NUTRITIONAL KNOWLEDGE OF KANSAS STATE UNIVERSITY PHYSICAL EDUCATION MAJORS

by

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INTRODUCTION

What constitutes an "optimum diet" for athletic competition is a perennial question. Durnin (1) stated that there is still no area of nutrition in which faddism and misconceptions are more obvious than in athletics. Misinformation relating to nutrient supplements, weight control, pre-game meals, and overall training diets represents a vast proportion of currently circulating fads and fallacies in the sports world.

Even though the number of athletes participating in sports is substantial, Mickelsen (2) said that there is little information about the diets, food preferences, and nutritional knowledge of athletes. Bobb et al. (3) found that athletes frequently have irregular meal patterns and consume insufficient amounts of vegetables, fruits, eggs, and milk. The majority of the athletes studied did not apply basic nutrition principles to dietary practices; many of them consumed inadequate diets while attempting to lose weight. In a national study of the practices of secondary coaches in recommending diets, Horwood (4) concluded that most coaches based their food advice on personal experience, rather than following guidelines of nutritionists. Steel's study (5) of Australian Olympic athletes indicated that most of the participants had not received qualified dietary advice and many were psychologically dependent on the medicinal use of large quantities of vitamins.

This study was conducted to determine the nutritional knowledge, food attitudes, and nutrition knowledge sources of physical education students at Kansas State University.

REVIEW OF LITERATURE

Historical Perspective

Mayer (6) stated that training table practices, recorded as far back as 5th century B. C., are based on folklore and superstitions, rather than scientific research. Early records studied by Harris (7) indicated that Hippocrates (460-377 B. C.) stressed the importance of specific diets for athletes. The earliest Greek athlete whose diet is on record, Charmis of Sparta, trained on dried figs and won a distance race in the Olympic Games. Large quantities of meat were not recommended until 5th century B. C.--when Dromius of Stymphalus, a long-distance runner, trained on a diet largely composed of meat. Steel (5) reported that meat was not given attention until two athletes departed from the usual Greek vegetarian diet and were said to have gained in strength and endurance.

Harris (7) indicated that shortly after the birth of Christ, Philostatus, author of the only surviving Greek book devoted to athletes, regarded athletes as effeminate and believed physicians were responsible for recommending diets more suited to the ill. Athletes often became finicky eaters who insisted on merits of particular food items.

Van Itallie et al. (8) reviewed the customs of English athletes at the end of the 18th century; the sportsmen began training by consuming milk, beer, unseasoned red meat, and bread. The Oxford crew attributed their 1861-1869 repeated victories to their peculiar diet of underdone mutton or beef, tea, beer, and bread.

Fads and Idiosyncracies

Numerous food fads and idiosyncracies have been followed by athletes the world over. These may relate to consumption of protein, milk, vitamin supplements, wheat germ oil, Gatorade, high-fat foods, gas-forming foods, "irritating foods," and bulky foods.

Protein

Health, weight training, and athletic journals are filled with advertisements encouraging the use of protein supplements and other dietary aids. The value of such supplements is a controversial subject. Bassett et al. (9) were unable to observe any effect on physical work capacity of subjects consuming a meat diet. Van Itallie (10) claimed additional protein is needed to increase total muscle mass and is beneficial in building up protein stores. Astrand (11) declared that protein combustion is not higher under physical stress than under resting conditions. Several researchers (12-14) concluded that large quantities of protein supplements produced no beneficial results in connection with physical performance.

Novich and Taylor (15) said that coaches emphasize the necessity for consuming sizeable amounts of protein, because they believe that beef replaces muscle protein lost during muscular activity. However, Bullen et al. (16) reported that protein needs are governed by body growth and maintenance, rather than increased physical expenditure. Darling et al. (17) found no beneficial effects by increasing protein intakes from 50 to 160 grams daily for a period of two months, while engaging in strenuous physical activity. Hedman (18) stated that experiments with cross-country skiers resulted in no noticeable change in nitrogen output compared to resting

controls. The intake of additional protein may be more influenced by psychological factors and taste, rather than that of sound physiology. Upjohn et al. (19) stated that both high school athletes and non-athletes need additional protein to meet growth demands.

Milk

In the past, several unfounded beliefs have caused coaches to exclude milk from meals on game day. Van Huss et al. (20) reported the concept that milk impairs endurance performance is based upon a combination of the following contentions: milk consumption causes a decrease in salivary gland activity and results in a cottony feeling in the mouth, milk ingested just previous to physical activity curdles in the stomach and interferes with performance, and milk increases fat intake and lowers the respiratory quotient. Another fallacy is that milk ingestion will increase mucus secretions of the respiratory system. None of these beliefs has been substantiated in any scientific study (21).

The National Dairy Council (21) reviewed research that concluded saliva flow and condition of the saliva are related to the amount of perspiration and reduction in water content of the body and are not affected by the kind of food eaten prior to exercise. Van Huss et al. (20) concluded that performance was not impaired by milk consumption and found no differences in training over a time period, whether milk was included or excluded from the diet.

Vitamin Supplements

Approximately thirty years ago reports suggested that physical performance was altered by additional amounts of vitamins, especially the B-complex

vitamins. Keys (22) was unable to discover any benefit in work performance or capacity from daily supplements of B vitamins. He was unable to find evidence that supplements of vitamins B, C, or E, separately or in combination, would enhance physical performance of well-nourished persons. Bourne (23) recommended increased vitamin dosages for athletic competition based on the concept that the requirement for certain vitamins may be greatly increased by strenuous exercise. Hirata (24) reported the unjustified widespread use of vitamin B_{12} intramuscular injections to increase energy production. Van Itallie et al. (8) confirmed the general belief that the increased need for vitamins are proportional to the additional caloric intake for energy expenditure. Nelson (25) studied effects of a well-known vitamin supplement on selected gross motor tests and found no significant differences in performance. The Medical Journal of Australia (26) reported that when well-balanced diets are consumed, health and performance are not improved by consumption of vitamin supplements.

Sharman and colleagues (27) studied a-tocopheryl acetate in relation to energy output and its contribution to improved physical performance; however, they did not report any conclusions. Cureton (28) found improved treadmill running time and other physical measures of endurance skills in a group of subjects given wheat germ oil supplements. However, Thomas (29) found no significant differences between vitamin E dosed and undosed subjects in cardiorespiratory and motor-fitness tests. Claims of improved performance in swimming with vitamin E supplementation were reported in the British Medical Journal (30). While conclusions were usually favorable to the value of vitamin E, the results were unconvincing on scientific grounds. Sharman and

co-workers (27) found no significant effect of vitamin E on swimming performance.

Wheat Germ Oil

Wheat germ oil has been publicized as an anti-fatigue agent. Cureton (28) first reported an improved running capacity in physical education students; however, he saw no improvements in a control group of swimmers. Animal studies by Consolazio et al. (31) concluded that the oil had no effect in improving either the time during which maximal physical activity could be maintained or the speed of performance.

Gatorade

Another food fad, developed by Shires and Bradley at the University of Florida, has received some attention in the last few years. The drink, Gatorade, consists of citric acid, salt, glucose, water, .040% sodium carboxymethylcellulose, sodium orthophosphate, .053% calcium cyclamate, potassium chloride, gum acacia, potassium orthophosphate, sodium bicarbonate, natural and artificial flavor, artificial color, and .005% sodium saccharin (32). The University of Florida football team credited all season wins with the use of Gatorade on the field. Turco and Savastano (32) stated that from a medical standpoint, the salt and water--important in preventing heat stroke--and the sweetener may be the components in the solution that result in improved performance.

High-fat Foods

Fried foods and pork have been restricted by some coaches, since they are classified as "hard-to-digest" foods. Upjohn et al. (19) stated that this taboo is justified more when related to high caloric intake, rather than

ease of digestibility. When foods are fried at correct temperatures, there is no additional strain in digestion and utilization by the body. Desserts, gravies, concentrated sweets, and salad dressings should be an integral part of the diet if all other protective foods are included. These foods should be restricted if the individual is concerned with maintaining weight at a specific level.

Gas-forming Foods, "Irritating Foods," and Bulky Foods

Many coaches recommend restriction or omission of "gas-forming" foods. However, there is no rigid statement that can be made concerning foods that are flatulent in nature (33). Dried beans, cabbage, onions, cauliflower, radishes, and turnips are some alleged items causing belching and flatus. Because an item may affect one individual and not influence another, the athlete should use personal discretion concerning these foods. An additional factor to consider is increased discomfort from swallowing excess air.

A common misconception is that of restricting spicy or bulky vegetables and cereals high in cellulose from the athletic diet. Little information has been found to substantiate popular beliefs relating foods to ease of digestion. Varieties of peppers, cloves, and mustard seed can be irritating to some gastrointestinal tracts; however, these items generally affect individuals with difficulties in digestion. There is no logical explanation for restricting use of other spices, e.g., mace, thyme, cinnamon, sage, paprika, and allspice (33). Leafy, green vegetables are often cited as high-roughage foods. Fruits and vegetables do not cause problems in digestion; in fact, they are necessary for normal fecal bulk.

Nutritional Considerations for the Athlete

Nutritionists and medical authorities agree that an athlete's coordination and energy expenditure are related to training skills and not influenced by the consumption of foods apart from the normal diet. Novich and Taylor (15) reported that neuromotor coordination is primarily the result of natural endowment, conditioning, and motivation, and that performance cannot be enhanced by special foods, e.g., wheat germ and vitamin supplements. Stare (34) stated that the diet of an athlete should follow the same food pattern as for the non-athlete, with the exception that the athlete must ingest additional calories to compensate for increased energy expenditure.

Numerous researchers (8, 34, 35) noted that athletic performance can be impaired significantly by malnutrition (including obesity and undernutrition), but the manipulation of an existing balanced diet cannot enhance physical efficiency. Stare (34) claimed that supplementation of adequate diets has not generally given clearly defined results. The problem encountered in the experimental design of studies to test advantages of supplements is that they do not rule out the influence of progressive conditioning and motivation.

Body Composition and Caloric Requirements

In order to obtain the required energy and dexterity for a winning team, an adequate diet is essential throughout the training period--not merely on days of competition (16, 19). Long-term conditioning is important since brief periods of strenuous exercise depend on energy reserves and training, not the size or composition of the pre-exercise meal. Yet most of the emphasis is placed on the pre-game meal, and there are no magic foods that will produce superpower or agility.

