Menstrual Cycle Status, Body Composition and Dietary Characteristics of Female Collegiate Gymnasts, Dance-Majors and Non-Athletes

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MENSTRUAL CYCLE STATUS, BODY COMPOSITION AND DIETARY CHARACTERISTICS OF FEMALE COLLEGIATE GYMNASTS, DANCE-MAJORS AND NON-ATHLETES

by

Robyn Lesley Mills

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Health, Physical Education and Recreation

Western Michigan University
Kalamazoo, Michigan
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MENSTRUAL CYCLE STATUS, BODY COMPOSITION AND
DIETARY CHARACTERISTICS OF FEMALE COLLEGIATE
GYMNASTS, DANCE-MAJORS AND NON-ATHLETES

Robyn Lesley Mills, M.A.
Western Michigan University, 1986

This study investigated the incidence of regular menstrual cycles, secondary amenorrhea and oligomenorrhea in collegiate female gymnasts, dance-majors and non-athletes. Menstrual cycle characteristics and eating attitudes were surveyed by questionnaire. Dietary status was determined by a 5 day dietary diary, and body composition was measured by hydrostatic weighing to determine the relationship of these variables with menstrual cycle status.

The frequency of amenorrhea, oligomenorrhea and regular cycles differed significantly (p<.05) between activity groups. The gymnasts reported the highest incidence of amenorrhea (16%) and oligomenorrhea (32%). A significant difference (p<.05) was found between activity groups for age at menarche, percent body fat, dietary status and eating attitudes.

Statistical analysis of the main effect of menstrual cycle status showed a significant difference for caloric intake and eating attitudes. The amenorrheic subjects consumed fewer calories and scored higher on the EAT compared to the regularly cycling subjects. A significant interaction, $F(4,66)=2.88$, p<.05, was found between activity group by menstrual cycle status for caloric intake.
ACKNOWLEDGEMENTS

My sincere appreciation is extended to Dr. M. Dawson, my advisor, whose guidance and support throughout the study made this endeavor possible, and who I will remember most as a source of excitement, inspiration and knowledge during class.

My special thanks are extended to Kathy Beauregard, Womens' Gymnastics Coach at Western Michigan University, who offered a unique coaching and learning experience which added considerably to the breadth of my gymnastic knowledge.

My appreciation is extended to the Womens' Gymnastics Coaches and Physical Education faculty at: (a) Ball State University, (b) Northern Illinois University, and (c) Indiana State University for arranging testing facilities and organizing the gymnasts.

My special thanks are extended to the Merze Tate Center staff and student patrons, for the opportunity to work and pursue my research and academics in such a unique conducive atmosphere.

Finally, I wish to acknowledge my mother. Agnus Mills, and father, Leslie Mills, whose love and faith in me added special meaning to this thesis.

Robyn Lesley Mills
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MENSTRUAL CYCLE STATUS, BODY COMPOSITION AND DIETARY CHARACTERISTICS OF FEMALE COLLEGIATE GYMNASISTS, DANCE-MAJORS AND NON-ATHLETES

Western Michigan University

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CHAPTER I

INTRODUCTION

Research surveying the menstrual cycle characteristics of female athletes was conducted as early as 1964 by E. Zaharieva. Zaharieva (1965), concluded that the menstrual cycle patterns of sportswomen participating in the 1964 Olympic Games were within normal limits. However, the results of Zaharieva's (1965) study do not support the current research surveying the female athlete of the 1970s and 1980s. The more recent research indicates that the incidence of menstrual irregularities is higher in populations who exercise in comparison to populations who do not exercise.

Attitudes toward the physical abilities of females have changed drastically over the past two decades, precipitating an increase in the number of women participating in highly demanding physical activities, and affecting both the quality and quantity of training. The female athlete of today trains longer and harder than her predecessor.

The menstrual cycle irregularities more commonly surveyed in female athletes include primary and secondary amenorrhea and oligomenorrhea. Primary amenorrhea is described as the absence of menarche, or failure of the menstrual cycle to begin before the eighteenth year. Secondary amenorrhea denotes the cessation of the menstrual cycle for more than three (3) months (Benson, 1978, p. 1).
Oligomenorrhea refers to a decreased frequency of the menstrual cycle, with only one menses in a period of three (3) months (Benson, 1978, p. 114).

Little attention has been directed to the prevalence of the short luteal phase menstrual cycle. A short luteal phase menstrual cycle can appear normal in length but upon closer examination the follicular phase is abnormally long and the luteal phase is less than 10 days (Bonen, Belcastro, Ling & Simpson, 1981). Thus the prevalence of a normal menstrual cycle in physically active women may be much lower when the incidence of amenorrhea and short luteal phase are fractioned out. For example, Prior, Cameron, Yuen and Thomas (1982), surveyed the menstrual cycle patterns of marathon runners and found that 66% of the sample displayed "normal" menstrual cycles, while 33% displayed secondary amenorrhea. When the incidence of the short luteal phase was attended to, only 34% of the sample population displayed normal menstrual cycle patterns.

A total description and comparison of the incidence of menstrual cycle irregularities occurring in all specific athletic groups is difficult to make because not all groups have been surveyed. The gynecological data that have been collected on specific athletic populations are far from complete but indicate that menstrual irregularities appear to occur more frequently in long distance runners, swimmers, and ballet dancers.

Menstrual cycle irregularities observed in athletes have been statistically correlated to body weight and percent body fat (Frisch
& McArthur, 1974), intensity of training (Feicht, Johnson & Martin, 1978) and the level of plasma hormones (Bonen & Belcastro, 1978). Some authors have interpreted a statistical relationship as indicating a cause and effect relationship and then generalized this to encompass the entire population of physically active women. Such broad generalizations do not consider the multi-dimensionality of physical activity. For example, the physical demands of gymnastics are not the same as long distance running (Mathews & Fox, 1971, p. 24). To suggest that there is one cause of menstrual cycle irregularities found in physically active women is to ignore the diversity of physical activities and the complexity of factors affecting the human menstrual cycle.

The actual cause of exercise-induced menstrual irregularities is still unknown, yet recent evidence suggests that the delicate balance of hormones which regulates the menstrual cycle can be disrupted by intense physical training (Bonen & Belcastro, 1978; Jurkowski, Jones, Walker, Younglia & Sutton, 1978). The hormonal disruption may be a reduced metabolic clearance of hormones due to the training stimulus itself (Jurkowski et al., 1978). The majority of research on the cause of exercise-induced menstrual cycle irregularities dealt with endurance type athletes or utilized predominately aerobic exercise as the training stimulus. There appears to be a paucity of literature dealing with anaerobic exercise.

The human menstrual cycle can be disrupted by pathological
conditions such as hypothyroidism and ovarian tumors as well as changes in life-style and diet. Menstrual cycle irregularities manifest themselves during chronic, rapid and simple weight loss. In particular, amenorrhea accompanies the psychogenic disorder, anorexia nervosa (Fries, Nillius & Peterson, 1974) and simple weight loss in otherwise normal females (Crisp, 1981). Frisch and McArthur (1974) suggested that the onset and maintenance of regular menstrual function in women are dependent on a minimal body weight/height ratio, representing a critical level of stored, easily mobilized fat for the production of estrogen. Research studies which utilized the "Critical Weight Hypothesis" to investigate the possible etiology of exercise-induced menstrual irregularities produced mixed results, but generally indicate that body composition alone does not account for the high incidence of amenorrhea and oligomenorrhea in female athletes (Calabrese et al., 1983; Plowman & McSwegin, 1981).

Abnormalities of eating behavior have been associated with menstrual dysfunction (Frisch, 1982b; Katz, Boyar, Roffwarg, Hellman & Weiner, 1978) and not weight loss per se. Indeed, Bruch (1973), identified a group of chronic dieters called "thin-fat" who display abnormal eating behavior but do not manifest the classical weight loss observed in anorexia nervosa patients. Katz et al. (1978) reported that anorexic patients who regained normal body weight but maintained abnormal eating habits do not resume menses. This may indicate that abnormal eating behavior such as food aversion and starvation have a negative effect on hypothalamic function.
Amenorrhea in anorexia nervosa is characterized by a specific reproductive hormone pattern, a hypogonadotropic pattern, but exercise-induced amenorrhea has not been defined as specifically. Loucks and Horvath (1985) suggested that the inability to classify exercise-induced amenorrhea may be due to methodological differences of previous studies and the lack of a standard definition of amenorrhea. Fears, Glass and Vigersky (1983) suggested that amenorrhea in anorexia nervosa and exercise-induced amenorrhea are distinct entities; anorexia nervosa results in a hypogonadotropic amenorrhea, while chronic exercise, particularly endurance training, may induce mild ovarian failure amenorrhea. To date, the role of abnormal eating behaviors in physically active women has not been fully investigated when surveying the incidence of menstrual cycle irregularities associated with chronic physical training. Diagnosing amenorrhea due to exercise per se, versus abnormal eating habits with exercise as a symptom, needs to be addressed.

Gymnastics and ballet dancing are surrounded by a social atmosphere which emphasize a lean and aesthetically appealing body. The percent body fat of gymnasts and ballet dancers is reported as averaging 15.5% for female gymnasts (Sinning, 1978) and 16.9% for female ballet dancers (Calabrese et al., 1983).

