wrestlers. Wrestlers gained an average of 3.4 kg, which represents a 4.81% gain of body weight. The range across weight classes and age groups was -2.68 kg (-2.1% loss of body weight) to +16.73 kg (13.4% gain

⁴¹ B. L. Alderman, D. M. Landers, J. Carlson, and J. R. Scott, "Factors related to rapid weight loss practices among international-style wrestlers." *Med Sci Sports Exerc.*, 36, 2, 2004, pp.249-252.

of body weight). No differences in RWG existed as a function of the represented state teams. In addition, wrestlers who were older and more successful (i.e., placers) gained significantly more weight than their younger and less successful counterparts ($P < 0.001$). Excessive running, using saunas, and wearing vapor-impermeable suits were cited as the most common methods used to achieve RWL. These results suggest that RWL still exists in international style wrestling, and similar policies to those recently instituted by the NCAA are warranted.

Buford *et al.*, (2008)⁴² examined the physiological response of collegiate wrestlers to their competitive season. Eleven Division I collegiate wrestlers (mean \pm SD; 19.45 \pm 1.13 y) volunteered and completed 4 testing sessions throughout the course of the collegiate wrestling season. Testing sessions were conducted pre-, mid-, and postseason, as well as before the national tournament. Testing consisted of weigh-in, skinfold body composition testing, and a 50-rep concentric, isokinetic leg extension muscle endurance test (180 degrees /s). Muscular performance variables measured included peak torque, peak torque at fatigue, percent decline, and peak torque/body mass ratio. A significant increase ($P < .05$) of 2.9% was observed for body mass between midseason and postseason (2.38 kg). From pre- to postseason, a mean increase of 3.8% (3.1 kg) was observed for body mass. An increase ($P < .05$) in BF% of 2.9% was observed between prenationals and postseason. No significant differences ($P > .05$) were observed between consecutive time points for quadriceps peak torque; however, there was a significant increase ($P < .05$) between preseason and prenationals (23.39 N.m). Peak torque at fatigue was greater ($P < .05$) at midseason than preseason, representing an increase of 9.82 N.m. Between midseason and prenationals testing, we observed an 11% increase ($P < .05$) in %DCLN. Finally, we noted an increase ($P < .05$) from 0.6 to 0.69 in peak torque/body mass ratio between

⁴² T. W. Buford, D. B. Smith, M. S. O'Brien, A. J. Warren, and S. J. Rossi, "Seasonal changes of body mass, body composition, and muscular performance in collegiate wrestlers." *Int J Sports Physiol Perform*, 3, 2, 2008, pp.176-184.

preseason and prenationals. These results indicate that while force values seem to suffer at midseason, the wrestlers compensated and were strongest just before their national competition.

In another study Buford *et al.*, (2006)⁴³ examined the effects of a collegiate wrestling season on body weight, hydration, and muscular performance. Twelve Division I collegiate wrestlers (mean +/- SE; 20.75 +/- 0.41 year) volunteered to participate in testing sessions during midseason and 3 weeks following the season. Testing consisted of weigh-in, providing a urine sample for hydration analysis, and a measure of isometric leg extension peak torque. Weight significantly increased ($p < 0.05$) following the completion of the competitive season. No significant change in urine specific gravity ($p > 0.05$) was observed. Muscular performance was affected by the season as peak torque (PT) and PT-to-body weight ratio increased significantly ($p < 0.05$). Following the collegiate wrestling season, augmentation in body weight and muscular performance of the wrestlers occurs without alterations in hydration status. Further research is warranted on what type of strength training program would most effectively reduce the decrements in strength associated with weight loss and the strain of a competitive season.

Horswill, Park and Roemmich (1990)⁴⁴ studied the protein nutritional status of adolescent wrestlers to determine whether changes occur during a season of competition and weight loss. Subjects (N = 18) were measured prior to the start of the season (PRE), twice in the midseason, and once during late season (LATE) for weight, percent body fat, and height. At each of these times, a venous blood

⁴³ T. W. Buford, S. J. Rossi, D. B. Smith, M. S. O'Brien, and C. Pickering, "The effect of a competitive wrestling season on body weight, hydration, and muscular performance in collegiate wrestlers." *J Strength Cond Res*, 20, 3, 2006, pp.689-692.