In determining appropriate diet patterns, two major considerations of the well-nourished athlete are present body composition (proportion of fat to lean body mass) and type of caloric expenditure related to the sport.

Bullen et al. (16) stated that a preliminary assessment of fat reserves prior to training is important, since energy costs of activity are proportional to body weight in most events. Thus, an overweight athlete expends more energy and burns more body reserves to accomplish the same amount of work than he would if he were at his optimal weight.

Energy needs of an athlete are considerably greater than that of a sedentary individual, depending on the sport and degree of participation (19). Each individual differs in caloric requirements; one athlete may utilize 2,400 kilocalories daily, while another may utilize 7,000 kilocalories daily. Nutritional demands may differ according to the type of physiological needs imposed upon the body by different types of exertion. The caloric requirements in a long-distance swimming event differ significantly from a single-effort track event.

Nutrient Requirements

Protein

Under normal circumstances protein requirements should be met by a well-balanced meal pattern. Excess high-quality protein will not increase efficiency of performance, but will insure the supply needed for proper maintenance and growth (16). Growing high school adolescents will need additional quantities of protein for these demands.

Carbohydrate

The amount and type of carbohydrate eaten may influence performance

depending on the type and duration of the competitive event. Bullen et al. (16) stated that the physiological demands developing from short, intense efforts and the nature of the resulting fatigue are different from those of long-duration events.

The body can utilize stored energy available from the energy-rich organic phosphates, adenosine triphosphate, and creatine phosphate in single-effort events and those requiring short bursts of energy (16). Anaerobic breakdown of glycogen to lactic acid can also provide energy of short duration (8). In short-term events the type of fuel supply is of minor concern, since the amounts of energy utilized are relatively small.

In marathon races and endurance swimming--sports in which endurance may be a deciding factor--the type of food nutrient becomes more important (8). According to Parizkova (36) numerous workers have noted that when sufficient carbohydrate is available, it is used preferentially over fat reserves for muscular work. Krogh and Lindhard (37) reported that subjects on high-carbohydrate diets demonstrated a greater net muscular efficiency than when they consumed a high-fat, low-carbohydrate diet. Parizkova (36) stated that the type and amount of exercise may influence the proportion of nutrients used as fuel. Studies by Dole (38), Gordon and Cherkes (39), and Spitzer (40) showed that the level of fatty acids in the blood varies inversely with the rate of glucose utilization.

Throughout long-duration sports events, a continuous supply of energy becomes essentially dependent upon oxidation processes to replenish high-energy phosphate stores. Availability of oxygen and its efficient use can then become the limiting factor in performance. In considering oxygen utilization efficiency, one liter of oxygen yields five kilocalories if

carbohydrate is utilized, but only 4.5 and 4.6 kilocalories if protein and fat are utilized, respectively. Bullen et al. (16) claimed that this 10% difference may be an important factor in competitive endurance sports.

In a review of earlier research, Astrand (41) found that the degree of work in relation to an athlete's maximal aerobic power will influence the percentage of carbohydrate and fat utilization. The closer the athlete works to his maximum power, the more the body relies on carbohydrate as the energy source. Therefore, carbohydrate utilization depends on the amount of oxygen supplied to the working muscles; the more inadequate the oxygen supply, the greater the carbohydrate metabolism. A second conclusion is that the diet affects the participation of fat versus carbohydrate in work metabolism. A carbohydrate-rich diet for several days prior to the prolonged heavy exercise will improve performance capacity and increase the respiratory quotient.

Stare (34) stated that the beneficial effect of sugar consumption prior to competition is not confirmed for light exercise, but may become a limiting factor in long-distance events. Monosaccharides or dissacharides administered in the form of such foods as table sugar, honey, fruit juices, and candy can be administered to increase ability to perform in endurance sports. All sugars are readily assimilated; honey is not more rapidly digested than other sugars (33). Caution should be exercised in administering excess doses of sugar, since it can draw water into the gastrointestinal tract from other parts of the body, contributing to dehydration (33). Cramps, nausea, and distention are other side effects from excess sugar consumption.

Fats

Fats and carbohydrates both serve as fuels for muscular exercise; but higher fat oxidation is accompanied by depletion of carbohydrate reserves in

sustained exercise (8). High-fat foods need not be unduly restricted because they are carriers of fat-soluble vitamins, a source of concentrated energy, and a hunger retardant. The presence of fat in the gastrointestinal tract stimulates enterogastrone, which decreases digestion.

Caffeine and Alcohol

Tea and coffee, both stimulating beverages with caffeine as a constituent, should be used in moderation (16). Excess caffeine should not be relied upon as an agent to alleviate fatigue.

Alcoholic beverages, a central nervous system depressant, will affect the fine body movements even with ingestion of small quantities. The American Medical Association Committee on the Medical Aspects of Sports (42) reviewed studies that showed alcohol as the cause of marked decrease in physical capacity and loss of skill. Since alcohol requires no digestion and reaches the brain rapidly, it exerts a dulling effect that alters neuromuscular coordination. Alcoholic beverages should be forbidden before competition or practice conditioning. Durnin's opinion (1) on alcohol is that reasonable quantities will not affect the athlete if he will not be engaging in sports competition following consumption.

Electrolyte Balance

Coaches stress the importance of maintaining water balance and prevention of dehydration, which leads to fatigue during competition (42). Heat fatigue, due to excess sweating and loss of water and salts, causes a decrease in athletic alertness. Heat exhaustion--depletion of excess salt and water--and heat stroke--overheating from failure of the sweating mechanism to function--can lead to serious physical harm.

It is sometimes thought that water consumption during the athletic event is detrimental. Upjohn et al. (19) declared that an inordinate quantity of water accompanied by exercise will produce cramps. However, small amounts of approximately a half glass of liquid should be consumed at hourly intervals to prevent dehydration.

Additional salt intake is advised under conditions of prolonged exercise, hot weather, and adaptation to pre-season conditioning (33). However, most athletes will obtain sufficient quantities of salt by table seasoning. A recommendation of one to three cups of liquid with the pre-game meal should insure sufficient hydration.

Meal Patterns

Meal Frequency

Bullen et al. (16) reviewed work completed by Haggard and Greenberg, who concluded that frequent meals resulted in higher levels of performance and that total work output could be increased by five meals daily. Hutchinson (43) believed that frequent, moderate-sized meals produce maximum efficiency, viewed from a psychological aspect. He related long meal intervals to unfavorable effects. Bullen et al. (16) concluded that at least three meals and perhaps more frequent, lighter meals per day seem to be the most efficient for the athlete.

The Pre-game Meal

It is generally agreed that the pre-game meal should not contain an excess quantity of protein or fat (44). A very high proportion of fat in the meal will delay digestion. Avoiding a high protein intake is recommended since amino acid residues are excreted only via the kidneys. Cooper (45)

emphasized the fact that during exercise, effective kidney functioning ceases, preventing acid excretion by this system. Blood is shunted around the kidneys during exercise. High quantities of indigestible residue are not recommended for prolonged sports competition (33).

Meals are usually consumed three to four hours prior to game time (8, 21, 32, 45). If additional salt is necessary, it should be taken with the meal; salt tablets ingested just prior to competition can irritate the stomach and may cause vomiting in some individuals (45).

Theoretically three to five hours following ingestion of a meal will be sufficient for digestion. Upjohn et al. (19) claimed that pre-game emotional strain can increase digestion time up to six hours. Williams (44) recommended not partaking in physical exercise two hours prior to a meal, since it causes a decrement in muscular circulation. This can give rise to cramps or a reversal of the visceral shunt, causing indigestion and possible diarrhea and/or vomiting.

The Liquid Meal

Experiments by Rose and Fuenning (46) demonstrated that emotional tension retarded total stomach-emptying time up to four hours. Johnson (47) stated that the familiar "knotted stomach" is caused by tension-induced contraction of the pyloric muscle. This condition, in turn, can progress to regurgitating and delayed release of food energy. Various researchers (47-49) have found that liquid meals are more rapidly and easily digested than the conventional meal. Coaches should refrain from encouraging high school athletes to rely upon the liquid meal--for it would deprive the growing individual of essential nutrients and bulk.

The Psychological Element in Food Intake

Food possesses a significance greater than that of any nutrient which it may provide. Food consumed during training and pre-game meals may have a psychological meaning that exceeds the metabolic element. Influenced by family, friends, and cultural setting of the athlete, particular foods may represent status and security and provide a sense of well-being. Turco and Savastano (32) mentioned that Spanish-American athletes perform very effectively on a bowl of chili, while Scandinavian and German athletes partake of rich, high-caloric desserts. For these reasons, it is difficult for a trainer to demand a rigid pattern of food restriction. The cultural and individual needs should be balanced with other nutritive foods. Depriving an athlete of familiar foods may actually be a detriment to performance on the field.

Weight Control

A very serious problem for some athletes is that of "crash reducing diets." High school and collegiate wrestling coaches have required growing boys to attain and maintain certified weights considerably below their optimum weights and have advised them to reduce suddenly by crash diets involving starvation or dehydration. Ideally the athlete should lose excess weight gradually until he achieves a class permitting maximum performance. Henson (50) stated that too often wrestlers lose in competition, not by opponent alone, but by the program of weight reduction which has been followed prior to competition. Loss of a few pounds of fluid may be dangerous; to the athlete, it can be disastrous to physical and mental efficiency. Ribisl and Herbert (51) stated that a 5% weight loss within 48 hours caused by dehydration is sufficient to significantly reduce the physical working capacity.

Henson (50) stated that under prolonged or rapid dehydration, electrolyte concentration departs from normal values because of a fluid and electrolyte lag adjustment in the body. With advancing dehydration, kidney function is impaired and loss of blood volume and intracellular fluids result. With moderate electrolyte imbalance, extreme weakness, mental confusion, and muscular incoordination results.

Paul (52) explained that excretion of urine volume is dependent on protein and electrolyte intake. In dehydration, urine volume is governed by the amount of urea and other nitrogenous metabolites that must be eliminated. When fluid intake is low, the body excretes water to eliminate waste products. Intracellular and extracellular salts in the urine are excreted to maintain a normal concentration of solutes. When the body can spare no additional fluid, there is an increase in blood concentration of wastes. This concept is of most importance when an athlete decreases water intake, increases protein consumption, and loses fluid by sweating.