Gymnastics training does not emphasize aerobic training but rather anaerobic training and skill acquisition. As such, the lower percent body fat found in gymnasts cannot merely be attributed to the metabolic cost of the activity, although their energy...
requirements would be greater than sedentary non-athletes. A reduced dietary intake and chronic dietary control are other possible explanations. Thus, the incidence of menstrual cycle irregularities may not be directly due to the physical activity itself but rather associated with the dietary practices of the women who engage in such physical activities.

Statement of the Problem

The problem under investigation was to determine the relationship between menstrual cycle irregularities and dietary characteristics of female collegiate gymnasts, dance-majors and non-athletes. This investigation attempted to describe those individuals, in each group, with regular cycles versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, dietary status, dietary attitudes, and body composition.

Purpose of the Study

The purpose of this study was to compare the incidence of secondary amenorrhea and oligomenorrhea in female collegiate gymnasts, dance-majors and non-athletes. More specifically, the study concentrated on the phenomenon of menstrual cycle irregularities of women who are involved in physical activities which emphasize low body fat and a lean body image. The role and influence of diet and eating behavior on the menstrual cycle of female collegiate gymnasts and dancers may become clear.
This study was not designed to negate the hypothesis that intense physical training can alter the human menstrual cycle, but to determine whether other factors need to be considered and controlled when investigating the incidence and cause of menstrual cycle irregularities in women who are involved in different types of physical training.

Need for the Study

Although there exists an abundance of literature and scientific research on menstrual cycle irregularities related to strenuous physical training, the following problems still remain:

1. What mechanism(s) are involved in menstrual cycle irregularities?

2. How are menstrual irregularities due to training distinct from those due to factors such as diet?

3. Are there any acute or chronic health problems associated with menstrual irregularities?

4. Can menstrual cycle irregularities experienced by female athletes be controlled or managed without interrupting training?

In order to clarify the cause and effect relationship between menstrual cycle irregularities and strenuous physical training, other factors, such as emotional stress, diet and even more severe pathological conditions need to be considered and controlled in future investigations. This investigation will help clarify the role that diet plays.
A complete description and comparison of the incidence of menstrual cycle irregularities observed in women who are involved in specific types of physical activities is not yet possible because not all groups have been surveyed. Thus it is difficult to identify high risk groups in order to monitor related health problems.

Delimitations

This study was delimited to the following:

1. Healthy collegiate female gymnasts, dance majors and non-athletes who are not taking oral contraceptives.
2. Surveying dietary status over a period of 5 days during the school year.
3. The menstrual irregularities defined as amenorrhea and oligomenorrhea.

Limitations

This study was limited by the following:

1. The windmill spirometer was used to estimate residual volume.
2. The subjects' ability to accurately recall their menstrual characteristics.
3. The applicability of the recommended daily allowances of nutrients for each sub-population.
Assumptions

The following assumptions must be considered when reviewing this study:

1. Subjects performed maximal forced expirations when being weighed underwater.
2. The subjects answered the survey questions honestly.
3. The subjects recorded their daily dietary intakes correctly and completely.

Hypotheses

The main purpose of this investigation was to determine the relationship between menstrual irregularities and dietary characteristics in female collegiate gymnasts, dance-majors and non-athletes. To accomplish the purpose of this investigation, the following hypotheses were examined:

1. The incidence of menstrual cycle irregularities is greater in female collegiate gymnasts and dancers compared to non-athletes.
2. There is a difference in the age at menarche of gymnasts, dance-majors and non-athletes.
3. There is a difference in the age at menarche of secondary amenorrheic, oligomenorrheic and regularly cycling subjects.
4. The female collegiate gymnasts and dance-majors have lower percent body fat compared to the non-athletes.
5. The percent body fat of the subjects with secondary amenorrhea, oligomenorrhea and regular cycles is similar.

6. There is a difference between gymnasts, dance-majors and non-athletes for dietary status.

7. The subjects with secondary amenorrhea and oligomenorrhea and regular menstrual cycles have different dietary intakes.

8. There is a difference in the eating attitudes of gymnasts, dance-majors and non-athletes.

9. There is a difference in the eating attitudes of the secondary amenorrheic, oligomenorrheic and regularly cycling subjects.

Definitions

For the purpose of this investigation the following operational definition of terms was adopted:

1. Age at menarche was defined as the age at which the episode of menses first occurred.

2. Dietary attitudes were defined as encompassing attitudes toward dieting, food preoccupation, oral control and fear of being overweight.

3. Dietary status was defined as the degree to which dietary intake meets the recommended daily allowance of calories, protein, fat, carbohydrates and iron.

4. Follicular phase was defined as the phase of the menstrual cycle which denotes the period of follicular maturation. When
considering a "normal" 28 day cycle, the follicular phase denotes the endocrine and morphological changes in the ovary that occur from day 1 to day 14 of the menstrual cycle, where day 1 is defined as the beginning of menses.

5. Luteal phase was defined as the phase of the menstrual cycle which denotes the period of maturation and regression of the corpus luteum. When considering a 'normal' 28 day cycle, the luteal phase denotes the endocrine changes and morphological changes in the corpus luteum that occur immediately following ovulation (day 14) to day 28.

6. Non-athletes were defined as persons who participated in physical training and activity for less than 5 hours per week, for the purpose of physical fitness.

7. Oligomenorrhea was defined as the occurrence of menses type episodes that were more than 38 days apart but not absent for longer than six (6) months.

8. Secondary amenorrhea was defined as the absence of menses for a period of time equal to or longer than 6 months following the onset and establishment of menstrual cycle pattern.
CHAPTER II

REVIEW OF LITERATURE

Overview of the Human Menstrual Cycle
and Menstrual Cycle Irregularities

The length of a "normal" menstrual cycle is often quoted as 28 days. Trealoar, Boynton, Behn and Brown (1967) contended that there is no substantial justification that all women will adhere to this norm. After accumulating data on the menstrual cycle of over 2,000 post-menarcheal females, Trealoar et al. (1967) suggested that each woman had her own central trend which changed with age. Therefore, when a woman reported that her menses occurred every 35 days, there was no substantial evidence to consider this abnormal or irregular.

The human menstrual cycle is regulated by rhythmic changes in gonadotropic and gonadal hormones, which are themselves controlled by higher centers in the Central Nervous System. The hormones involved in the regulation of the menstrual cycle include the gonadotropins, Follicule Stimulating Hormone (FSH) and Luteinzing Hormone (LH); which are secreted by the anterior pituitary gland; and the gonadal hormones, estrogen and progesterone (Yen, 1978). Speroff and Vande Weile (1971) documented the cyclic changes of the gonadotropic and gonadal hormones during a normal menstrual cycle and indicated that the endocrinological changes correspond to morphological changes in the ovary and corpus luteum.
Prior to ovulation, the events of the menstrual cycle are dominated by the development of the follicle; this phase is defined as the follicular phase. During this phase there is a rise in the level of estrogen, a decrease in FSH, while LH remains fairly constant until a mid-cycle surge. The endocrinological phenomenon called the LH surge occurs immediately prior to ovulation -- the release of the mature follicle from the ovary. Following ovulation the development of the corpus luteum increases the level of the gonadal hormones, estrogen and progesterone. This final phase is called the luteal phase and coincides with the maturation and regression of the corpus luteum (Speroff & Vande Weile, 1971).

Immediately following menarche, the menstrual cycle tends to be irregular (Trealoar et al., 1967) and anovulatory (Apter, Viinikka & Vihko, 1978). This is due to the immature level of FSH and LH. The available literature indicated the gonadotropic and gonadal hormones do not reach mature concentration for 2 to 3 years (Apter et al., 1978).

Hormonal regulation of the menstrual cycle is very delicate and any stimulus which disrupts the synthesis, release and clearance of gonadotropic and gonadal hormones can cause menstrual dysfunction. Amenorrhea is a condition which indicates a defect in the reproductive system. Yen (1978) identified three types of amenorrhea: anatomic, ovarian and chronic anovulation. Loucks and Horvath (1984) stated that the most prevalent type of amenorrhea is chronic anovulation.
Specific endocrine disorders such as hypothalamic dysfunction and hypothyroidism disrupt the balance of reproductive hormones and result in anovulation. For example, hypothalamic dysfunction depresses the release of the anterior-pituitary hormones FSH and LH (Vigersky, Anderson, Thompson & Loriaux, 1977). Ovarian tumors, which are estrogen producing agents affect the steroid feedback mechanism to the hypothalamic-pituitary unit (Yen, 1978). Although the etiology of chronic anovulation amenorrhea is numerous, the endocrinological disruption can be diagnosed to a specific location in the hypothalamic-pituitary-ovarian complex (Loucks & Horvath, 1984).

Rebar (1983) classified chronic anovulation according to the deviation of the gonadotropic hormones beyond normal limits. Three distinct hormonal patterns were defined: (a) hypogonadotropic pattern, (b) normogonadotropic pattern, and (c) an elevated LH pattern. Such endocrine disturbances can be primary or caused by metabolic disorders and environmental stress. Indeed, Vigersky et al. (1974) identified hypothalamic dysfunction in subjects with simple and excess weight loss.