⁴⁴ C. A. Horswill, S. H. Park, J. N. Roemmich, "Changes in the protein nutritional status of adolescent wrestlers." *Med Sci Sports Exerc*, 22, 5, 1990, pp.599-604.

sample was obtained from the subjects, who were fasted, and analyzed for concentrations of albumin, prealbumin, retinol binding protein (RBP), blood urea nitrogen (BUN), hemoglobin, hematocrit, and 23 amino acids. Diet records were kept by subjects to assess daily energy, protein, fat, and carbohydrate intake. Data were analyzed by repeated measures ANOVA. Results showed that wrestlers decreased weight by an average of 6.6 +/- 0.9% and that percent body fat, fat-free weight, plasma levels of prealbumin and RBP, the ratio of total essential amino acids to total amino acids, and dietary energy nutrient intakes were significantly lower at LATE compared to PRE. RBP decreased during midseason and averaged (+/- SE) 3.21 +/- 0.15 mg.100 ml⁻¹ at LATE; prealbumin was significantly lower at LATE with a mean value of 19.8 +/- 1.0 mg.100 ml⁻¹. Total energy intake decreased from PRE values by 35%, to approximately 27 kcal.kg⁻¹.d⁻¹ during the season. In conclusion, in these high school wrestlers who lost approximately 6.6% of weight, there were adverse effects on some of the indices of protein nutritional status.

Twenty-five competitive wrestlers were studied by Mourier *et al.*, (1997)⁴⁵ after restriction of their caloric intake (28 kcal.kg⁻¹.day⁻¹) for 19 days, using a hypocaloric control (hC, n = 6), hypocaloric high-protein (hHP, n = 7), hypocaloric high-branched-chain amino acid (hBCAA, n = 6), hypocaloric low-protein (hLP, n = 6) diet to determine the effects of caloric restriction on body composition and performances versus control diet (C, n = 6). Anthropometric parameters (weight, percent body fat) and adipose tissue (AT) distribution measured by magnetic resonance imaging (MRI) obtained before and after diet, were compared. A significant highest body weight loss (-4 kg, p < 0.05) and decrease in the percent of body fat (-17.3%, p < 0.05) were observed for subjects of the hBCAA group. Subjects of the hBCAA group exhibited a significant

⁴⁵ A. Mourier, A. X. Bigard, E. de Kerviler, B. Roger, H. Legrand, and C. Y. Guezennec, "Combined effects of caloric restriction and branched-chain amino acid supplementation on body composition and exercise performance in elite wrestlers." *Int J Sports Med*, 18, 1, 1997, pp.47-55.

reduction (-34.4%, $p < 0.05$) in abdominal visceral adipose tissue (VAT). There was no change in aerobic (VO_{2max}) ($p > 0.75$) and anaerobic capacities (Wingate test) ($p > 0.81$), and in muscular strength ($p > 0.82$). From the results it was concluded that under these experimental conditions, the combination of moderate energy restriction and BCAA supplementation induced significant and preferential losses of VAT, and allowed maintenance of a high level of performance.

McMurray, Proctor and Wilson (1991)⁴⁶ determined the acute effect of caloric deficiency on aerobic and anaerobic exercise performance as well as growth hormone (hGH) and insulin-like growth factor 1 (IGF-1) levels. For this Twelve competitive wrestlers restricted their caloric intake (92 kJ/kg FFW/day) for 7 days, using a high (HC) or normal (NC) carbohydrate diet. The subjects were tested while on a eucaloric diet and at the end of the dietary restriction. Neither the dietary restriction nor composition had an effect on the ability to complete an 8-minute run at 85% of maximal capacity, but both produced an increased fat utilization during the run. The responses to the Wingate Anaerobic Test indicated that the NC group had a significant reduction in total and mean power output (-7% & -6%, respectively; p less than 0.05), whereas the HC group maintained all power measures. The caloric restriction, regardless of dietary composition, increased the exercise hGH response more for the NC group than the HC group (p less than 0.05). IGF-1 levels were significantly lowered by the diet, but the diet composition had no effect. These results indicate that even during caloric restriction, a high carbohydrate diet better maintains anaerobic exercise performance. Furthermore, the composition of the diet appears to have no effect on the resting hGH and IGF-1 responses to caloric deficits. However, carbohydrate composition may have an effect on the gGH response to exercise.