Weight control abuses related to dehydration measures include, but are not limited to, hot boxes, rubberized apparel, and induced vomiting. Rapid water loss causes premature fatigue, and if water deficiencies are accompanied by other nutrient deficiencies, deleterious effects are more marked (53). Clinical symptoms of starvation noted by Paul (52) are fatigue, marked tension, irritability, decreased ability to concentrate on holds, and inability to follow instructions. Tension accompanied by reduced speed allow forfeiting of points to the opponent. Nausea and vomiting, though temporary, may result; occasionally, abdominal pains occur.

Rapid weight reduction can result in occurrence of dangerous side effects in individuals with histories of rheumatic fever, scarlet fever,

gout, or diabetes mellitus (52). Individuals with previous kidney infections from one of the streptococcic diseases may intensify a kidney lesion, which can progress to chronic nephritis. Athletes on a crash diet with limited salt and water intake may develop renal irritation as oliguria ensues.

Maganzini (54) noted that rapid weight fluctuations of any magnitude are the result of fluid shifts and do not represent true fat loss. Loss of excess body fat is desirable weight loss; loss of body fluids represent an "artificial" reduction and persists until replenishment occurs with thirst. Proper weight reduction is accomplished if a negative caloric intake is combined with sufficient nutrients to meet the athlete's body needs.

The Coach's Role in Nutrition

Novich and Taylor (15) believe the coach must demonstrate as much interest in diet as in the conditioning program. To maintain highest degree of health and well being and to obtain maximum physical performance, coaches must understand and disseminate knowledge in the following:

1. physiology of the gastrointestinal tract and preparation of foods for absorption and assimilation into body tissues and energy,
2. knowledge of the foods that are best utilized for growth, tissue repair, maintenance, and energy,
3. understanding of the body fluids and electrolyte balance, and
4. caloric requirements for different events.

PROCEDURE

Selection of Subjects

All students who were junior, senior, or graduate status physical education (PE) majors at Kansas State University in the spring semester of 1972 were asked to participate in this study. One hundred and thirty-eight PE students (82 men and 56 women), which represented 63% of the eligible students served as subjects. Most of the students completed the interview schedule in one of their physical education classes; others participated in small group sessions. In addition a group of 81 women students in a Basic Nutrition (BN) course at Kansas State University completed the interview schedule during the last week of the spring semester. Basic Nutrition is a class taught for non-nutrition majors and has no prerequisite.

Instrument

The interview schedule consisted of three sections: a questionnaire for general background information, recommendations concerning diet and athletics, and a nutrition knowledge test (see appendix, pages 56 through 63 for the questionnaire and page 64 for correct responses to the nutrition knowledge test). For the nutrition knowledge test, participants responded to true-false statements and indicated degree of certainty of their responses. A letter of introduction and brief explanation of the research project was distributed in physical education classes prior to administration of the instrument (see appendix, page 65).

Tabulation and Statistical Analysis of Data

All data were coded and punched onto computer cards for analysis.

Nutrition Knowledge Test

The number of correct and incorrect responses (disregarding degree of certainty) for individuals in each group was determined. A chi-square test was used to determine whether there was a significant difference in correct responses for the physical education and nutrition students.

The nutrition test responses were assigned a numerical value according to correctness of response and degree of certainty as follows:

Subject's Response	Degree of Certainty	Assigned Numerical Value
Correct	1	+1
	2	+2
	3	+3
	4	+5
	5	+8
Incorrect	1	-1
	2	-2
	3	-3
	4	-5
	5	-8

The mean nutrition knowledge test scores were calculated for the PE and BN students. A t-test was used to determine whether there was a significant difference between scores for the two groups. The percentage of total correct and incorrect responses for each question in the test was calculated for the two classifications, i.e., physical education and basic nutrition.

Nutrition Knowledge Scores as Affected by Sex and Class

The mean nutrition knowledge scores for subcategories of sex and class level were determined for the PE majors. No males participated in the BN group.

Sources of Nutrition Knowledge

All students were asked to rank the three sources of nutrition information which have contributed most to their knowledge. Responses for the physical education men, physical education women, total physical education students, and basic nutrition students were tabulated. Subjects were requested to check subject matter which may have contributed to their nutrition knowledge. Independent of ranking, frequency responses for the subcategories were tabulated, e.g., high school general science, college physical education, and college coach.

Factors Affecting Nutrition Knowledge

Two-way analyses of variance for unequal subclasses were utilized to determine any significant differences in nutrition scores when comparing group classification (PE and BN) and:

a. all subjects' responses ranked as first source of nutrition knowledge;
b. all subjects' ranking of "high school" as a source of knowledge;
c. all subjects' ranking of "college" as a source of knowledge;
d. all subjects' ranking of "coaches" as a source of knowledge; and
e. all subjects' ranking of "parents" as a source of knowledge.

Sports Participation and Nutrition Knowledge

A two-way analysis of variance for unequal subclasses was utilized to determine any significant differences in nutrition scores when comparing group classification (PE and BN) and students' participation in: (a) no sports, (b) baseball only, (c) basketball only, (d) football only, and (e) cross country only, and (f) more than one sport.

Food Recommendations for the Athlete

The percentage of recommendations concerning diet and athletics were calculated for the PE and BN groups. A chi-square test was performed to determine any significant differences in responses according to the classifications of PE and BN.

RESULTS AND DISCUSSION

Nutrition Knowledge Test

Scores for the Nutrition Knowledge Test

The possible minimum and maximum total scores for the fifty-question test were -400 and +400 based on both correctness of response and degree of certainty. Distribution of students' scores are shown below. Scores for each individual are found in the appendix, tables 15 and 16.

TABLE 1

Distribution of nutrition knowledge test scores

Test score range	Students			
	Physical education		Basic nutrition	
	Number	Percent	Number	Percent
201 to 300	8	5.8	20	24.7
101 to 200	51	37.0	44	54.3
1 to 100	73	52.9	16	19.8
-100 to 0	6	4.3	1	1.2

About one-half of the physical education students' (PE) scores in the range of 1 to 100, and more than one-chird were between 101 to 200. Approximately half

of the basic nutrition (BN) students' scores were located in the 101 to 200 range, and about one-fourth were between 201 to 300. Slightly less than one-fifth of the BN scores ranged from 1 to 100. The mean score of the BN group was 156.6, and this score was significantly higher ($P < 0.01$) than the mean of 92.3 of the PE group.

Nutrition Knowledge Scores as Affected by Sex and Class

Mean nutrition knowledge scores were calculated for female and male junior, senior, and graduate class levels. Graduate PE students scored higher than underclassmen PE majors. The mean scores for the PE women were higher than the PE men, although still lower than mean scores for the BN students (BN = 156.6 and PE women = 109.6). See table 2 for scores of PE majors according to sex and class subcategories.

TABLE 2

Mean nutrition scores of physical education majors according to sex and class

Class	Sex			
	Female		Male	
	Score	Number	Score	Number
Junior	108.9	23	62.1	37
Senior	106.5	25	82.6	29
Graduate	121.0	8	115.8	16
Totals	109.6	56	79.8	82

Effect of Degree of Certainty on Nutrition Knowledge Scores

Students were requested to respond to correctness (true-false) of the statements in the nutrition knowledge test as well as to indicate the degree of certainty of each answer. Positive values were assigned to 65% of the responses of the PE group, compared to 75% of the BN students. Negative values were assigned to 32% of the responses of the PE students as compared to 25% of the responses of the BN students. See table 3 for distribution of students' responses according to point values assigned for degrees of certainty and correctness of response.

TABLE 3

Percent of group responses according to point values assigned

Group	Incorrect response					Point value "0"	Correct response				
	-8	-5	-3	-2	-1		+1	+2	+3	+5	+8
BN	4.3	6.8	7.6	3.1	2.7	1.6	4.7	4.7	12.3	18.2	33.8
PE	6.3	6.2	9.0	4.9	5.2	3.5	6.9	7.2	14.9	14.4	21.2

A larger percentage of BN students than PE students responded with greater certainty in answering questions and were correct, which contributed to higher nutrition scores. Approximately 36% of the PE group responded correctly and were assigned point values of +5 or +8; while 52% of the BN students were assigned point values of +5 and +8. However, a similar proportion of each group responded that they were very certain about their answers, when in fact, they were incorrect. Approximately 13% of the PE group and 11% of the BN students responded incorrectly with high degrees of certainty (-8 and -5 point values assigned).

Total Correct Responses for Both Groups

Without consideration of degree of certainty, the number of total correct and incorrect responses was tabulated for the PE and BN students. The PE group averaged approximately 40% correct responses for the nutrition test (disregarding degree of certainty); the BN group averaged 74% correct responses.

Discussion of Individual Questions

Comparisons of correct responses (disregarding degree of certainty) by physical education and basic nutrition groups were made for each question on the nutrition knowledge test. The questions were categorized into the following subject areas for discussion: protein, vitamins, minerals, lipids, energy, weight control, digestion and metabolism, and general nutrition concepts (see appendix, table 15). Numbers stated in parentheses represent percentage of correct responses by the PE and BN students unless otherwise indicated. See appendix, table 16, for percentages of all correct, incorrect, and "0" responses for each question (subjects responded with "0" when completely uncertain).

Protein

More than half of the students in each group (PE = 61.6%; BN = 51.9%) did not believe that excess protein will be stored in the body until needed for growth and maintenance of tissues. Most of the subjects in both groups indicated that eggs are a source of high-quality protein (PE = 89.1%; BN = 96.3%). More basic nutrition students realized that quality of beef protein is considerably higher than that of wheat protein (PE = 68.1%; BN = 87.7%). A large majority of both groups (PE = 79.9%; BN = 95.1%)

believed that dried beans, peas, and nuts can be substituted for some of the daily protein needs. A larger number of BN students (88.9%) than PE majors (72.5%) believed that high-protein supplements could be incorporated into the diet of an athlete to improve physical efficiency.

Vitamins

A greater percentage of BN students realized that deep green and yellow vegetables were excellent sources of vitamin A (PE = 77.5%; BN = 97.5%). More BN students recognized that vitamin C is not synthesized by the body with exposure to the sun (PE = 65.9%; BN = 86.4%). Approximately the same proportion of both groups indicated that citrus fruits are not the only source of ascorbic acid in the normal diet (PE = 63.8%; BN = 67.9%). About three-fourths of the BN students (75.3%) but less than half of the PE majors (42.8%) recognized that vitamin E does not reduce the severity of chronic diseases. Slightly more physical education majors than basic nutrition students indicated complete uncertainty to the interaction of vitamin E and chronic disease (PE = 10.9% and BN = 7.4% uncertainty). The two groups generally believed vitamin A deficiency can cause night blindness (PE = 84.4%; BN = 92.6%). Less than three-fourths of the PE and BN students (PE = 59.4%; BN = 74.1%) knew that B vitamins are necessary for energy production.