Exercise-induced Amenorrhea

Recent evidence suggested that exercise can also disrupt the human menstrual cycle. A summary of current survey data collected on female athletes involved in different sports and training programs is presented in Table 1. Although the sample size of many
Table 1

Summary of Data on Menstrual Irregularities in Female Athletes

<table>
<thead>
<tr>
<th>Sport</th>
<th>Number of Subjects</th>
<th>Percent of Menstrual Irregularities</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Country</td>
<td>143</td>
<td>70</td>
<td>Webb &amp; Procter (1983)</td>
</tr>
<tr>
<td>X-Country</td>
<td>42</td>
<td>42</td>
<td>Plowman &amp; McSwegin (1981)</td>
</tr>
<tr>
<td>College Athletes</td>
<td>21</td>
<td>28.6</td>
<td>Malina et al. (1978)</td>
</tr>
<tr>
<td>Olympic Athletes</td>
<td>18</td>
<td>33</td>
<td>Malina et al. (1978)</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>5</td>
<td>40</td>
<td>Webb, Millan &amp; Strolz (1979)</td>
</tr>
<tr>
<td>Basketball</td>
<td>7</td>
<td>0</td>
<td>Webb, Millan &amp; Strolz (1979)</td>
</tr>
<tr>
<td>Track</td>
<td>15</td>
<td>0</td>
<td>Webb, Millan &amp; Strolz (1979)</td>
</tr>
<tr>
<td>Swimming</td>
<td>12</td>
<td>58</td>
<td>Webb, Millan &amp; Strolz (1979)</td>
</tr>
<tr>
<td>Marathon</td>
<td>49</td>
<td>66</td>
<td>Prior et al. (1982)</td>
</tr>
<tr>
<td>Dancers</td>
<td>33</td>
<td>51</td>
<td>Calabrese et al. (1983)</td>
</tr>
<tr>
<td>Dancers</td>
<td>299</td>
<td>34</td>
<td>Frisch, Washak &amp; Vincent (1980)</td>
</tr>
</tbody>
</table>
of the studies was small and not all athletic groups were surveyed, the data indicated that the incidence of menstrual cycle irregularities differed from one sport to another. Menstrual cycle irregularities occurred more frequently in long distance runners, dancers and swimmers. The menstrual cycle irregularities observed in female athletes are called exercise-induced amenorrhea. It is difficult to state what percentage of athletes are experiencing exercise-induced menstrual irregularities because previous studies fail to screen for conditions such as ovarian-tumors, malnutrition and metabolic disorders.

The actual mechanism responsible for exercise-induced amenorrhea remains obscure. Amenorrhea and oligomenorrhea observed in athletes was significantly correlated to weight loss and low body fat (Frisch & McArthur. 1974), intensity of training (Feicht, Johnson & Martin, 1978), age at menarche (Cohen, Kim, May & Ertel, 1982) and an alteration of gonadal and gonadotropic hormone concentrations (Bonen & Belcastro, 1978).

Research focused on the effect of exercise on the gonadal and gonadotropic hormones must be viewed in terms of: (a) the chronic effect on basal hormone concentrations, and (b) the acute hormone response to exercise. Bonen and Belcastro (1978) and Jurkowski et al. (1978) reported that progesterone and estrogen levels are significantly elevated following a bout of bicycle exercise. Both studies concluded that the hormonal changes were related to intensity of training and phase of the menstrual cycle.
Basal concentrations of the gonadal and gonadotropic hormones of athletes while at rest were compared to non-athletes by Dale and Goldberg (1982) and Bonen and Belcastro (1978). Both studies found that the athletes displayed significantly lower levels of FSH, progesterone and estradiol compared to non-athletes. The results from Dale and Goldberg (1981) study suggested that the intensity of training may be a factor in determining the hormonal response. Most of the data indicated that athletes tend to display a depressed FSH concentration. It is difficult to draw any conclusion about LH due to methodological problems assessing basal LH concentrations (Loucks & Horvath, 1985).

The endocrinological research enabled exercise-induced amenorrhea to be classified as chronic anovulation, however the exact site of the disturbance has not yet been identified. Loucks and Horvath (1985) reported two possible sites of the disturbance: (a) the Central Nervous System-Hypothalamic Unit, and (b) a peripheral defect, disrupting the steroid feedback unit.

Although exercise may alter the gonadal and gonadotropic hormones, Wakat, Sweeney and Rogol (1982) reported no significant differences between the amenorrheic, oligomenorrheic and regularly cycling athletes with respect to post-exercise levels of LH and FSH, intensity of training, and age when training began. The hormonal profile of exercise-induced amenorrhea is not complete and the actual percentage of women with exercise-induced amenorrhea is still not known. The inability to answer such questions may be due, in
part, to methodological errors (Loucks & Horvath, 1985). Indeed, differentiation between amenorrhea due to exercise versus amenorrhea due to other factors, in the female athletic population, has been largely ignored. Further, is the amenorrhea observed in the various sporting groups of the same type?

To date the majority of research focused on endurance type athletes. There is a paucity of research on athletes engaged in anaerobic activities, such as gymnastics.

Amenorrhea, Nutrition and Weight Loss

Amenorrhea is manifest during excess and simple weight loss. In particular amenorrhea accompanies the psychogenic disorder, anorexia nervosa (Fries, Nillius & Peterson, 1974; Warren, Jewelewicz & Dyrenfruth, 1975) and simple weight loss in otherwise normal females (Vigersky et al., 1977). Frisch and McArthur (1974) hypothesised that a critical percent body fat, lean body weight ratio is necessary for the onset and maintenance of the human menstrual cycle. These investigators observed that menses was absent in women who were below their critical body weight and menses resumed at a heavier weight than their critical body weight. Frisch (1972a) suggested that a minimum amount of stored, easily mobilized fat is essential to the production of estrogen. A lack of estrogen would disrupt the steroid feedback mechanism and result in chronic anovulation amenorrhea (Loucks & Horvath, 1985). Rice (1984) reported a significant relationship between estrogen concentration
and percent body fat in active women.

Malina (1982) criticized Frisch and McArthur's (1974) hypothesis, because it is based on a small sample size and body composition was estimated as opposed to a more accurate determination such as hydrostatic weighing. In spite of the criticism, the 'critical weight hypothesis' was used to investigate the possible etiology of exercise-induced amenorrhea.

Studies relating menstrual irregularities, physical training and body composition produced mixed results, but generally indicate that body composition alone does not account for the high incidence of amenorrhea and oligomenorrhea in female athletes. Of particular interest are the results of studies by Calabrese et al. (1983), Plowman and McSwegin (1981) and Wakat et al. (1982), who reported the occurrence of amenorrhea and oligomenorrhea in athletes and ballet dancers who were above their critical body weight.

The "critical weight hypothesis" may not totally explain the cause of menstrual cycle irregularities in physically active women; however, the association between amenorrhea, nutrition and eating habits must not be overlooked. Russell and Bearlwood (1970) observed that obese cyclic women on a low caloric diet may become amenorrheic even though such women had sufficient body weight for normal menstrual function.

Research studies which focused on the effect of nutrition on menstrual cycle status in athletes are lacking. Dale and Goldberg (1981) compared the nutritional status of long distance runners,
committed exercisers and sedentary controls. No significant relationship was found between diet, body fat, exercise and menstrual cycle status; however, the investigators did not differentiate between the nutritional status of the regular and irregular subjects. The study indicated that marathon and long distance runners were deficient in calcium and that this group also experienced more bone fractures.

Frisch (1983) conducted a dietary analysis of athletes who began training prior to menarche and after menarche. The study found that the pre-menarcheal trained athletes consumed significantly fewer calories, less protein, less saturated fat and less calcium than the post-menarcheal trained athletes.

The nutritional requirements of athletes are still unclear (Buskirk & Haymes, 1972) yet strenuous physical training may alter nutritional requirements beyond the recommended daily allowance. Pate, McGuire and Van Wyke (1979) and de Wijn, de Jongste, Mosterd and Willebrand (1971) indicated that iron deficiency is prevalent amongst athletes and the increased energy demand placed on the body during physical training increases the body's total caloric intake.

Considering the association between nutrition and reproductive function (Frisch, 1982), there is an obvious need for further research in this area. In particular, a comparison of the nutritional status of athletes with regular and irregular menses.
Eating Attitudes

Amenorrhea is associated with the abnormal eating behavior, such as anorexia nervosa (Loucks & Horvath, 1985). The etiology of chronic anovulation amenorrhea in anorexia nervosa has been traced to a hypothalamic dysfunction producing a deficiency in Gonadotropin Releasing Hormone (GNRH). The cause of the GNRH deficiency may be the result of a neurotransmitter abnormality (Fears et al., 1983). Similar but less severe hypothalamic dysfunction was diagnosed in women experiencing secondary amenorrhea associated with simple weight loss. Russell and Bearlwood, (1970) reported hypothalamic dysfunction in subjects with abnormal eating behaviors rather than weight loss per se.

Abnormal eating behavior, in particular chronic dietary behavior, can occur without the classic weight loss observed in anorexia nervosa. Bruch (1973) reported on a group of chronic dieters called "thin-fat" whose eating behaviors and psychological orientation are not distinguishable from anorexia nervosa patients, but they do not display the classic weight loss. Garner and Garfinkel (1979) identified a similar group using the Eating Attitudes Test (EAT).