⁴⁶ R. G. McMurray, C. R. Proctor, and W. L. Wilson, "Effect of caloric deficit and dietary manipulation on aerobic and anaerobic exercise." *Int J Sports Med*, 12, 2, 1991, pp.167-172.

Baseline dietary intake data were collected for four years on 10 men's and 6 women's university athletic teams by Short and Short (1983)⁴⁷. Caloric intake means for specific teams were higher than those stated in nutrition textbooks (5,270 kcal for football, with a 14,000 kcal per day maximum). Athletes' caloric intakes cannot be grouped, as some athletes (wrestlers and gymnasts) have low intakes (400 kcal per day). Protein intake of all athletes except wrestlers and gymnasts is high (in many cases more than twice any recommendation). The diets of teams with high caloric intakes had a high (more than 50%) fat content. The fat content of the diets of other athletes ranged from 30% to 40%. The wrestling team had more members with poor nutrient intake (less than two-thirds of recommendations) than any other team. Poor vitamin A intakes were noted for all athletic teams studied. Low potassium intakes also were common. Members of women's teams had low iron intakes even though their protein and caloric intakes were high.

Fogelholm (1993)⁴⁸ studied seven male wrestlers and three judo athletes (weight 55-93 kg) during two weight reductions. In the "gradual" procedure (GP), a 5.0 +/- 0.4% (mean +/- SEM) weight loss was achieved in 3 weeks by energy restriction. In the "rapid" procedure (RP), 6.0 +/- 0.6% of body weight was lost in 2.4 days by fluid and diet restriction and forced sweating, and followed by a 5-h "loading" (food and drinks ad libitum). The net weight loss after GP and loading was 2.7 +/- 0.5%. Protein intakes (4-d food records) during GP and RP were 71 +/- 16 and RP 56 +/- 17 g.d-1, respectively. Carbohydrate intakes were 239 +/- 56 (GP) and 182 +/- 55 g.d-1 (RP). During GP and RP, mean thiamin, magnesium, and zinc intakes were at or below the respective recommendation.

⁴⁷ S. H. Short, and W. R. Short, "Four-year study of university athletes' dietary intake." *J Am Diet Assoc*, 82, 6, 1983, pp.632-645.

⁴⁸ G. M. Fogelholm, R. Koskinen, J. Laakso, T. Rankinen, and I. Ruokonen, "Gradual and rapid weight loss: effects on nutrition and performance in male athletes." *Med Sci Sports Exerc*, 25, 3, 1993, pp.371-377.

Thiamin, riboflavin, potassium, iron, and zinc status, assessed from blood chemistry, remained stable during both procedures. Changes in vitamin B6 indicator (E-ASTAC) and S-magnesium concentration were different ($P < 0.01$) between the procedures, suggesting negative trends during GP. Sprint (30-m run) and anaerobic (1-min Wingate test) performance was similar throughout the study. Following GP, vertical jump height with extra load increased by 6-8% ($P < 0.01$). Jumping results were not affected by RP. Hence, $< \text{ or } = 5\%$ loss in body weight by either method did not impair experienced athletes' performance.