Minerals

Almost all subjects indicated adults need a source of calcium (PE = 92.0%; BN = 97.5%). However, somewhat fewer subjects indicated that meat, fish, and poultry were not good sources of calcium (PE = 66.7%; BN = 86.4%). Practically all the BN students (BN = 98.8%) and a considerable

proportion of PE majors (81.9%) believed that minerals participated in maintenance of water balance.

Lipids

Both groups scored very low in correct responses to the statement that corn, soybean, and coconut oils are high in polyunsaturated fats (PE = 20.3%; BN = 17.3%). Approximately the same proportion of both groups responded correctly to the statement that cholesterol is a normal body constituent (PE = 68.8%; BN = 69.1%). Slightly more BN students realized that polyunsaturated fats in the diet will not increase the cholesterol level in the blood (PE = 50.0%; BN = 64.2%). About half of the PE students (52.2%) and 65.4% of the BN students indicated that butter is not a higher source of polyunsaturated fats than vegetable oil margarines. Most of the BN students and three-fourths of the PE majors responded that the type of fat in the diet was not the sole dietary factor involved in heart disease (PE = 77.5%; BN = 92.6%). Correct responses of all students were very low when asked whether or not organ meats were high in cholesterol (PE = 30.4%; BN = 19.8%).

Energy

A low percentage of both groups understood that "basal metabolism" did not constitute both the energy needed for involuntary body functions and physical activities (PE = 26.1%; BN = 34.6%). Approximately half of the two groups indicated that alcoholic beverages can serve as sources of energy (PE = 55.0%; BN = 48.1%). A considerable majority of both groups understood that protein can be used as an energy source (PE = 81.9%; BN = 87.7%). Most students in both groups did not realize that the caloric value of protein is equal to that of carbohydrate (PE = 14.5%; BN = 35.8%).

Weight Control

A majority of both groups indicated that use of diuretics is not a good means to reduce body fat (PE = 65.9%; BN = 75.3%). A minority of students realized that diets totally without carbohydrate cannot be consumed satisfactorily even if sufficient fat and protein are provided for energy needs (PE = 38.4%; BN = 49.4%). Large proportions of both groups believed that commercially-available liquid diets are not satisfactory for lengthy weight-reducing periods (PE = 77.5%; BN = 92.6%).

Digestion and Metabolism

Most students realized that emotional stress can affect the body's capacity to utilize nutrients (PE = 89.9%; BN = 97.5%). Over three-fourths of each group indicated that stomach-emptying time can be delayed due to pre-game tension (PE = 78.3%; BN = 84.0%). More BN students (81.5%) answered that carbohydrates are more easily and rapidly digested than proteins and fats (PE = 66.7%). More than half the PE students realized table sugar is not more rapidly and easily digested than honey (PE = 63.8%; BN = 44.4%). Less than half of the PE majors (45.7%) and 74.1% of the BN students realized that reducing fecal bulk involves reducing consumption of whole grains, vegetables, and fruits. A slight majority of PE subjects (60.9%) realized that excess consumption of concentrated sugars can cause dehydration, cramps, nausea, and distention, while only 37.0% of the BN students were aware of this concept. A very high percentage of all students understood that consumption of excess fats during a pre-game meal can retard digestion (PE = 92.0%; BN = 96.3%).

General Concepts

Slightly more than half of the PE majors (57.2%) and 88.9% of the BN students thought that milk is not a perfect food. About half of the students (PE = 50.1%; BN = 56.8%) recognized that the body has a unique ability to increase nutrient absorption when nutrient stores are low. Less than half of the PE majors (45.6%) and 77.8% of the BN students recognized that organically-grown foods were not higher in nutritive value than foods grown with chemical fertilizers.

About two-thirds of both groups believed that a vegetarian diet with the inclusion of milk and eggs can be adequate nutritionally (PE = 68.8%; BN = 69.9%). A very high percentage of BN students (90.1%) and less than three-fourths of the PE majors (68.1%) indicated that iron is not the only nutrient needed for red blood cell formation and prevention of anemia. More than four-fifths of each group understood that nutrient retention is influenced by food preparation and storage methods (PE = 81.9%; BN = 84.0%). Almost all BN students (92.6%) and 85.5% of the PE majors realized that every age group needs the same nutrients, but in varying quantities.

More than three-fourths of the students (PE = 79.0%; BN = 87.7%) believed that maximum nutrient utilization is obtained by a consumption of a combination of carbohydrate, fat, and protein. Large proportions of both groups realized that it is not beneficial to consume large amounts of all vitamins and minerals (PE = 80.4%; BN = 93.8%). Almost all subjects believed that nutrient imbalance may occur in overweight or obese individuals (PE = 94.2%; BN = 96.3%). Large percentages of all students understood that strength and endurance of an individual varies with his nutritional status (PE = 85.5%; BN = 95.1%).

Slightly more than half of the PE students and over four-fifth of the BN students did not believe that a "fortified" food contains all the essential vitamins and minerals needed for a balanced diet (PE = 57.2%; BN = 84.0%). Approximately four-fifths of the BN students and over half of the PE majors realized that the primary nutrient contributions of breads and cereals are B vitamins and calories (PE = 57.2%; BN = 81.5%). Nearly equal proportions of both groups recognized that USDA "Choice" grade meats are not more nutritious than USDA "Good" (PE = 52.2%; BN = 54.3%). A high percentage of all students recognized hormonal imbalance can affect utilization of some nutrients (PE = 93.5%; BN = 92.6%). More than half of all students (PE = 60.9%; BN = 63.0%) realized that diet margarines contain more water than regular margarines.

Both groups appear to hold misconceptions in nutrition concepts. In general BN students responded correctly more frequently than the PE groups, but both groups performed poorly in statements relating to energy and lipids.

Sources of Nutrition Knowledge

Sources of Major Contributions of Knowledge

Subjects were asked to rank the three primary sources of nutrition knowledge (see Questionnaire, page 57, column A). See table 4 for specific sources as ranked by the physical education men, women, total PE, and basic nutrition students. The PE women ranked college courses, high school courses, and parents as having made a major contribution to sources of knowledge. The PE men ranked college courses, high school courses, and coaches as their three primary sources of knowledge. Parents and magazines or popular books rated below the previously mentioned categories for the PE men. More PE men

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

TABLE 4

Percentage of students ranking sources of nutrition knowledge first, second, and third

Source	PE women[1]			PE men[1]			Total PE			Basic nutrition[2]		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
High school courses	9.4	11.6	8.7	3.6	12.3	13.0	13.0	23.9	21.7	11.1	45.7	14.8
College courses	15.9	8.0	4.3	29.0	5.8	8.7	44.9	13.8	13.0	74.1	11.1	4.9
Coaches	0.0	1.5	5.1	7.2	13.8	11.6	7.2	15.3	16.7	1.2	1.2	18.5
Parents	8.7	7.2	6.5	9.4	8.7	5.1	18.1	15.9	11.6	8.6	12.3	28.4
Physicians or nurses	0.7	0.7	0.0	0.7	1.5	1.5	1.4	2.2	1.5	1.2	3.7	1.2
News media	0.7	2.9	5.1	0.0	2.2	4.3	0.7	5.1	9.4	0.0	3.7	4.9
Nutritionists/ dietitians	0.0	1.5	0.7	0.7	0.0	0.0	0.7	1.5	0.7	0.0	3.7	2.5
Magazines or popular books	1.5	4.3	5.8	4.3	5.8	5.1	5.8	10.1	10.9	0.0	6.2	3.7
4-H	2.9	2.9	3.6	0.0	0.7	0.7	2.9	3.6	4.3	1.2	7.4	9.9

[1]Percentages are based on total number of physical education subjects: 219.

[2]Total number of basic nutrition subjects: 81.

obtained nutrition information from coaches than PE women. A moderate majority of nutrition students ranked college courses as the primary source of information. High school courses and parents ranked below the college courses. A small proportion of both PE and BN women considered 4-H as an avenue of information. Very few students reported that nutritionists/ dietitians, physicians and nurses, news media, or magazines and popular books contributed to their nutrition knowledge.

Contributions of Knowledge by Categories of Subject Matter and Coaches

High School Courses

PE men frequently responded that high school physical education and/or health and general science courses contributed to nutrition information, while the PE women believed home economics and physical education and/or health courses to be most valuable sources (see table 5). Nutrition students relied more on home economics than physical education and/or health and general sciences for information.

College Courses

The PE men reported college health and science courses were responsible for disseminating nutrition information. The PE women placed less emphasis on sciences and health, although these courses did offer knowledge. However, the PE women seemed to rely more than the PE men on physical education classes and nutrition courses for information. Basic nutrition students indicated that nutrition and foods courses contributed more nutrition information. See table 6 for data.

TABLE 5

Percentage of students' responses to high school courses as sources of nutrition knowledge

Group	High school courses		
	General sciences	Home economics	PE and/or health
PE			
Men[1]	16.6	1.4	30.4
Women[2]	10.9	22.5	21.7
Total	27.5	23.9	52.1
Basic nutrition	16.1	64.2	22.2

[1]82 men students.

[2]56 women students.

[3]81 nutrition students.

TABLE 6

Percentage of students' responses to college courses as sources of nutrition knowledge

Group	College courses			
	Sciences	Nutrition or foods	Health	Physical education
PE				
Men[1]	27.5	1.4	34.1	8.0
Women[2]	20.3	9.4	26.8	16.7
Total	47.8	10.8	60.9	24.7
Basic nutrition[3]	20.1	91.4	17.3	2.5

[1]82 men students.

[2]56 women students.

[3]81 nutrition students.

Coaches

More PE men than PE women stated that high school and college coaches were sources of information (see table 7). A small number of basic nutrition students indicated high school and college coaches contributed to nutrition knowledge. City recreation coaches were not a major source of information.

TABLE 7

Percentage of students' responses to coaches as sources of nutrition knowledge

Group	Coaches		
	High school	College	City recreation
PE			
Men[1]	26.8	23.9	1.4
Women[2]	8.7	8.0	1.4
Total	35.5	31.9	2.8
Basic nutrition[3]	12.4	6.2	1.2

[1]82 men students.

[2]56 women students.

[3]81 nutrition students.