Little attention has been directed towards the occurrence of abnormal eating habits in athletes. Garner and Garfinkel (1978) administered the EAT to 112 professional dance students. The mean EAT score of the dancers was 31 and more dancers obtained an EAT
score of 30 or above when compared to a normal population. Although only five percent of the dancers were diagnosed as having primary anorexia nervosa, many of the dancers displayed abnormal attitudes toward food, diet and body image. Druss and Silverman (1979) investigated diet, menstrual irregularities and body image in professional dancers. The mean caloric intake of the dancers was 1,000 calories per day, with some dancers eating as few as 600 calories per day. Seventy-percent of the dancers reported irregular menstrual cycles and engaged in chronic dietary behavior.

The social atmosphere and expectations surrounding dancers and gymnasts emphasize low body weight and a lean physical appearance. Such demands may provide the appropriate atmosphere for the encouragement of severe weight control to maintain a linear appearance for aesthetic purposes. Indeed, the low percent body fat recorded for gymnasts and dancers (Sinning, 1978; Calabrese et al., 1983) cannot be solely attributed to the physical demands of the training program. Schantz and Astrand (1984) investigated the physiological demands of classical ballet training and found that the intensity of a training session averaged 30 to 40 percent of a dancer's maximum aerobic capacity, and that this was not constantly maintained throughout the session.

Gymnastics training is largely anaerobic, intermittent and emphasizes skill acquisition. The low percent body fat reported for gymnasts (Sinning, 1978) may be due to a reduced dietary intake and chronic dietary behavior. Considering the observation of Garner and
Garfinkel (1978) for professional dance students, a similar situation may exist among female gymnasts. Indeed, the demands placed on the gymnasts to maintain a linear appearance may provide the social milieu for the reinforcement of abnormal attitudes about food, diet and body image. Unfortunately, there is no available literature reporting the incidence of abnormal eating habits among female gymnasts.

The Eating Attitudes Test as proposed by Garner and Garfinkel (1979) provides a survey test to recognize abnormal eating attitudes. The EAT is a 40 item test reflecting attitudes toward: (a) food preoccupation, (b) body image for thinness, (c) vomiting and laxative abuse, (d) slow eating, (e) clandestine eating, and (f) perceived social pressure to gain weight. The concurrent validity of the EAT was reported by Garner and Garfinkel (1979) to be $R=.72$, $p<.0001$, based on criterion group membership of normal and anorexic patients. In addition, the predictive ability of the test, determined by cross-validation was reported to be $r=.87$ ($p<.001$) (Garner & Garfinkel, 1979). The EAT provides a relatively simple method with moderately high validity to survey groups for abnormal eating habits. Considering the association between amenorrhea, undernutrition and eating disorders in general and the paucity of literature reporting the incidence of eating habits and dietary status of female gymnasts, a descriptive study of the dietary status, eating attitudes and menstrual cycle characteristics of post-menarcheal gymnasts and dancers is indicated.
CHAPTER III

DESIGN AND METHODOLOGY

The purpose of this investigation was to determine the relationship between menstrual irregularities and dietary characteristics of female collegiate gymnasts, dance-majors and non-athletes. The procedures used in the collection and analysis of the data for this study are organized under the following headings: (a) subjects, (b) apparatus, and (c) procedures.

Subjects

The subjects invited to participate in this investigation were 30 female collegiate gymnasts, 15 collegiate dance-majors and 29 collegiate non-athletes. The female collegiate gymnasts were from Division I universities in Michigan, Indiana and Illinois. The female collegiate dance-majors were members of the University Dance Theatre and undergraduates majoring in dance at Western Michigan University. The sample of non-athletes were undergraduate students at Western Michigan University. All subjects were informed of the purpose of the investigation, read, and signed an informed consent form (See Appendix A).
Apparatus

Percent body fat was determined both hydrostatically and anthropometrically. For the hydrostatic weighing, vital capacity was measured using a windmill spirometer, model No. 64400.

Hydrostatic weighing of the dance-majors and non-athletes was conducted in a 4x4x4 foot tank, in which a T-bar was suspended from a Chatillon 9.1 kg scale. Hydrostatic weighing of the gymnasts was conducted at four different locations. At two of the sites, hydrostatic weighing was conducted in a 4x4x4 foot tank, in which a T-bar was suspended from a Chatillon scale. At the other two sites, hydrostatic weighing was conducted in a swimming pool, in which a seat was suspended from a Chatillon 9.1 kg scale.

Skinfold fat was measured on the right side of the body using a Syndex Electronic Body Fat Caliper. The caliper measured the skinfold thickness to the nearest 0.1 mm.

Procedures

Percent Body Fat

When the subjects reported to the laboratory they were measured for dry land body weight. Body weight measurements were taken to the nearest pound. Skinfold measures were then determined. Vital capacity was measured with each subject performing 3 trials. Although vital capacity and underwater weight were determined separately, the same postural position was used for both
measurements. Pulmonary residual volume was estimated as 28% of the subjects' vital capacity. Hydrostatic weighing was performed four to six times, with the heaviest weight counting as the underwater weight for the subject. Lean body mass and percent body fat were calculated using the equation described by Benhke and Wilmore (1974).

The skinfold sites were as follows:
1. Triceps - a vertical fold mid-way between the acromion and olecranon process on the posterior side of the arm;
2. Suprailiac - an oblique fold on the iliac crest at the mid-axillary line;
3. Abdominal - a vertical fold adjacent to the umbilicus, but not including umbilical tissue;
4. Subscapular - an oblique fold on the lateral and downward line at the inferior angle of the scapula;
5. Thigh - a vertical fold mid-way between the knee and hip joint; and
6. Biceps - a fold taken over the belly of the biceps with arm hanging freely in extension.

The average of three skinfold sites were used to represent each site.

The Wilmore and Behnke (1970) equation:

\[
LBW = 8.629 + .690 \times \text{weight} - .163 \times \text{subscapular SF} - .081 \times \text{triceps SF} - .054 \times \text{thigh SF}
\]

was used to predict percent body fat for comparison with the
hydrostatic weighing. The equation has a reliability coefficient of $R = .93$ for gymnasts and $R = .96$ for non-athletic females.

**Menstrual Cycle Status**

Age at menarche and menstrual patterns for all subjects were obtained by questionnaire. Age of menarche was therefore based on retrospective data, such data are influenced by error of recall, however, Bergstern-Brucefors (1976) indicates that most women can recall age of menarche within 2 to 3 months of the actual event.

In addition, all subjects were surveyed by questionnaire to determine the occurrence of menstrual irregularities, whether they were experiencing menstrual irregularities at the time of the investigation and use of oral contraceptives. The questionnaire focused on menstrual patterns and the experience of amenorrhea and oligomenorrhea (see Appendix B).

**Dietary Status**

Dietary status was determined using a survey approach. The subjects recorded food, drink and nutritional supplements ingested over a 5 day period. The gymnasts recorded their nutritional intake over 5 days during the competitive season. The dance-majors and non-athletes recorded their nutritional intake over 5 days during the middle of the semester. The nutritional information was processed using the Dine System (Dennison, 1984) to determine dietary status.
Dietary Attitudes

The Eating Attitudes Test was used to determine the subjects' attitudes toward diet, food and body image. The questionnaire is a 40 item Likert scale developed by Garner and Garfinkel (1979) to identify individuals with eating disorders associated with anorexia nervosa. The EAT has a concurrent validity coefficient of $R = .72$ ($p < .0001$) (see Appendix C).

Data Analysis

Descriptive statistics were used to describe the menstrual cycle characteristics, body composition, dietary status and eating attitudes of the three groups. Statistical analysis of menstrual cycle status (regular, amenorrheic and oligomenorrheic) was performed using a Chi square contingency table. Statistical comparison of the activity groups by menstrual cycle patterns was performed using an Analysis of Variance (ANOVA). Pairwise comparisons of means was performed using the Tuckey Honestly Significant Difference Test. The dependent variable was defined as menstrual cycle status. The independent variables included age at menarche, percent body fat, dietary status and eating attitudes. The significance level was set at .05.
CHAPTER IV

RESULTS

Introduction

The purpose of this study was to compare the incidence of regular menstrual cycles, secondary amenorrhea and oligomenorrhea for female collegiate gymnasts, dance-majors and non-athletes. The study attempted to describe those individuals in each group, with regular menstrual cycles versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, body composition, dietary intake and eating attitudes. Data were gathered for the purpose of testing the hypotheses presented in Chapter I.

Characteristics of the Subjects

The mean age, physical characteristics and training histories for the gymnasts, dance-majors and non-athletes are presented in Table 2. The three groups were similar in age and height. Body weight indicated that the gymnasts and dance-majors weighed less than the non-athletes.

The training histories of the gymnasts and dancers are presented in Table 2. The training histories of the non-athletes are not presented. By definition the non-athletes participated in physical training for no more than 5 hours per week, as was confirmed by questionnaire. The statistical treatments of the data
are presented according to each research hypothesis.