Participants in the sport of bodybuilding are judged by appearance rather than performance. In this respect, increased muscle size and definition are critical elements of success. The purpose of this review conducted by Lambert, Frank and Evans (2004)⁴⁹ was to evaluate the literature and provide recommendations regarding macronutrient intake during both 'off-season' and 'pre-contest' phases. Body builders attempt to increase muscle mass during the off-season (no competitive events), which may be the great majority of the year. During the off-season, it is advantageous for the bodybuilder to be in positive energy balance so that extra energy is available for muscle anabolism. Additionally, during the off-season, adequate protein must be available to provide amino acids for protein synthesis. For 6-12 weeks prior to competition, body builders attempt to retain muscle mass and reduce body fat to very low levels. During the pre-contest phase, the bodybuilder should be in negative energy balance so that body fat can be oxidised. Furthermore, during the pre-contest phase, protein intake must be adequate to maintain muscle mass. There is evidence that a relatively high protein intake (approximately 30% of energy intake) will reduce lean mass loss relative to a lower protein intake (approximately 15% of energy intake) during energy restriction. The higher protein intake will also provide a relatively large

⁴⁹ C. P. Lambert, L. L. Frank, and W. J. Evans, "Macronutrient considerations for the sport of bodybuilding." *Sports Med*, 34, 5, 2004, pp.317-327.

thermic effect that may aid in reducing body fat. In both the off-season and pre-contest phases, adequate dietary carbohydrate should be ingested (55-60% of total energy intake) so that training intensity can be maintained. Excess dietary saturated fat can exacerbate coronary artery disease; however, low-fat diets result in a reduction in circulating testosterone. Thus, authors suggest dietary fats comprise 15-20% of the body builders' off-season and pre-contest diets. Consumption of protein/amino acids and carbohydrate immediately before and after training sessions may augment protein synthesis, muscle glycogen resynthesis and reduce protein degradation. The optimal rate of carbohydrate ingested immediately after a training session should be 1.2 g/kg/hour at 30-minute intervals for 4 hours and the carbohydrate should be of high glycaemic index. In summary, the composition of diets for body builders should be 55-60% carbohydrate, 25-30% protein and 15-20% of fat, for both the off-season and pre-contest phases. During the off-season the diet should be slightly hyperenergetic (approximately 15% increase in energy intake) and during the pre-contest phase the diet should be hypoenergetic (approximately 15% decrease in energy intake).

Horvath *et al.*, (2000)⁵⁰ examined the effects of varying dietary fat levels on nutrients in female and male endurance runners. Three diets (low, medium and high fat) were designed for each subject using their food preferences and three-day food records. Each diet was eaten for 28 to 31 days. The diets were self-selected from seven-day sample menus. Twelve male and 13 female runners between 18 and 55 years of age who averaged 42 miles/week participated in the study. Daily food intakes, activity records and weekly palatability/hunger scales were completed. Dietary fat intakes, as a percent of total energy intake (%E), averaged 17%E, 31%E, and 44%E on the low, medium and high fat diets, respectively. Energy consumption was less than their estimated energy

⁵⁰ P. J. Horvath, C. K. Eagen, S. D. Ryer-Calvin, and D. R. Pendergast "The effects of varying dietary fat on the nutrient intake in male and female runners." *J Am Coll Nutr*, 19, 1, 2000, pp.42-51.

expenditure (EEE) on all diets. On the low fat diet, the female runners were consuming approximately 60% of their EEE. As dietary fat increased, the difference between calorie intake and estimated energy expenditure became less and the subjects were less hungry on the two higher fat diets. For all subjects, as energy intakes increased, so did carbohydrate intake. Therefore, carbohydrate intake was not different on the two lower fat diets. Irrespective of gender, calcium and zinc intakes, which were below 1989 RDAs, increased with increasing fat intakes, between the low and medium fat diets. Zinc intake was also higher on the highest fat diet. Essential fatty acid intakes for females on the low fat diet were less than 2.5%E. Half of the female runners ate less than the RDA of calcium and zinc on the low fat diet and Fe on the medium fat diet. This study suggests that endurance runners may not be consuming enough calories on a low fat diet and that increasing dietary fat increased energy consumption. On the low fat diet, essential fatty acids and some minerals (especially zinc) may be too low. A low fat diet could compromise health and performance.