Sources of Nutrition Knowledge and Test Scores

Sources Ranked as the First Source of Nutrition Knowledge

An analysis of variance was used to determine whether ranking of sources as first affected mean nutrition knowledge scores of combined PE and BN students (tables 8 and 9). Subjects who ranked "college courses" as contributing most nutrition knowledge scored higher ($P < 0.10$) than those

TABLE 8

Adjusted mean nutrition test scores according to highest ranking source of nutrition information of all students

Source ranked	College	High school	Other	Parents	Coaches
Means[1]	133	125	114	101	101

[1] $LSD_{(0.10)}$ for rankings of:

high school:college	= 22	college:parents	= 20
high school:coaches	= 37	college:other	= 25
high school:parents	= 27	coaches:parents	= 35
high school:other	= 31	coaches:other	= 38
college:coaches	= 32	parents:other	= 29

TABLE 9

Analysis of variance of nutrition scores according to items ranked as first source of nutrition information

Variable	DF	Mean squares	F-ratio
Sources	4	8147	2.210+
Groups	1	123454	33.491**
Residual	206	3686	

\+ Indicates significance at the 0.10 level.

** Indicates significance at the 0.01 level.

students ranking "coaches" or "parents" as their primary source of nutrition information.

Ranking of Sources as 1, 2, 3, or 0

Analyses of variance were used to determine whether the ranking of the different sources of nutrition information as 1 (first), 2 (second), 3 (third), or 0 (not ranked) affected mean nutrition scores. See table 10 for adjusted means according to rankings and table 11 for analyses of variances. Students who ranked "college" courses first had scores significantly higher ($P < 0.05$) than those who ranked "college" as their third source of knowledge or those who did not rank "college" at all. Ranking of "high school" courses did not affect mean nutrition scores. There was no significant difference in

TABLE 10

Adjusted mean scores of nutrition knowledge according to rankings of sources of nutrition information and group

Source	Rank				Group	
	1	2	3	4	PE	BN
College[1]	134	128	99	95	89	138
High school	125	136	119	114	93	154
Coaches	88	54	130	127	86	114
Parents[2]	94	132	153	120	100	148

[1] $LSD_{(0.05)}$ for rankings of 0:1 = 30, 1:2 = 28, 0:2 = 45, 1:3 = 34, 0:3 = 43, 2:3 = 42

[2] $LSD_{(0.05)}$ for rankings of 0:1 = 31, 1:2 = 36, 0:2 = 24, 1:3 = 34, 0:3 = 22, 2:3 = 29

TABLE 11

Analyses of variance of nutrition scores according to sources ranked as contributions of nutrition knowledge and groups

Variable	DF	Mean squares	F-ratio
		College	
Source ranking	3	8147	2.210+
Groups	1	123454	33.491**
Interaction	3	798	0.217ns
Residual	211	3679	
		High school	
Source ranking	3	5417	1.497ns
Groups	1	142358	37.305**
Interaction	3	629	0.165ns
Residual	211	3816	
		Coaches	
Source ranking	3	8674	2.313+
Groups	1	5649	1.506ns
Interaction	3	3489	0.930ns
Residual	211	3750	
		Parents	
Source ranking	3	16613	4.590**
Groups	1	72259	19.963**
Interaction	3	4808	1.328ns
Residual	211	3619	

+ Indicates significance at the 0.10 level.

** Indicates significance at the 0.01 level.

ns Indicates nonsignificance.

mean scores when students ranked "coaches" first or second; however, students who ranked "coaches" as the third source of knowledge or did not rank "coaches" at all had significantly higher ($P < 0.10$) scores than those who ranked "coaches" second. The ranking of "parents" significantly affected adjusted mean scores, although not in a linear relationship. Students ranking "parents" second or third had significantly higher ($P < 0.01$) mean scores than those students ranking them as first. Subjects who ranked "parents" third had mean scores significantly higher ($P < 0.01$) than subjects who did not rank "parents."

Adjusted mean nutrition scores for the BN students were significantly higher ($P < 0.01$) than for the PE majors in three of the four analyses of variance. All interactions of source rankings and groups were nonsignificant (see table 11).

Sports Participation and Test Scores

Adjusted mean nutrition scores were not significantly different in those who did not participate in sports and those playing one or more high school or collegiate sports.

Food Recommendations for the Athlete

Students were asked to check appropriate foods that they would recommend be:

a. eaten in a pre-game meal of an endurance sport (such as basketball),
b. omitted in a pre-game meal,
c. eaten to increase muscle mass,
d. eaten during the entire training season to improve overall performance,

e. eaten to increase resistance to colds, infections, etc., and

f. omitted in a weight reduction plan.

Chi-square analyses were used to determine significant differences between responses of physical education and basic nutrition students (see table 12). Percentages of all students' food recommendations are reported (see table 13). Recommendations were significantly different for 101 of the 258 variables (43 food items repeated for the six circumstances listed above). Significant differences in food recommendations of the two groups will be discussed only when 33.3% or more of at least one group made the recommendation.

Recommendations in the range of 33.3% to 66.6% will be designated as "moderately recommended," while more than 66.6% will represent "most frequently recommended." Unless otherwise specified, discussions of variables will be applicable to both groups. See table 13 for listings of all percentage recommendations.

Foods Recommended to be Eaten in a Pre-game Meal

The following foods were recommended more frequently by PE majors than BN students to be eaten in a pre-game meal of an endurance sport: honey, soups, and tea/coffee ($P < 0.01$); gelatin ($P < 0.01$); wheat germ ($P < 0.05$); and beef ($P < 0.10$). The BN group recommended cheese and milk ($P < 0.01$); poultry ($P < 0.05$), and B-complex vitamins ($P < 0.10$) more frequently than the PE students.

Most frequently recommended foods for the pre-game meal were citrus fruits and vegetables. Foods recommended moderately were candy, eggs, fruits, Gatorade, green salads, high-protein supplements, iron supplements, milk, and all vitamins.

TABLE 12

Significance levels of chi-square analyses of students' food recommendations

Foods	Eaten in a pre-game meal of an endurance sport (e.g., basketball)?	Omitted in a pre-game meal?	Eaten to increase muscle mass?	Eaten during entire training season to improve overall performance?	Eaten to increase resistance to colds, infections, etc.?	Omitted in a weight reduction plan?
Apples	ns[1]	.05	.05	ns	.01	.05
Beans	ns	ns	ns	ns	.05	ns
Beef	.10	ns	ns	ns	.05	ns
Beer	ns	ns	.01	.01	.10	ns
Breads	ns	.01	.01	ns	ns	.01
Butter/margarine	ns	.01	.10	ns	ns	.01
Cabbage	ns	ns	ns	ns	ns	ns
Candy	ns	ns	.05	.01	.10	.05
Calcium tablets	ns	ns	ns	ns	ns	ns
Carbonated drinks	ns	ns	ns	.10	.10	.01
Cereals	ns	ns	.10	ns	.05	ns
Cheese	.01	.01	ns	ns	.01	.01
Citrus fruits/juices	ns	ns	ns	ns	ns	ns
Cottage cheese	ns	.01	ns	ns	ns	.01
Eggs	ns	.10	ns	.10	.05	.10
Fish	ns	ns	ns	ns	.05	.05
Fried foods	ns	ns	ns	.05	ns	ns
Fruits	.05	ns	.01	ns	ns	.10

TABLE 12 (continued)

Foods	Eaten in a pre-game meal of an endurance sport (e.g., basketball)?	Omitted in a pre-game meal?	Eaten to increase muscle mass?	Eaten during entire training season to improve overall performance?	Eaten to increase resistance to colds, infections, etc.?	Omitted in a weight reduction plan?
Gatorade	ns	ns	ns	.10	.01	.05
Gelatin	.01	ns	ns	ns	.01	ns
Green salads	ns	ns	.01	ns	.10	.10
Gravies	ns	ns	ns	.10	ns	.01
High-protein supplements	ns	ns	ns	ns	ns	.01
Honey	.01	.01	.01	.01	.01	.01
Ice cream	ns	ns	.01	.01	.05	ns
Iron supplements	ns	ns	.10	ns	ns	ns
Jams and jellies	ns	ns	.05	.05	.05	.05
Milk	.01	.01	ns	.05	ns	.01
Other	ns	ns	ns	ns	ns	ns
Pastries	ns	ns	.10	.05	ns	ns
Pork	ns	.05	ns	ns	.05	ns
Poultry	.05	.01	ns	.10	.05	.05
Soups	.01	.01	.05	ns	.01	ns
Sour cream	ns	ns	.10	ns	ns	.05
Tea/coffee	.01	.05	ns	.10	.05	ns
Vegetables	ns	ns	.10	.01	ns	.05
Wheat germ	.05	ns	.01	.05	.01	ns
Vitamin A	ns	ns	ns	ns	.05	ns
Vitamin B_{12}	ns	ns	ns	ns	.01	ns

TABLE 12 (concluded)

Foods	Eaten in a pre-game meal of an endurance sport (e.g., basketball)?	Omitted in a pre-game meal?	Eaten to increase muscle mass?	Eaten during entire training season to improve overall performance?	Eaten to increase resistance to colds, infections, etc.?	Omitted in a weight reduction plan?
B-complex vitamins	.10	.10	ns	ns	ns	ns
Vitamin C	ns	ns	ns	ns	ns	ns
Vitamin D	ns	ns	ns	ns	ns	ns
Vitamin E	ns	ns	.10	ns	.01	ns
Wine and other alcoholic drinks	ns	ns	ns	ns	ns	ns

[1]Nonsignificant.