Table 2

Personal Characteristics of Study Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Yrs.)</td>
<td>20.35</td>
<td>21.07</td>
<td>20.64</td>
</tr>
<tr>
<td>Height (in.)</td>
<td>63.09</td>
<td>63.83</td>
<td>64.05</td>
</tr>
<tr>
<td>Weight (lb.)</td>
<td>122.32</td>
<td>123.87</td>
<td>131.41</td>
</tr>
<tr>
<td>Age Began Training (Yrs.)</td>
<td>10.1</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>Training per Day (Hr.)</td>
<td>3.2</td>
<td>4.9</td>
<td></td>
</tr>
</tbody>
</table>

Menstrual Status

The hypothesis to investigate menstrual cycle status stated: The incidence of secondary amenorrhea and oligomenorrhea is greater in female collegiate gymnasts and dance-majors compared to non-athletes. This hypothesis was tested by computing a Chi square on the frequencies of menstrual cycle patterns by activity group. The incidence of regular menstrual cycles, secondary amenorrhea and oligomenorrhea is presented in Table 3. The gymnasts displayed the highest incidence of secondary amenorrhea and oligomenorrhea.
At the time of the study 16.13% of the gymnasts were experiencing secondary amenorrhea and 32.26% were experiencing oligomenorrhea. The Chi-square, $=37.021$, was statistically significant at the .05 level of probability. The research hypothesis was supported and the null hypothesis was rejected.

Table 3

<table>
<thead>
<tr>
<th>Activity</th>
<th>Regular</th>
<th>Amenorrheic</th>
<th>Oligomenorrheic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>23</td>
<td>79.31</td>
<td>2</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>16</td>
<td>51.61</td>
<td>5</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>10</td>
<td>66.67</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>65.33</td>
<td>9</td>
</tr>
</tbody>
</table>

Age at Menarche

A primary objective of this study was to describe those individuals, in each group, with regular menstrual cycles versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, percent body fat, dietary intake and eating attitudes. To accomplish this the gymnasts, dance-majors and non-athletes were sub-grouped according to menstrual cycle status.
The research hypotheses for age at menarche stated: (a) There is a difference in the age at menarche of gymnasts, dance-majors and non-athletes; and (b) there is a difference in the age at menarche of secondary amenorrheic, oligomenorrheic and regularly cycling subjects.

In order to test the hypotheses for age at menarche, an ANOVA which tested for differences between means on age at menarche for activity group by menstrual cycle status was computed. Data on the age at menarche is summarized in Tables 4 and 5. The descriptive statistics for age at menarche, presented in Table 4, show that the mean age at menarche for the gymnasts, dance-majors and non-athletes was 15.21, 14.35 and 13.69 years respectively. The gymnasts tend toward an older menarcheal age. The results of the ANOVA, refer to Table 5, indicate a significant difference $F(2,66)=9.75$, $p<.05$ between the three groups.

The Tuckey Honestly Significant Difference (HSD) test for multiple comparisons, was computed to determine between which groups significant differences occurred. All pairwise comparisons for the mean age at menarche for gymnasts, dance-majors and non-athletes are shown in Table 6. The critical value, HSD(.95 $q$ 3,60)=0.762 was exceeded by the obtained difference of 1.51 found between the mean age at menarche of non-athletes and gymnasts, and the obtained difference of 0.85 found between the mean age at menarche of dance-majors and gymnasts. The gymnasts were significantly ($p<0.5$) older than the non-athletes and dance-majors for age at menarche.
## Table 4

Means and Standard Deviations for Age at Menarche

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  Mean  SD</td>
<td>N Mean SD</td>
<td>N Mean SD</td>
<td>N Mean SD</td>
</tr>
<tr>
<td>Regular</td>
<td>16 14.84 1.01</td>
<td>10 13.86 1.33</td>
<td>23 13.34 0.99</td>
<td>49 14.01 0.16</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5 15.05 1.32</td>
<td>2 14.86 0.71</td>
<td>2 14.36 1.29</td>
<td>9 14.25 1.29</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10 15.74 0.99</td>
<td>3 13.33 1.12</td>
<td>4 13.37 1.01</td>
<td>17 14.48 0.83</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31 15.21 0.60</td>
<td>15 14.35 0.96</td>
<td>29 13.69 0.89</td>
<td></td>
</tr>
</tbody>
</table>

Note: Age at Menarche is presented in years.
Therefore, the research hypothesis that there is a difference in the age at menarche of gymnasts, dance-majors and non-athletes was supported and the null hypothesis was rejected.

Mean age at menarche for menstrual cycle pattern reveals that the secondary amenorrheic and oligomenorrheic subjects reached menarche slightly later than the regular subjects for each group. No significant difference $F(2,66)=1.45$, $p<.05$ was found between menstrual cycle pattern for age of menarche. Therefore, the research hypothesis that there is a difference between the age at menarche of amenorrheic, oligomenorrheic and regularly cycling subjects, was not supported.

Table 5

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>22.045</td>
<td>2</td>
<td>11.023</td>
<td>9.75*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>3.42</td>
<td>2</td>
<td>1.671</td>
<td>1.48</td>
</tr>
<tr>
<td>Interaction</td>
<td>4.388</td>
<td>4</td>
<td>1.072</td>
<td>0.95</td>
</tr>
<tr>
<td>Error</td>
<td>74.601</td>
<td>66</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>104.278</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p<.05$
Table 6

Pairwise Comparisons of Activity Group Means for Age at Menarche

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Non-athletes</th>
<th>Dance-majors</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-athletes</td>
<td>13.69</td>
<td>-</td>
<td>0.66</td>
<td>1.51*</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>14.35</td>
<td>-</td>
<td>-</td>
<td>0.85*</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>15.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained difference between means are presented.

HSD (.95 q 3, 60) = 0.762

*p<.05

Characteristics of Menstrual Cycle

The characteristics of the subjects early menstrual cycles are shown in Table 7. An examination of the age at which the menstrual cycle became regular revealed that none of the gymnasts achieved regularity between 10 and 13 years, while 13% of the dance-majors and 17% of the non-athletes reported regularity between 10 and 13 years of age. Between the ages of 14 and 17 years, 42% of the gymnasts, 20% of the dancers and 56% of the non-athletes achieved regularity. Thirteen gymnasts, 1 dance-major and 3 non-athletes ranging in age from 18 to 22 years declared that their menstrual cycle had not yet become regular.
Table 7

Characteristics of Early Menstrual Cycle

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R A O</td>
<td>R A O</td>
<td>R A O</td>
</tr>
<tr>
<td></td>
<td>N % N % N %</td>
<td>N % N % N %</td>
<td>N % N % N %</td>
</tr>
</tbody>
</table>

Age of Regular Menses

<table>
<thead>
<tr>
<th>Age</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-17</td>
<td>11 36 1 3 1 3</td>
<td>3 20</td>
<td>14 48 1 4 1 4</td>
</tr>
<tr>
<td>Over 17</td>
<td>5 11</td>
<td>5 33 1 7 3 20</td>
<td>4 14</td>
</tr>
<tr>
<td>Still not</td>
<td></td>
<td>4 13 9 29</td>
<td>1 7</td>
</tr>
</tbody>
</table>

Interval of Early Cycle

<table>
<thead>
<tr>
<th>Interval</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-24</td>
<td>2 7</td>
<td></td>
<td>7 24</td>
</tr>
<tr>
<td>25-30</td>
<td>7 23</td>
<td>3 10</td>
<td>8 28</td>
</tr>
</tbody>
</table>
Table 7 (Cont'd.)

Characteristics of Early Menstrual Cycle

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>A</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Interval of Early Menstrual Cycle (Cont'd.)

<table>
<thead>
<tr>
<th></th>
<th>21-30</th>
<th>31-60</th>
<th>OVER 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gymnasts</td>
<td>4 13</td>
<td>1  3</td>
<td>3  10</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>2 14</td>
<td>-- --</td>
<td>3  20</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>1  7</td>
<td>--  17</td>
<td>2  14</td>
</tr>
</tbody>
</table>

Duration of Early Menses

<table>
<thead>
<tr>
<th></th>
<th>&lt;3</th>
<th>3-6</th>
<th>UP TO 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gymnasts</td>
<td>1</td>
<td>15</td>
<td>-- --</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>1</td>
<td>7</td>
<td>1  3</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>1</td>
<td>4</td>
<td>4 14</td>
</tr>
</tbody>
</table>

Note: R is Regular Cycles; A is Amenorrheic; and O is Oligomenorrheic.
The secondary amenorrheic and the oligomenorrheic subjects from each group tended to achieve regularity at a later age or reported that their cycle is still not regular. Notably, 80% of the secondary amenorrheic gymnasts and 90% of the oligomenorrheic gymnasts report that their cycle had not yet become regular.

Fifty-eight percent of the gymnasts, 60% of the dancers and 69% of the non-athletes reported that the interval of their early menstrual cycle was between 21 to 30 days. Only one subject, an oligomenorrheic gymnast, reported that her early menstrual cycle was less than 21 days. Early menstrual cycle intervals which were over 30 days were present in all groups. There was no abnormal trend observed for the interval of the early menstrual cycle with respect to regular, amenorrheic and oligomenorrhic subjects.

The duration of menses during the first year, was between 3 to 6 days for 90% of the gymnasts, 57% of the dance-majors and 76% of the non-athletes. Two gymnasts, 5 dance-majors and 2 non-athletes reported that a menses during the first year, was shorter than 3 days. A menses of up to 8 days was reported by 1 gymnast, 3 dancers and 5 non-athletes.