Kordi *et al.*, (2011)⁵¹ evaluated the weight loss behavior of male wrestlers in Tehran. This study was a population-based cross sectional survey. Subjects were 436 wrestlers randomly selected from the wrestling clubs in Tehran employing cluster sample setting method. Subjects were interviewed based on a designed questionnaire. Body fat levels were measured based on skin fold measurements. Weight loss methods practiced by 62% of all subjects during the previous year employing rapid (≤ 7 days before the matches) and gradual (> 7 days before the matches) weight reduction methods (73% and 34% of wrestlers who reduced their weight respectively). In addition, opinions on weight reduction, the methods of weight loss used, and the side effects of the weight loss practices as well as consumption of supplements among the subjects were reported in this

⁵¹ R. Kordi, V. Ziaee, M. Rostami, and W. A. Wallace, "Patterns of weight loss and supplement consumption of male wrestlers in Tehran." *Sports Med Arthrosc Rehabil Ther Technol*, 3, 1, 2011, p.4.

study. The mean percentage of body fat of subjects was 15.9%. Rapid weight loss for matches and the use of unsafe methods of weight reduction such as fasting, and fluid reduction methods as well as acute side effects of weight loss were prevalent among wrestlers in Tehran. Some preventive measures including education and new rules such as scheduling weigh-ins immediately prior to the competitions and mat-side weigh-in are needed to prevent these unhealthy practices. The weight loss behaviors of these wrestlers should be changed from using dehydration methods to using gradual methods of weight loss.

Tarnopolsky *et al.*, (1996)⁵² conducted a study to examine the effect of energy restriction and wrestling on muscle glycogen content in highly-trained male wrestlers. Twelve highly trained male wrestlers volunteered as subjects and were randomly assigned to one of two groups (Group A, n = 6; Group B, n = 6) as defined below. Assessment of risk factors: All subjects were free of medical conditions that would preclude participation in the study and all had performed rapid weight loss at least three times/year with no medical complications. interventions: Group A: simulated wrestling tournament, four 5-min wrestling bouts (> 7 h) following a 5% body weight loss and 17 h repletion period; Group B: 5% weight loss through energy restriction (1,141 kcal/day), exercise, fluid restriction, and dehydration methods (sauna) > 72 h. Main outcome measures: Group A: muscle glycogen content before and after wrestling tournament and plasma lactate after each bout; Group B: muscle glycogen before and after weight loss. Results: Group A: no significant effect on muscle glycogen concentration, yet large increases were observed in blood lactate concentrations (up to 14.7 mmol/L); Group B: weight loss resulted in a 54% ($p < 0.018$) reduction in muscle glycogen concentration. Conclusions: The weight loss methods commonly performed by wrestlers resulted in large decreases in muscle glycogen

⁵² M. A. Tarnopolsky, N. Cipriano, C. Woodcroft, W. J. Pulkkinen, D. C. Robinson, J. M. Henderson, and J. D. MacDougall, "Effects of rapid weight loss and wrestling on muscle glycogen concentration." *Clin J Sport Med*, 6, 2, 1996, pp.78-84.

concentration that were largely reversed during the 17-h repletion period between weigh-in and the start of the competition; participation in a wrestling tournament did not have a significant impact upon biceps brachii glycogen concentration when ad libitum feeding is allowed between matches.

Scott, Horswill and Dick (1994)⁵³ determined the magnitude of weight gained in collegiate wrestlers between the weigh-in and beginning of tournament competition. Body weight of the qualifiers for the NCAA Division I, II, and III wrestling finals (N = 668) was recorded at the official weigh-in and again approximately 20 h later, before the first round of competition in the tournament. The results showed that on average (+/- SD), wrestlers gained 4.9 +/- 2.4% (3.3 +/- 1.5 kg) of body weight before competing. An inverse relationship was found such that wrestlers in the lightest weight classes gained the most weight (kg) compared with heavier wrestlers ($r = -0.45$, $P < 0.05$). Despite the large mean weight gain, the mean discrepancy between first round opponents was 2.1 +/- 3.0 kg and even less when heavyweight wrestlers were excluded from the analyses (1.5 +/- 1.2 kg, N = 607). A significant correlation between weight gain and weight discrepancy of opponents was found ($r = 0.65$, $P < 0.05$). Conclusion: collegiate wrestlers, excluding heavyweights, gained significant amounts of weight (3.7 kg average) during the 20-h period prior to tournament competition. The magnitude of weight gain was positively correlated to the degree of weight discrepancy (size advantage) over the opponent; however, because weight gain of some magnitude after the weigh-in was common in most participants, the average discrepancy between opponents was only about 1.5 kg.