TABLE 13

Percentage of students recommending foods under various circumstances

Foods	A Eaten in a pre-game meal of an endurance sport (e.g., basketball)?		B Omitted in a pre-game meal?		C Eaten to increase muscle mass?		D Eaten during entire training season to improve overall performance?		E Eaten to increase resistance to colds, infections, etc.?		F Omitted in a weight reduction plan?	
	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN
Apples	27.5	35.8	24.6	13.6	9.4	2.5	69.6	64.2	74.6	58.0	5.1	0.0
Beans	6.5	8.6	69.6	64.2	18.8	17.3	36.2	37.0	10.1	1.2	31.9	38.3
Beef	76.8	65.4	8.0	3.7	84.8	84.0	90.6	92.6	28.3	16.0	2.9	0.0
Beer	0.7	0.0	94.9	92.6	15.2	0.0	7.2	0.0	4.3	0.0	90.6	90.1
Breads	39.1	28.4	32.6	16.0	33.3	17.3	65.2	71.6	10.1	8.6	74.6	39.5
Butter/margarine	18.1	24.7	48.6	22.2	27.5	17.3	47.8	56.8	8.0	6.2	83.3	59.3
Cabbage	14.5	12.3	40.6	34.6	13.0	6.2	52.9	53.1	26.8	22.2	5.1	1.2
Candy	39.1	38.4	36.2	38.3	5.8	0.0	11.6	1.2	3.6	0.0	81.9	93.8
Calcium tablets	12.3	14.8	20.3	13.6	28.3	19.8	44.2	38.3	25.4	17.3	8.7	7.4
Carbonated drinks	9.4	7.4	71.0	75.3	1.4	0.0	7.2	0.0	4.3	0.0	72.5	90.1
Cereals	25.4	18.5	18.5	23.5	29.7	13.6	66.7	67.9	19.6	8.6	23.2	17.3
Cheese	11.6	30.9	44.9	17.3	49.3	48.1	71.0	77.8	19.6	6.2	36.2	19.8
Citrus fruits/juices	76.1	74.1	6.5	2.5	19.6	13.6	81.2	79.0	92.8	91.4	2.9	0.0
Cottage cheese	31.9	32.1	27.5	11.1	36.2	45.7	71.7	74.1	18.8	13.6	10.9	0.0
Eggs	44.2	44.4	20.3	8.6	69.6	71.6	87.7	95.1	30.4	16.0	6.5	1.2
Fish	27.5	27.2	22.5	18.5	59.4	60.5	79.7	84.0	25.4	13.6	5.8	0.0
Fried foods	2.9	1.2	84.1	79.0	10.9	4.9	25.4	8.6	2.2	2.5	85.5	87.7
Fruits	68.8	53.1	5.8	2.5	25.4	9.9	87.0	88.9	85.5	76.5	2.2	0.0

TABLE 13 (continued)

Foods	A Eaten in a pre-game meal of an endurance sport (e.g., basketball)?		B Omitted in a pre-game meal?		C Eaten to increase muscle mass?		D Eaten during entire training season to improve overall performance?		E Eaten to increase resistance to colds, infections, etc.?		F Omitted in a weight reduction plan?	
	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN
Gatorade	45.7	51.9	11.6	7.4	2.9	2.5	36.2	24.7	22.5	4.9	8.0	17.3
Gelatin	45.7	24.7	9.4	8.6	14.5	9.9	53.6	43.2	24.6	4.9	5.8	9.9
Green salads	47.1	44.4	19.6	14.8	26.1	8.6	84.1	86.4	46.4	33.3	3.6	0.0
Gravies	3.6	4.9	76.1	70.4	51.2	12.3	29.0	18.5	2.9	0.0	77.5	93.8
High-protein supplements	37.7	38.3	8.7	6.2	65.2	60.5	53.6	46.9	22.5	14.8	18.1	4.9
Honey	84.1	56.8	2.2	24.7	19.6	4.9	58.7	22.2	22.5	8.6	42.8	80.2
Ice cream	13.0	17.3	60.1	61.7	18.1	3.7	32.6	13.6	7.2	0.0	84.1	88.9
Iron supplements	34.1	37.0	13.0	6.2	55.8	44.4	68.8	60.5	44.9	38.3	3.6	2.5
Jams and jellies	25.4	18.5	36.2	40.7	9.4	2.5	26.8	12.3	8.0	1.2	74.6	87.7
Milk	37.0	66.7	44.2	16.0	68.8	61.7	84.8	93.8	44.9	35.8	21.7	2.5
Pastries	6.5	3.7	79.7	87.7	10.1	3.7	14.5	3.7	2.2	0.0	93.5	96.3
Pork	23.9	32.1	47.1	33.3	67.4	58.0	68.8	75.3	18.1	7.4	31.2	25.9
Poultry	31.9	45.7	30.4	12.3	63.0	55.6	76.1	86.4	21.7	9.9	8.7	1.2
Soups	52.9	28.4	15.9	30.9	19.6	8.6	60.9	50.6	30.4	7.4	5.1	8.6
Sour cream	2.2	0.0	68.8	64.2	13.8	6.2	18.1	13.6	1.4	1.2	76.1	88.9
Tea/coffee	50.7	16.0	31.9	48.1	2.9	0.0	19.6	9.9	10.9	2.5	8.7	4.9
Vegetables	73.2	74.1	4.3	2.5	47.8	34.6	84.1	96.3	66.1	45.7	7.2	0.0
Wheat germ	41.3	25.9	12.3	11.1	57.2	25.9	73.9	58.0	43.5	18.5	9.4	6.2

TABLE 13 (concluded)

Foods	A Eaten in a pre-game meal of an endurance sport (e.g., basketball)?		B Omitted in a pre-game meal?		C Eaten to increase muscle mass?		D Eaten during entire training season to improve overall performance?		E Eaten to increase resistance to colds, infections, etc.?		F Omitted in a weight reduction plan?	
	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN	PE	BN
Vitamin A	39.1	42.0	8.0	6.2	41.3	33.3	76.8	75.3	55.8	38.3	5.1	1.2
Vitamin B_{12}	41.3	37.0	7.2	3.7	41.3	34.6	74.6	77.8	57.2	30.9	3.6	1.2
B-complex vitamins	33.3	44.4	8.7	2.5	39.1	42.0	71.7	60.7	52.9	42.0	2.9	1.2
Vitamin C	44.9	50.6	5.8	3.7	37.0	29.6	80.4	74.1	89.1	87.7	2.9	2.5
Vitamin D	37.0	46.9	8.7	3.7	39.9	43.2	76.1	79.0	48.6	39.5	4.3	1.2
Vitamin E	36.2	33.3	8.7	7.4	38.4	25.9	71.7	76.5	50.0	25.9	4.3	1.2
Wine and other alcoholic drinks	0.7	0.0	82.6	86.4	5.1	2.5	4.3	3.7	2.9	2.5	81.9	84.0

Foods Recommended to be Omitted in a Pre-game Meal

Foods recommended more frequently by the PE majors than by the BN students to be omitted in a pre-game meal were: milk, breads, and poultry ($P < 0.01$); apples and pork ($P < 0.05$), and B-complex vitamins ($P < 0.10$). Recommendations found to be more frequent by the BN students were honey and soups ($P < 0.01$); and tea/coffee ($P < 0.05$).

Foods most frequently recommended for omission were: alcoholic beverages, carbonated drinks, fried foods, gravies, and pastries. Items moderately recommended for omission were: cabbage, candy, and ice cream.

Foods Recommended to Increase Muscle Mass

Foods recommended more frequently by the PE students to increase muscle mass were: wheat germ and breads ($P < 0.01$); iron supplements, vegetables, and vitamin E ($P < 0.10$). The BN students did not rate any foods significantly more often than the PE majors.

Foods most frequently recommended were beef and eggs. Items recommended moderately often by both groups were: cheese, cottage cheese, fish, high-protein and iron supplements, poultry, vegetables, and vitamins A, B_{12}, B-complex, and D.

Foods Recommended to Improve Overall Performance

The following foods were recommended more frequently by the PE majors for improving overall performance during the training season: honey ($P < 0.01$); wheat germ ($P < 0.05$); Gatorade ($P < 0.10$). The BN students' responses were higher for vegetables ($P < 0.01$); milk and poultry ($P < 0.05$); and eggs ($P < 0.10$).

Foods most frequently recommended for inclusion during the training season were: beef, cereals, cheese, citrus fruits, cottage cheese, eggs, fish, fruits, green salads, milk, pork, poultry, vegetables, and all vitamins. Foods recommended moderately often were: butter/margarine, cabbage, calcium tablets, gelatin, high-protein and iron supplements, pork, and soups.

Foods Recommended to Increase Resistance to Colds, Infections, etc.

The following foods recommended more frequently by PE majors than BN students to resist onset of colds and infections were: wheat germ, vitamin B_{12}, vitamin E, and apples ($P < 0.01$); eggs and vitamin A ($P < 0.05$); and green salads ($P < 0.10$). The BN students did not recommend any foods significantly higher than the PE majors.

Foods highly recommended by both groups were all fruits and vitamin C. Green salads, iron supplements, milk, vegetables, and vitamins A, B_{12}, and B-complex were recommended moderately often by most students.

Foods Recommended to be Omitted in a Weight Reduction Program

Foods recommended more often by PE majors than BN students to be omitted on a weight reduction plan were: breads, butter/margarine, and cheese ($P < 0.01$). The BN students more frequently recommended omission of the following foods: carbonated drinks, gravies, and honey ($P < 0.01$), candy, jams and jellies, and sour cream ($P < 0.05$).

Items most frequently recommended for omission by most subjects were: beer, candy, carbonated beverages, high-fat and high-carbohydrate foods, and alcohol.

Summary of Food Recommendations

According to the previous recommendations, both groups appear to hold misconceptions concerning various food categories. Most students thought beans, cabbage, and high-fat foods should not be consumed in a pre-game meal. Not many students thought calcium tablets were beneficial; however, high-protein supplements and wheat germ were recommended moderately often by the PE group. Vitamin supplements were more frequently recommended for increasing muscle mass and overall improvement of season performance by the PE majors. Alcoholic beverages were generally not suggested for consumption by most students. The majority of fruits, vegetables, and meats were recommended for inclusion in the diet pre-game meals and to be eaten throughout the training season. Some PE majors recommended that milk should be omitted from the pre-game meal; however, they did recommend milk for the training season. Fruits and vitamins were especially suggested by PE students to increase resistance to colds, infections, etc. Breads, candy, high-fat foods, and alcohol were most often recommended to be omitted in a weight reduction program by PE students. More than half of the PE group included a recommendation for honey in the pre-game meal and for inclusion throughout the training season. Basic nutrition students placed less emphasis on nutrient supplements for the pre-game meal and training season and more emphasis on foods, such as meats, dairy products, and fruits.

SUMMARY

The nutrition knowledge of 219 Kansas State University physical education majors (PE) and 81 basic nutrition (BN) students, i.e., students who had just completed a basic nutrition course, was studied. An interview schedule

consisting of sports participation data, nutrition information sources, food recommendations for the athlete, and a nutrition knowledge test (scored according to correctness of response and degree of certainty) was administered.

The mean score of the BN students (156.6) for the nutrition test was significantly higher ($P < 0.01$) than that of the PE majors (92.3). The mean scores for PE women were higher than for the PE men, and graduate PE students scored higher than underclassmen. More than half of the BN scores were distributed in the 101 to 200-point range, while the majority of the PE scores ranged from 0 to 100 points. The average percentage of correct responses per student was 74 for the BN students and 40 for the PE group. Both groups have nutrition misconceptions, although the BN students generally answered more questions correctly. However both PE and BN students rated poorly in concepts relating to lipids and energy.