Table 8 summarizes the characteristics of the subjects present menstrual cycle. The interval of the present menstrual cycle for 55% of the gymnasts, 53% of the dance-majors and 83% of the non-athletes was 21 to 30 days. Only 6% of the gymnasts and 13% of the dance-majors reported an interval shorter than 21 days. A menstrual cycle interval greater than 30 days was present in 39% of the gymnasts, 33% of the dance-majors and 17% of the non-athletes. The
<table>
<thead>
<tr>
<th>Variable</th>
<th>Gymnasts</th>
<th>Dance-Majors</th>
<th>Non-Athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R A O</td>
<td>R A O</td>
<td>R A O</td>
</tr>
<tr>
<td></td>
<td>N % N % N %</td>
<td>N % N % N %</td>
<td>N % N % N %</td>
</tr>
<tr>
<td>Interval of Cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;21</td>
<td>1 3</td>
<td>2 13</td>
<td>-- -- -- -- --</td>
</tr>
<tr>
<td>21-24</td>
<td>2 7</td>
<td>1 7</td>
<td>4 14</td>
</tr>
<tr>
<td>25-30</td>
<td>6 19</td>
<td>3 20</td>
<td>14 48</td>
</tr>
<tr>
<td>21-30</td>
<td>4 13</td>
<td>2 13</td>
<td>3 10</td>
</tr>
<tr>
<td>Over 30</td>
<td>3 10 5 16 4 13</td>
<td>2 13 2 13 1 7</td>
<td>2 7 3 10</td>
</tr>
<tr>
<td>Duration of Menses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3</td>
<td>2 7 1 3 1 3</td>
<td>-- -- -- -- --</td>
<td>1 7 1 4</td>
</tr>
<tr>
<td>3-6</td>
<td>13 42 4 13 8 26</td>
<td>10 66 2 13 2 13</td>
<td>20 69 2 7 3 10</td>
</tr>
<tr>
<td>Up to 8</td>
<td>1 3</td>
<td>-- -- -- -- --</td>
<td>3 10</td>
</tr>
</tbody>
</table>
majority of the secondary amenorrheic subjects reported that when their cycle was fairly regular it was longer than 30 days.

The duration of menses, for the majority of the subjects, was between 3 to 6 days. Only 6% of the dance-majors, 12% of the gymnasts and 3% of the non-athletes reported a menses shorter than 3 days. A duration of menses up to 8 days was reported by none of the dancers, 6% of the gymnasts and 10% of the non-athletes. No abnormal trend was observed for duration of menses between regular, secondary amenorrheic and oligomenorrheic subjects.

Percent Body Fat

The research hypotheses proposed to investigate the effect of percent body fat stated that: (a) The female collegiate gymnasts and dance majors will have lower percent body fat compared to the non-athletes; and (b) the percent body fat of the subjects with secondary amenorrhea, oligomenorrhea and regular menstrual cycles will be similar.

Table 9 summarizes the percent body fat measurements. The means of 17.26% and 18.24% for the gymnasts and dancers are lower than the mean of 22.43% for the non-athletes. The statistical analysis of the data is shown in Table 10. The ANOVA revealed that the main effect of activity group on percent body fat was statistically significant $F(2,66)=6.41$, $p<.05$.

The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which activity groups...
Table 9

Means and Standard Deviations for Percent Body Fat

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>17.62</td>
<td>3.71</td>
<td>10</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>17.48</td>
<td>3.49</td>
<td>2</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>16.69</td>
<td>3.65</td>
<td>3</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>17.26</td>
<td>0.82</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 10

ANOVA Summary Table for Percent Body Fat

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>210.757</td>
<td>2</td>
<td>105.375</td>
<td>6.41*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>32.469</td>
<td>2</td>
<td>16.235</td>
<td>0.99</td>
</tr>
<tr>
<td>Interaction</td>
<td>24.826</td>
<td>4</td>
<td>6.207</td>
<td>0.38</td>
</tr>
<tr>
<td>Error</td>
<td>1084.719</td>
<td>66</td>
<td>16.435</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1352.773</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p< .05

Table 11

Pairwise comparisons of Activity Group Means for Percent Body Fat

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gymnasts</td>
<td>17.26</td>
<td>-</td>
<td>0.98</td>
<td>5.17*</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>18.24</td>
<td>-</td>
<td>-</td>
<td>4.19*</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>22.43</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

HSD(.95 g 3,60)=2.91

*p<.05
the significant difference occurred. All pairwise comparisons for the mean percent body fat of gymnast, dance-majors and non-athletes are summarized in Table 11. The critical value, HSD (.95 $g 3, 60) = 2.91 was exceeded by the obtained difference of 5.17 found between the mean percent body fat of gymnasts and non-athletes, and the obtained difference of 4.19 found between the mean percent body fat of the dance-majors and non-athletes. The percent body fat of the non-athletes was significantly ($p<.05$) higher than the gymnasts and dance-majors. Therefore, the research hypothesis that the female collegiate gymnasts and dance-majors have lower percent body fat compared to the non-athletes was supported.

The secondary amenorrheic and oligomenorrheic gymnasts and dancers had a slightly lower percent body fat compared to their regularly cycling counterparts. Statistical significance at the .05 level of probability was not found for the variance between the cell categories of menstrual cycle status, nor for the interaction effect. Thus the results support the research hypotheses that, the percent body fat of the subjects with secondary amenorrhea, oligomenorrhea and regular menstrual cycles will be similar.

Dietary Status

Analysis of the five day dietary diary is presented in Tables 12 to 26. The daily intake of calories from food and liquid sources is presented. The major chemical groups of protein, fat and carbohydrates are given in terms of average daily caloric intake.
The average daily iron intake is reported in milligrams per day.

To investigate the effect of dietary status, the following research hypotheses were proposed: (a) there is a difference between gymnasts, dance-majors and non-athletes for dietary intake; and (b) the subjects with secondary amenorrhea and oligomenorrhea display different dietary intake compared to the regularly cycling subjects.

In order to test the research hypotheses, ANOVAs were performed for activity group by menstrual cycle pattern to determine the differences between means on daily caloric intake, protein, fat, carbohydrates and iron. These data are summarized in Tables 12 to 26.

The average daily caloric intake of the study groups is shown in Table 12. Note that the dance-majors consumed fewer calories per day compared to the gymnasts or non-athletes. An ANOVA, refer to Table 13, revealed that the gymnasts, dance-majors and non-athletes differed significantly $F(2,66)=6.61$, $p<.05$, for average daily caloric intake.

In addition, as summarized in Table 12, the secondary amenorrheic and oligomenorrheic dance-majors and non-athletes consumed fewer calories per day than their regularly cycling counterparts. In the case of the gymnasts only, the secondary amenorrheic gymnasts consumed fewer calories than their regularly cycling counterparts. A significance difference $F(2,66)=3.33$, $p<.05$, was found for the variance between the cell categories of menstrual cycle pattern.
Table 12

Means and Standard Deviations for Caloric Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean  SD</td>
<td>N</td>
<td>Mean  SD</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>1508.6 332.1</td>
<td>10</td>
<td>1463.4 448.7</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>1439.0 467.6</td>
<td>2</td>
<td>393.0 22.6</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>1602.6 424.4</td>
<td>3</td>
<td>1123.3 1371.5</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>1516.7 231.8</td>
<td>15</td>
<td>993.2 123.9</td>
</tr>
</tbody>
</table>


Table 13

ANOVA Summary Table for Caloric Intake

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>195861.92</td>
<td>2</td>
<td>979325.96</td>
<td>6.61*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>987679.28</td>
<td>2</td>
<td>493839.64</td>
<td>3.33*</td>
</tr>
<tr>
<td>Interaction</td>
<td>1707436.66</td>
<td>4</td>
<td>426859.17</td>
<td>2.88*</td>
</tr>
<tr>
<td>Error</td>
<td>9781965.83</td>
<td>66</td>
<td>148211.604</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14435733.69</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p< .05

A significant interaction effect between the activity groups by menstrual cycle status for average daily caloric intake, $F(4,66) =2.88$, $p<.05$ was found. Figure 1 graphically displays the interaction effect between the activity groups and menstrual cycle status for average daily caloric intake. A review of Figure 1 shows that the regularly cycling gymnasts, dance-majors and non-athletes tend to display similar caloric intakes. The secondary amenorrheic gymnasts, dance-majors and non-athletes consume fewer calories than their regularly cycling counterparts. Notably, the amenorrheic dance majors have the lowest caloric intake compared to all other groups. The oligomenorrheic subjects from each activity group consume more calories than their respective amenorrheic counterparts.
Figure 1. Interaction effect of activity group by Menstrual Cycle Status for Caloric Intake.
Although the secondary amenorrheic gymnasts and non-athletes tend to have similar caloric intakes, the secondary amenorrheic dance-majors consume significantly fewer calories per day than the oligomenorrheic gymnasts and non-athletes. The large difference observed for the secondary amenorrheic and oligomenorrheic dance-majors may be a reflection of the small sample size. The significant interaction effect suggests that the relationship between the subjects' activity and menstrual cycle status affects daily caloric intake.

The average daily caloric intake from protein for the three activity groups is shown in Table 14. The gymnasts consumed more calories from protein per day compared to the dance-majors and non-athletes. The ANOVA which tested for differences between means on protein intake for activity group by menstrual cycle status, shown in Table 15, revealed that gymnasts, dance-majors and non-athletes differ significantly $F(2,66)=11.33$, $p<.05$, for average daily caloric intake from protein.