⁵³ J. R. Scott, C. A. Horswill, and R. W. Dick, "Acute weight gain in collegiate wrestlers following a tournament weigh-in." *Med Sci Sports Exerc*, 26, 9, 1994, pp.1181-1185.

The aim of the study conducted by Ooppik *et al.*, (2002)⁵⁴ was to test the hypothesis that creatine supplementation with concomitant carbohydrate ingestion during recovery period after rapid body mass reduction accelerates the restoration of body mass and physical performance in well-trained wrestlers. Methods: A double-blind, placebo-controlled cross-over study was conducted on five young healthy male wrestlers, who reduced their body mass by 4.5-5.3% in two series of investigations separated by one month. During 17 hrs recovery period they consumed controlled diet supplemented in random order with glucose (GL trial) or with glucose plus creatine (GL+CR trial). The capacity of the subjects to perform submaximal and maximal (W(max)) intensity work was measured using 5 min intermittent intensity test exercise at the Cybex II device before (Test 1) and after body mass loss (Test 2), also after the recovery (Test 3) on both trials. Results: There was no effect of treatment on the extent of body mass regain during 17 hrs recovery. A significant increase (19.2%) in W(max) from Test 2 to Test 3 was observed in GL+CR trial whereas no change was evident with GL treatment. A strong correlation ($r=0.92$) was established between the whole body creatine retention and the extent of change in W(max) from Test 2 to Test 3. Conclusions: The results suggest that creatine supplementation with concomitant glucose ingestion during 17 hrs recovery from rapid body mass loss does not accelerate the restoration of body mass but still stimulates the regain of physical performance in maximal intensity efforts in well-trained wrestlers.

The purpose of this study conducted by Finn, Dolgener and Williams (2004)⁵⁵ was to determine the effects of carbohydrate refeeding on intermittent sprint

⁵⁴ V. Oopik, M. Paasuke, S. Timpmann, L. Medijainen, J. Erelina, and J. Gapejeva, "Effects of creatine supplementation during recovery from rapid body mass reduction on metabolism and muscle performance capacity in well-trained wrestlers." *J Sports Med Phys Fitness*, 42, 3, 2002, pp.330-339.

⁵⁵ K. J. Finn, F. A. Dolgener, and R. B. Williams, "Effects of carbohydrate refeeding on physiological responses and psychological and physical performance following acute weight reduction in collegiate wrestlers." *J Strength Cond Res*, 18, 2, 2004, pp.328-333.

exercise, blood lactate response, and mood following a typical weight-reduction program practiced by college wrestlers. Fifteen collegiate wrestlers from the University of Northern Iowa completed 3 trials of intermittent arm cranking and a mood inventory prior to weigh-ins (baseline), after weigh-ins, and 1 hour postconsumption of either 1.5 g carbohydrate (CHO)/kg body mass carbohydrate beverage (25% solution) or placebo taken within 1 hour after weigh-ins. Blood lactate responses were determined with each trial. Repeated measures analysis of variance indicated no significant interaction between group and trial for total work ($p = 0.08$), blood lactate ($p = 0.29$), positive mood ($p = 0.49$), or negative mood ($p = 0.78$). Simple effects analysis indicated a significant difference in lactate response between trials ($p = 0.002$); however, no difference for work ($p = 0.75$), positive mood ($p = 0.13$), or negative mood ($p = 0.08$). The results of this study suggest that intermittent sprint exercise, blood lactate response, and mood were not positively affected by ingestion of CHOs following an acute weight-reduction period.

The reports and reviews presented above indicate that most of the time wrestlers are using some methods for attaining particular weight, so that they can play in that weight category. However, the practices followed by them are not scientific or the wrestlers may not have adequate knowledge about the nutrition. In fact, there are very few studies conducted so far about the knowledge regarding the nutrition among wrestlers. Hence, the researcher of this study intends to see the nutritional knowledge among the wrestlers in Maharashtra.