PE students considered high school and college courses, parents, and coaches as their primary sources of nutrition knowledge, while the BN subjects rated college courses as their most important source of nutrition information. Very few students reported gaining knowledge from nutritionists/dietitians, physicians/nurses, news media, or popular books and magazines.

On the high school level, PE/health and general sciences were the reported subjects that contributed most nutrition knowledge for the PE men, and PE/health and home economics courses were rated the main avenues of information for the PE and BN women. On the college level, PE men rated health and sciences as offering most nutrition information, and women rated PE and nutrition courses as important sources.

Students who ranked college courses as their primary source of nutrition knowledge had significantly higher ($P < 0.10$) scores than those who ranked coaches or parents as their primary source of nutrition information. There was no significant difference in mean scores when high school was ranked first, second, third, or not at all as a source of nutrition knowledge. However, significantly higher ($P < 0.05$) mean scores were reported for students who ranked college as the first source than for those who ranked college third or not at all. Students ranking parents second or third had significantly higher ($P < 0.01$) scores than those who ranked parents first. Those who ranked parents third had significantly higher ($P < 0.01$) scores than students not ranking parents at all. Students who ranked coaches third or not at all as a source of nutrition knowledge had significantly higher ($P < 0.10$) scores than students ranking coaches second.

There were no significant differences in mean nutrition scores in students who had not participated in sports and those who had participated in one or more sports (for high school or collegiate participation).

Significant differences were found in more than one-third of the food recommendations made by the PE and BN students. Both groups held misconceptions concerning foods for the athletes. Most students believed beans, cabbage, and high-fat foods should be omitted in a pre-game meal. Not many subjects recommended the use of calcium tablets; however, high-protein supplements, wheat germ, and various vitamins were often recommended by the PE students, as well as the BN students for use throughout the training season and to increase resistance to infections and colds. Other foods recommended for inclusion during the entire training season were high-protein foods, such as beef and eggs, vegetables, fruits, dairy products, and cereals.

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APPENDIX

QUESTIONNAIRE

1. NAME _____

2. AGE _____

3. SEX ___ M _____ F _____

4. ADDRESS _____

5. CLASS _____ Freshman
   _____ Sophomore
   _____ Junior
   _____ Senior
   _____ Graduate

6. TELEPHONE NO. _____

7. CLASSIFICATION _____ Physical education major
   _____ Student who has completed Basic Nutrition

8. Have you completed student teaching? _____ Yes _____ No

9. If you are a graduate student, have you taught physical education previous to enrollment into the Master's program?

   _____ Yes If so, how many years? _____

   _____ No

10. If you have participated in any inter-school or intercollegiate sports, please check sport or sports:

	HIGH SCHOOL	COLLEGE
BASEBALL	_____	_____
BASKETBALL	_____	_____
CROSS COUNTRY/TRACK	_____	_____
FOOTBALL	_____	_____
GYMNASTICS	_____	_____
ROWING	_____	_____
SWIMMING	_____	_____
TENNIS	_____	_____
WRESTLING	_____	_____
OTHER, SPECIFY	_____	_____

_____

11. Rank the top 3 sources which you believe have contributed most to your your knowledge in nutrition (1 = most contribution in column A.)

If course work or coaches have contributed, check (✓) specific sub-categories which have added to your knowledge in column B.

A		B	
_____	High School Courses	_____	General sciences
		_____	Home economics
		_____	Physical education and/or health
		_____	Other _____
_____	College Courses	_____	Sciences (physiology, biology, etc.)
		_____	Nutrition or foods
		_____	Health
		_____	Physical education
		_____	Other _____
_____	Coaches	_____	High School
		_____	College
		_____	City recreation
		_____	Other _____

_____ Parents

_____ Physicians or nurses

_____ News media (television, radio, newspapers)

_____ Nutritionists or dietitians

_____ Magazines or popular books

_____ 4-H

_____ Other _____

ANSWER THE FOLLOWING QUESTION BY CHECKING THE APPROPRIATE FOODS.

AS A COACH OR PHYSICAL EDUCATION MAJOR, WHICH FOODS WOULD YOU RECOMMEND BE:

Food	a Eaten in a pre-game meal of an endurance sport (e.g., basketball)?	b Omitted in a pre-game meal?	c Eaten to increase muscle mass?	d Eaten during entire training season to improve overall performance?	e Eaten to increase resistance to colds, infections, etc.?	f Omitted in a weight reduction plan?
Apples						
Beans						
Beef						
Beer						
Breads						
Butter/margarine						
Cabbage						
Candy						
Calcium tablets						
Carbonated drinks						
Cereals						
Cheese						
Citrus fruits/juices						
Cottage cheese						
Eggs						
Fish						
Fried foods						
Fruits						

Food	a Eaten in a pre-game meal of an endurance *sport* (e.g., basketball)?	b Omitted in a pre-game meal?	c Eaten to increase muscle mass?	d Eaten during entire training season to improve overall performance?	e Eaten to increase resistance to colds, infections, etc.?	f Omitted in a weight reduction plan?
Gatorade						
Gelatin						
Green salads						
Gravies						
High-protein supplements						
Honey						
Ice cream						
Iron supplements						
Jams and jellies						
Milk						
Other						
Pastries						
Pork						
Poultry						
Soups						
Sour cream						
Tea/coffee						
Vegetables						
Wheat germ						
Vitamin A						
Vitamin B_{12}						

Food	a Eaten in a pre-game meal of an endurance sport (e.g., basketball)?	b Omitted in a pre-game meal?	c Eaten to increase muscle mass?	d Eaten during entire training season to improve overall performance?	e Eaten to increase resistance to colds, infections, etc.?	f Omitted in a weight reduction plan?
B-complex vitamins						
Vitamin C						
Vitamin D						
Vitamin E						
Wine and other alcoholic drinks						

TEST OF NUTRITION KNOWLEDGE

Respond to the statements by marking "T" for true and "F" for false on the answer sheet. Indicate how certain you are about the answer by darkening "1" if you are very doubtful; darken "5" if you are very confident of your answer. Darken other numbers to indicate degrees of certainty between these extremes.

If you are completely unsure of the answer, darken both "T" and "F" but do not darken a degree of certainty.

Please be sure to respond twice to every answer.

1. Excess protein will be stored in the body until needed for growth and maintenance of tissues.

2. Deep green and yellow vegetables are poor sources of Vitamin A.

3. Adults do not need a source of calcium after bone growth has been completed.

4. Milk is a perfect food since it provides all the essential nutrients in the proper amounts that will maintain health.

5. Vitamin C is referred to as the "sunshine" vitamin since exposure of the skin to the sun will result in synthesis of vitamin C.

6. Eggs are an excellent source of high-quality protein.

7. Corn oil, soybean oil, and coconut oil are high in polyunsaturated fats.

8. The body has a unique ability to increase nutrient absorption when nutrient stores are low.

9. Cholesterol is a normal body constituent.

10. The quality of wheat protein is considerably higher than beef protein.

11. Citrus fruits are the only food sources high in vitamin C.

12. Dried peas, beans, and nuts can be substituted for some of the daily protein needs.

13. Organically-grown foods are higher in nutritive value than foods grown with chemical fertilizers.

14. Polyunsaturated fats in the diet will increase the cholesterol level in the blood.

15. Butter is a higher source of polyunsaturated fats than vegetable oil margarines.

16. A vegetarian diet with the inclusion of milk and eggs can be adequate in all nutrients.

17. The type of fat consumed is the sole dietary factor involved in heart disease.

18. Vitamin E acts to reduce the severity of chronic diseases.

19. Emotional stress can affect the body's capacity to utilize nutrients.

20. The only nutrient needed for red blood cell formation and prevention of anemia is iron.

21. Vitamin A deficiency can cause night blindness.

22. Nutrient retention is influenced by food preparation and storage methods.

23. Every age group needs the same nutrients, but quantities needed may vary.

24. For maximum nutrient utilization within the body, some protein, carbohydrate, and fat should be eaten at each meal.

25. Meats, fish, and poultry are major food sources of calcium.

26. Organ meats are high in cholesterol.

27. Basal metabolism represents the energy needed for involuntary body functions and physical activities.

28. It is beneficial to consume large amounts of all vitamins and minerals since the body can store these nutrients until needed.

29. Use of diuretics is an excellent means of reducing body fat.

30. Diets without carbohydrate can be consumed satisfactorily if there is sufficient fat and protein for energy needs.

31. Alcoholic beverages cannot serve as an energy source.

32. High-protein supplements can be incorporated into the athlete's diet to improve physical efficiency.

33. Consumption of commercially-available liquid diets for lengthy periods of time is a satisfactory method of reducing body weight.

34. Stomach emptying time can be delayed due to pre-game tension.

35. Carbohydrates are more easily and rapidly digested than proteins and fats.

36. Table sugar is more rapidly and easily digested than honey.

37. Protein can be used as an energy source.

38. The "B" vitamins are necessary for conversion of foods to energy.

39. To temporarily reduce fecal bulk, it is advisable to reduce consumption of whole grains, vegetables, and fruits.

40. Nutrient imbalance may occur in overweight or obese individuals.

41. Minerals play a role in water balance of the body.

42. Strength and endurance of an individual varies with his nutritional status.

43. Excess consumption of concentrated sugars can cause dehydration, cramps, nausea, and distention.

44. Consumption of excess fats during a pre-game meal can retard digestion.

45. A "fortified" food contains all the essential vitamins and minerals necessary for a balanced diet.

46. The primary nutrient contributions of the breads and cereal products are "B" vitamins and calories.

47. An equivalent weight of carbohydrate has the same caloric value as protein.

48. USDA "Choice" meats are more nutritious than USDA "Good" meats.

49. Hormone imbalance can affect utilization of some nutrients.

50. Diet margarines contain much more water than regular margarines.

TABLE 14

Correct responses to the nutrition knowledge test

Question No.	Response	Question No.	Response
1	False	26	True
2	False	27	False
3	False	28	False
4	False	29	False
5	False	30	False
6	True	31	False
7	False	32	False
8	True	33	False
9	True	34	True
10	False	35	True
11	False	36	False
12	True	37	True
13	False	38	True
14	False	39	True
15	False	40	True
16	True	41	True
17	False	42	True
18	False	43	True
19	True	44	True
20	False	45	False
21	True	46	True
22	True	47	True
23	True	48	False
24	True	49	True
25	False	50	True

K A N S A S S T A T E U N I V E R S I T Y

Foods and Nutrition

April, 1972

Dear Physical Education Major:

Miss Marjorie Cho, a graduate student in the Department of Foods and Nutrition, is conducting a survey to determine the nutritional knowledge of students who are junior, senior or graduate physical education majors at KSU. The data collected will be summarized for a M.S. thesis, but information from individuals will be held confidential. Dr. Charles Corbin is a member of her supervisory committee and has approved the survey.