The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which activity groups the significant difference occurred. All pairwise comparisons for mean protein intake of gymnasts, dance-majors and non-athletes are summarized in Table 16. The critical value, $\text{HSD}(.95 \ _{3,60}) = 47.65$, was exceeded by the obtained difference of 119.06 found between the mean protein intake of dance-majors and gymnasts, and the obtained difference of 71.79 found between the mean protein intake of dance-majors and non-athletes. The dance-majors consumed
Table 14

Means and Standard Deviations for Protein Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>222.2</td>
<td>75.6</td>
<td>10</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>252.0</td>
<td>80.15</td>
<td>2</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>238.7</td>
<td>77.2</td>
<td>3</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>237.6</td>
<td>13.3</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: Protein Intake is presented in calories consumed from protein.
Table 15

ANOVA Summary Table for Protein Intake

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>100120.29</td>
<td>2</td>
<td>50060.15</td>
<td>11.33*</td>
</tr>
<tr>
<td>Menstrual Patterns</td>
<td>18231.36</td>
<td>2</td>
<td>9115.98</td>
<td>2.06</td>
</tr>
<tr>
<td>Interaction</td>
<td>34796.77</td>
<td>4</td>
<td>8699.19</td>
<td>1.97</td>
</tr>
<tr>
<td>Error</td>
<td>291537.19</td>
<td>66</td>
<td>4417.23</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>444685.61</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

Table 16

Pairwise Comparisons of Activity Group Means for Protein Intake

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dance-majors</td>
<td>118.57</td>
<td>-</td>
<td>71.79*</td>
<td>119.06*</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>190.36</td>
<td>-</td>
<td>-</td>
<td>42.27</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>47.65</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

HSD(.95 g 3,60)=47.65

*p<.05
significantly (p<.05) fewer calories from protein compared to the gymnasts and non-athletes. No significant difference was found for the between cell variance, F(2,66)=2.06, P<.05, or the interaction F(4,66)=1.97, p<.05.

Table 17 shows that the dancers consumed the fewest number of calories from fat per day, while the gymnasts consumed the most. Table 18 is a summary of the ANOVA on fat intake for activity group by menstrual cycle status. A significant difference, F(2,66)=4.24, p<.05, was found for the main effect of activity group on the caloric intake of fat. The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which activity groups the significant difference occurred. All pairwise comparisons of the means for fat intake are summarized in Table 19. The critical value, HSD(.095 g 3,60) = 53.77, was exceeded by the obtained difference found between the mean fat intake of dance-majors and gymnasts. The dance-majors consumed significantly (p<.05) fewer calories per day from protein compared to the gymnasts and non-athletes.

Statistical significance at the .05 level of probability was found for the variance between the cell categories of menstrual cycle status, F(2,66)=4.47, p<.05. The secondary amenorrheic gymnasts, dance-majors and non-athletes consumed fewer calories from fat than did the oligomenorrheic and regularly cyclic subjects. The Tuckey Honestly Significant Differnec test for multiple comparisons was computed to determine between which menstrual cycle status group the significant difference occurred. All pairwise comparisons for
Table 17

Means and Standard Deviations for Fat Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  Mean</td>
<td>SD</td>
<td>N  Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Regular</td>
<td>16    206.6</td>
<td>72.1</td>
<td>10   224.0</td>
<td>72.7</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5 189.8</td>
<td>80.6</td>
<td>2 29.5</td>
<td>34.6</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10    245.8</td>
<td>92.5</td>
<td>3 141.0</td>
<td>107.5</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31    214.1</td>
<td>15.1</td>
<td>15   131.5</td>
<td>24.2</td>
</tr>
</tbody>
</table>

Note: Fat Intake is presented in calories consumed from fat
Table 18

ANOVA Summary Table for Fat Intake

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>47685.99</td>
<td>2</td>
<td>23842.99</td>
<td>4.24*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>50329.67</td>
<td>2</td>
<td>25164.84</td>
<td>4.47*</td>
</tr>
<tr>
<td>Interaction</td>
<td>53697.00</td>
<td>4</td>
<td>13424.25</td>
<td>2.39</td>
</tr>
<tr>
<td>Error</td>
<td>371242.32</td>
<td>66</td>
<td>5624.08</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>522954.98</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

Table 19

Pairwise Comparisons of Activity Group Means for Fat Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dance-majors</td>
<td>131.5</td>
<td>-</td>
<td>53.04</td>
<td>82.55*</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>184.54</td>
<td>-</td>
<td>-</td>
<td>29.51</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>214.05</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

HSD(.95 g 3,60)=53.77

*p<.05
the amenorrheic, oligomenorrheic and regular groups are summarized in Table 20. The critical value, $HSD(.95 \times 3, 60) = 64.23$, was exceeded by the obtained difference of 86.62 found between the mean fat intakes of the amenorrheic and regular groups. The amenorrheic subjects consumed fewer calories from fat compared to the oligomenorrheic and regularly cycling subjects. No significant interaction effect was found at the .05 level of probability.

Table 20

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Amenorrheic</th>
<th>Oligomenorrheic</th>
<th>Regular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amenorrheic</td>
<td>126.10</td>
<td>-</td>
<td>64.17</td>
<td>86.62*</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>190.27</td>
<td>-</td>
<td>-</td>
<td>23.45</td>
</tr>
<tr>
<td>Regular</td>
<td>213.72</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

$HSD(.95 \times 3, 60) = 64.23$

*p<.05

The average daily caloric carbohydrate intakes are shown in Table 21. The mean daily intake of carbohydrates for the dancers was 351.57 calories. The dance-majors consumed the fewest number of calories from carbohydrates. The results of the ANOVA are presented.
Table 21
Means and Standard Deviation for Carbohydrate Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>542.6</td>
<td>137.1</td>
<td>10</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>645.4</td>
<td>185.1</td>
<td>2</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>541.4</td>
<td>120.3</td>
<td>3</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>576.5</td>
<td>27.3</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: Carbohydrate Intake is presented in calories consumed from carbohydrates.
### Table 22

ANOVA Summary Table for Carbohydrate Intake

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>SS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>349254.66</td>
<td>2</td>
<td>174627.33</td>
<td>9.42*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>31681.25</td>
<td>2</td>
<td>15840.62</td>
<td>0.85</td>
</tr>
<tr>
<td>Interaction</td>
<td>124256.85</td>
<td>4</td>
<td>31064.21</td>
<td>1.68</td>
</tr>
<tr>
<td>Error</td>
<td>1204624.22</td>
<td>66</td>
<td>18532.68</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1709816.97</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

### Table 23

Pairwise Comparisons of Activity Group Means for Carbohydrate Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dance-majors</td>
<td>$x_2 = 351.57$</td>
<td>-</td>
<td>151.93*</td>
<td>224.91*</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>$x_3 = 503.50$</td>
<td>-</td>
<td>-</td>
<td>72.98</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>$x_1 = 576.48$</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

$HSD(.95 \alpha 3,60)=97.60$

*p<.05
in Table 22. A significant difference, \( F(2,66)=9.42, p<.05 \), was found for the main effect of activity group on carbohydrate intake.

The Tuckey Honestly Significant Difference Test for multiple comparisons was computed to determine between which activity groups the significant difference occurred. All pairwise comparisons for gymnasts, dance-majors and non-athletes are summarized in Table 23. The critical value, \( HSD(.95 \% 3,60) = 97.60 \), was exceeded by the obtained difference of 151.93 found between the mean carbohydrate intakes of dance-majors and non-athletes and the obtained difference of 224.91 found between the mean carbohydrate intakes of dance-majors and gymnasts. The dance-majors consumed significantly (\( p<.05 \)) fewer calories from carbohydrates compared to the non-athletes and gymnasts. All groups consumed more calories from carbohydrates than they did from saturated fat and protein.

Analysis of the between cell variance of menstrual cycle status for carbohydrate intake was not significant at the .05 level of probability. Although the statistics were not significant the following trends were observed. The secondary amenorrheic gymnasts consumed more calories from carbohydrates compared to the oligomenorrheic and regularly cycling gymnasts. The secondary amenorrheic dance-majors and non-athletes consumed slightly fewer calories from carbohydrates compared to their oligomenorrheic and regularly cycling counterparts.

The average daily iron intake for activity groups and menstrual cycle status are summarized in Table 24. The average daily iron intake for the three groups was below the recommended daily
<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>8.92</td>
<td>2.28</td>
<td>10</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>11.84</td>
<td>5.53</td>
<td>2</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>8.60</td>
<td>2.94</td>
<td>3</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>9.79</td>
<td>0.65</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: Iron Intake is presented in milligrams
allowance of 18 milligrams. The dance-majors had the lowest mean daily iron intake, of 6.58 milligrams per day. This is only 37% of the recommended daily allowance. Although the gymnasts had the highest daily iron intake of 9.79 milligrams, this is still only 54% of the recommended daily iron intake. The ANOVA for iron intake for activity group by menstrual cycle status, shown in Table 25, revealed that the main effect of activity group on daily iron intake was statistically significant, F(2,66)=3.42, p<.05.

The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which activity groups the significant difference occurred. All pairwise comparisons for iron intake of gymnasts, dance-majors and non-athletes are summarized in Table 26. The critical value, HSD(.95 q 3, 60)= 2.36, was exceeded by the obtained difference between the mean iron intake of dance-majors and gymnasts. The dance-majors consumed significantly (p<.05) less iron compared to the gymnasts.