Miss Cho will be contacting you soon--either in a physical education class or individually. We hope that all eligible students will cooperate in this project by carefully filling out the survey form.

Sincerely,

Beth Fryer
Associate Professor

TABLE 15

Total scores in the nutrition knowledge test for individual physical education subjects

Subject No.	Score	Subject No.	Score	Subject No.	Score
1	149	47	102	93	64
2	67	48	82	94	178
3	32	49	109	95	183
4	45	50	69	96	49
5	36	51	164	97	202
6	68	52	83	98	108
7	117	53	136	99	43
8	24	54	215	100	116
9	64	55	204	101	71
10	34	56	168	102	163
11	71	57	118	103	35
12	30	58	217	104	101
13	167	59	156	105	70
14	42	60	129	106	77
15	91	61	124	107	56
16	11	62	84	108	47
17	41	63	75	109	63
18	128	64	-29	110	73
19	-1	65	78	111	37
20	75	66	172	112	54
21	124	67	97	113	44
22	-14	68	-12	114	228
23	12	69	201	115	31
24	91	70	156	116	152
25	116	71	19	117	187
26	56	72	112	118	152
27	71	73	64	119	163
28	18	74	160	120	90
29	26	75	98	121	218
30	-36	76	105	122	125
31	130	77	56	123	167
32	88	78	169	124	120
33	100	79	114	125	260
34	107	80	35	126	138
35	63	81	34	127	83
36	16	82	71	128	120
37	80	83	120	129	21
38	80	84	4	130	158
39	109	85	39	131	42
40	67	86	47	132	21
41	81	87	50	133	65
42	152	88	66	134	114
43	60	89	69	135	110
44	120	90	-11	136	61
45	15	91	109	137	168
46	104	92	171	138	114

TABLE 16

Total scores in the nutrition knowledge test for individual nutrition subjects

Subject No.	Score	Subject No.	Score	Subject No.	Score
1	190	28	201	55	162
2	189	29	67	56	56
3	217	30	85	57	178
4	178	31	187	58	174
5	263	32	139	59	186
6	225	33	92	60	142
7	97	34	282	61	76
8	255	35	131	62	212
9	122	36	67	63	141
10	97	37	236	64	186
11	37	38	132	65	230
12	163	39	27	66	120
13	229	40	188	67	231
14	118	41	139	68	42
15	169	42	160	69	176
16	232	43	125	70	165
17	283	44	181	71	194
18	217	45	43	72	118
19	103	46	257	73	169
20	196	47	126	74	256
21	52	48	139	75	205
22	122	49	198	76	248
23	222	50	175	77	194
24	107	51	121	78	46
25	156	52	122	79	242
26	98	53	73	80	194
27	194	54	140	81	-20

TABLE 17

Nutrition knowledge test questions categorized into subject areas

Protein	Vitamins	Minerals	Lipids	Energy	Weight control	Digestion and Metabolism	General concepts
1	2	3	7	27	29	19	4
6	5	25	9	31	30	34	8
10	11	41	14	37	33	35	13
12	18		15	47		36	16
32	21		17			39	20
	38		26			43	22
						44	23
							24
							28
							40
							42
							45
							46
							48
							49
							50

TABLE 18

Percentage of physical education and basic nutrition students responding correctly to questions in the nutrition knowledge test

Question	Physical education			Basic nutrition		
	Correct	Incorrect	"0" Response[1]	Correct	Incorrect	"0" Response[1]
1	61.6	37.7	0.7	51.9	46.9	1.2
2	77.5	20.3	2.2	97.5	2.5	0.0
3	92.0	8.0	0.0	97.5	2.5	0.0
4	57.2	41.3	1.4	88.9	11.1	0.0
5	65.9	32.6	1.4	86.4	13.6	0.0
6	89.1	10.9	0.0	96.3	3.7	0.0
7	20.3	76.1	3.6	17.3	81.5	1.2
8	50.0	43.5	6.5	56.8	42.0	1.2
9	68.8	29.0	2.2	69.1	29.6	1.2
10	68.1	29.0	2.9	87.7	9.9	2.5
11	63.8	36.2	0.0	67.9	30.9	1.2
12	79.7	18.8	1.4	95.1	4.9	0.0
13	45.6	50.0	4.3	77.8	21.0	1.2
14	50.0	42.8	7.2	64.2	29.6	6.2
15	52.2	42.8	5.1	65.4	30.9	3.7
16	68.8	31.2	0.0	69.9	30.9	0.0
17	77.5	19.6	2.9	92.6	6.2	1.2
18	42.8	46.4	10.9	75.3	17.3	7.4
19	89.9	6.5	3.6	97.5	2.5	0.0
20	68.1	28.3	3.6	90.1	8.6	1.2
21	84.8	12.3	2.9	92.6	7.4	0.0
22	81.9	15.9	2.2	84.0	14.8	1.2
23	85.5	14.5	0.0	92.6	7.4	0.0
24	79.0	18.8	2.2	87.7	12.3	0.0
25	66.7	30.4	2.9	86.4	11.1	2.5
26	30.4	63.0	6.5	19.8	75.3	4.9
27	26.1	70.3	3.6	34.6	63.0	2.5
28	80.4	18.1	1.4	93.8	6.2	0.0
29	65.9	22.5	11.6	75.3	16.0	8.6
30	38.4	56.2	5.1	49.4	50.6	0.0
31	55.1	44.2	0.7	48.1	51.9	0.0
32	26.8	72.5	0.7	11.1	88.9	0.0
33	77.5	21.7	0.7	92.6	7.4	0.0
34	78.3	18.1	3.6	84.0	14.8	1.2
35	66.7	32.6	0.7	81.5	18.5	0.0

TABLE 18 (concluded)

Question	Physical education			Basic nutrition		
	Correct	Incorrect	"0" Response[1]	Correct	Incorrect	"0" Response[1]
36	63.8	30.4	5.8	44.4	51.9	3.7
37	81.9	17.4	0.7	87.7	12.3	0.0
38	59.4	27.5	13.0	74.1	22.2	3.7
39	45.7	48.6	5.8	74.1	24.7	1.2
40	94.2	5.1	0.7	96.3	3.7	0.0
41	83.3	13.0	3.6	98.8	1.2	0.0
42	85.5	14.5	0.0	95.1	4.9	0.0
43	60.9	31.2	8.0	37.0	56.8	6.2
44	92.0	7.2	0.7	96.3	3.7	0.0
45	57.2	37.7	5.1	84.0	16.0	0.0
46	57.2	39.1	3.6	81.5	18.5	0.0
47	14.5	79.0	6.5	35.8	60.5	3.7
48	52.2	44.2	3.6	54.3	43.2	2.5
49	93.5	4.3	2.2	92.6	4.9	2.5
50	60.9	27.5	11.6	63.0	27.2	9.9

[1]A numerical value of "0" was assigned to questions in situations where respondents indicated complete uncertainty.

NUTRITIONAL KNOWLEDGE OF KANSAS STATE UNIVERSITY PHYSICAL EDUCATION MAJORS

by

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B. S., California State Polytechnic College, 1971

AN ABSTRACT OF A MASTER'S THESIS

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The nutrition knowledge of 219 physical education (PE) majors and 81 basic nutrition (BN) students was studied. An interview schedule consisting of sports participation data, nutrition information sources, food recommendations for the athlete, and a nutrition knowledge test (scored according to correctness of response and degree of certainty) was administered.

The mean score of the BN students (156.6) for the nutrition test was significantly higher ($P < 0.01$) than that of the PE majors (92.3). More than half of the BN scores were distributed in the 100 to 200-point range, while the majority of the PE scores ranged from 0 to 100. The average percent of correct responses was 74 for the BN group and 40 for the PE students. The mean scores for PE women were higher than for the PE men, and graduate students scored higher than underclassmen. Both groups have nutrition misconceptions, although the BN students generally answered more questions correctly. However, PE and BN students rated poorly in concepts relating to lipids and energy.

PE students considered high school and college courses, parents, and coaches as their primary sources of nutrition knowledge, while the BN students rated college courses as their most important source of nutrition information. Very few students reported gaining knowledge from nutritionists/dietitians, physicians/nurses, news media, or popular books and magazines.

On the high school level, PE/health and general sciences were the reported subjects that contributed most nutrition knowledge for the PE men, and PE/health and home economics courses were rated the main avenues of information for the PE and BN women. On the college level, PE men rated health and sciences as offering most nutrition information, and women rated

PE and nutrition courses as important sources.

Students who ranked college courses as their primary source of nutrition knowledge had significantly higher scores ($P < 0.10$) than those who ranked coaches or parents as their primary source of nutrition information. There was no significant difference in mean scores when high school was ranked first, second, third, or not at all as a source of nutrition knowledge. However, significantly higher mean scores ($P < 0.05$) were reported for students who ranked college as the first source of information than for those who ranked college third or not at all. Rankings of parents as sources of nutrition information showed significant differences in mean scores. Those ranking parents second or third had significantly higher scores ($P < 0.01$) than those who ranked parents first. Students who ranked parents third had significantly higher scores ($P < 0.01$) than the subjects not ranking parents at all. Students ranking coaches as their third source of nutrition information or not at all had significantly higher ($P < 0.10$) scores than those who ranked coaches second.

There were no significant differences found in students who were non-sports participants and those who participated in one or more sports.

Significant differences were found in more than one-third of the food recommendations made by the PE and BN students. Both groups held misconceptions concerning foods for the athletes. Most students believed beans, cabbage, and high-fat foods should be omitted from the pre-game meal. Not many subjects recommended the use of calcium tablets; however, high-protein supplements, wheat germ, and various vitamins were often recommended by the PE students, as well as the BN students for use throughout the training season and to increase resistance to colds and infections. Other foods

recommended for inclusion during the entire training season were high-protein foods, such as beef and eggs, vegetables, fruits, dairy products, and cereals.