No significant difference (p<.05) was found for the between cell variance for menstrual cycle status, nor for the interaction effect.

The results of the ANOVAs on the dietary intakes for the main effect of activity group are significantly different (p<.05) for total caloric intake, carbohydrate, fat, protein and iron intake. The research hypothesis that there is a difference between gymnasts, dance-majors and non-athletes for dietary intake was supported and the null hypothesis was rejected.
Table 25

ANOVA Summary Table for Iron Intake

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>72.48</td>
<td>2</td>
<td>36.24</td>
<td>3.42*</td>
</tr>
<tr>
<td>Menstrual Patterns</td>
<td>3.56</td>
<td>2</td>
<td>1.78</td>
<td>0.17</td>
</tr>
<tr>
<td>Interaction</td>
<td>71.01</td>
<td>4</td>
<td>17.75</td>
<td>1.67</td>
</tr>
<tr>
<td>Error</td>
<td>700.43</td>
<td>66</td>
<td>10.61</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>847.49</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

Table 26

Pairwise Comparisons of Activity Group Means for Iron Intake

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dance-majors</td>
<td>6.58</td>
<td>-</td>
<td>2.25</td>
<td>3.21*</td>
</tr>
<tr>
<td>Non-athletes</td>
<td>8.83</td>
<td>-</td>
<td>-</td>
<td>0.96</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>9.79</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.
HSD(.95 $\alpha$ 3,60)=2.36
*p<.05
The results of the ANOVAs on the dietary intakes for the main effect of menstrual cycle status are significantly different \((p<.05)\) for caloric intake and fat intake. The research hypothesis that the subjects with secondary amenorrhea and oligomenorrhea will display different dietary intakes compared to the regularly cycling subjects was supported, thus the null hypothesis was rejected.

**Eating Attitudes**

To investigate the effect of eating attitudes, the following research hypotheses were proposed: (a) There is a difference in the eating attitudes of gymnasts, dance-majors and non-athletes; and (b) there is a difference in the eating attitudes for the secondary amenorrheic, oligomenorrheic and regularly cycling subjects.

The results of the Eating Attitudes Test (EAT) are presented in Table 27. The mean EAT-scores were: 29.19 for the gymnasts, 22.22 for the dance-majors, and 21.47 for the non-athletes. The ANOVA on the EAT-score for the activity groups by menstrual cycle status is shown in Table 28. A significant difference was found for the main effect of activity group, \(F(2,66)=4.23, p<.05\).

The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which activity groups the significant difference occurred. All pairwise comparisons for the mean EAT-score of gymnasts, dance-majors and non-athletes are summarized in Table 29. The critical value, \(HSD(.95 \quad 3,60) = 6.57,\)
<table>
<thead>
<tr>
<th>Group</th>
<th>Gymnasts</th>
<th>Dance-majors</th>
<th>Non-athletes</th>
<th>Menstrual Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Regular</td>
<td>16</td>
<td>18.38</td>
<td>11.12</td>
<td>10</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>5</td>
<td>42.60</td>
<td>8.96</td>
<td>2</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>10</td>
<td>28.10</td>
<td>7.34</td>
<td>3</td>
</tr>
<tr>
<td>Activity Group</td>
<td>31</td>
<td>29.69</td>
<td>1.84</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 28
ANOVA Summary Table for The EAT-score

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>708.69</td>
<td>2</td>
<td>354.34</td>
<td>4.23*</td>
</tr>
<tr>
<td>Menstrual Pattern</td>
<td>2329.07</td>
<td>2</td>
<td>11645.53</td>
<td>13.89*</td>
</tr>
<tr>
<td>Interaction</td>
<td>438.24</td>
<td>4</td>
<td>109.56</td>
<td>1.31</td>
</tr>
<tr>
<td>Error</td>
<td>5534.98</td>
<td>66</td>
<td>83.86</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9010.98</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

Table 29
Pairwise Comparison of Activity Group Means for EAT-score

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Non-athletes</th>
<th>Dance-majors</th>
<th>Gymnasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-athletes</td>
<td>21.47</td>
<td>-</td>
<td>0.75</td>
<td>8.22*</td>
</tr>
<tr>
<td>Dance-majors</td>
<td>22.22</td>
<td>-</td>
<td>-</td>
<td>7.47*</td>
</tr>
<tr>
<td>Gymnasts</td>
<td>29.69</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.
HSD(.95 3, 60)=6.57
*p<.05
was exceeded by the obtained difference of 8.22 found between the mean EAT-scores of non-athletes and gymnasts, and the obtained difference of 7.47 found between the mean EAT-scores of dance-majors and gymnasts. The gymnasts scored significantly (p<.05) higher on the EAT compared to dance-majors and non-athletes. The research hypothesis that there will be a difference in the eating attitudes of gymnasts, dance-majors and non-athletes was supported, thus the null hypothesis was rejected.

Analysis of the main effect of menstrual cycle status on the EAT-score revealed a significant difference, \( F(2,66) = 13.87, p<.05 \). The mean EAT-score for the secondary amenorrheic subjects was 32.37, refer to Table 27. Further analysis of the means by menstrual cycle status revealed that the secondary amenorrheic subjects from each group scored higher on the EAT-score compared to their regularly cycling and oligomenorrheic counterparts. Notably, the mean EAT-score for the secondary amenorrheic gymnasts was 42.6. A score of 30 or more on the EAT indicates abnormal attitudes towards food, dieting, food aversion and body image.

The Tuckey Honestly Significant Difference test for multiple comparisons was computed to determine between which menstrual cycle groups the significant difference occurred. All pairwise comparisons of the amenorrheic, oligomenorrheic and regular groups are summarized in Table 30. The critical value, HSD(.95 \( g 3,60 \)) = 7.84, was exceeded by the obtained difference of 9.66 found between the regular and oligomenorrheic groups, and the obtained difference
Table 30

Pairwise Comparisons of Means by Menstrual Status for EAT-score

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Regular</th>
<th>Oligomenorrheic</th>
<th>Amenorrheic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>15.68</td>
<td>-</td>
<td>9.66*</td>
<td>16.69*</td>
</tr>
<tr>
<td>Oligomenorrheic</td>
<td>25.34</td>
<td>-</td>
<td>-</td>
<td>7.03</td>
</tr>
<tr>
<td>Amenorrheic</td>
<td>32.37</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The obtained differences between means are presented.

HSD(.95 $\times$ 3,60)=7.84

*p<.05

of 16.69 found between the amenorrheic and regular groups. The regularly cycling subjects scored significantly lower on the EAT-score compared to the secondary amenorrheic and oligomenorrheic subjects. The research hypothesis that there will be a difference in the eating attitudes for the secondary amenorrheic, oligomenorrheic and regularly cycling subjects was supported, thus the null hypothesis was rejected.

Summary

In order to describe the regular versus irregular menstruating gymnasts, dancers and non-athletes in relation to dietary intake and eating attitudes, a frequency table was organized. Table 31
describes the regular, secondary amenorrheic and oligomenorrheic subjects in terms of activity group, EAT-score and caloric intake. The subjects were categorized according to the following factors: (a) scoring 30 or above on the EAT, and (b) meeting the recommended daily allowance for calories. The main point to be made from Table 31 is that the secondary amenorrheic gymnasts and dance-majors obtained an EAT-score of 30 or above, and consumed less than the recommended daily allowance of calories.

Table 31

Summary Table of Subjects by Menstrual Pattern in Terms of EAT-Score and Caloric Intake

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regular</th>
<th>Amenorrheic</th>
<th>Oligomenorrheic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnasts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>11</td>
<td>22.45</td>
<td>-</td>
</tr>
<tr>
<td>EAT &lt;30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>2</td>
<td>4.08</td>
<td>-</td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>2</td>
<td>4.08</td>
<td>2</td>
</tr>
<tr>
<td>EAT &gt;30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>1</td>
<td>2.04</td>
<td>3</td>
</tr>
</tbody>
</table>

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Table 31 (Cont'd)

Summary Table of Subjects by Menstrual Pattern in Terms of EAT-Score and Caloric Intake

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regular</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Dance-Majors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>7</td>
<td>14.28</td>
<td>1</td>
<td>11.11</td>
<td>1</td>
</tr>
<tr>
<td>EAT &lt;30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>3</td>
<td>6.12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>22.20</td>
<td>2</td>
</tr>
<tr>
<td>EAT ≥30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-Athletes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>12</td>
<td>24.49</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>EAT &lt;30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>10</td>
<td>20.40</td>
<td>1</td>
<td>11.11</td>
<td>2</td>
</tr>
<tr>
<td>C.I.&lt;RDA</td>
<td>1</td>
<td>2.04</td>
<td>1</td>
<td>11.11</td>
<td>-</td>
</tr>
<tr>
<td>EAT ≥30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.&gt;RDA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: C.I. = Caloric Intake  
RDA= Recommended Daily Allowance  
EAT= Eating Attitudes Test-score
CHAPTER V

DISCUSSION

This study was designed to investigate questions about the incidence of regular menstrual cycles, secondary amenorrhea and oligomenorrhea and the relationship to age at menarche, body composition, dietary status and eating attitudes for female collegiate gymnasts, dance-majors and non-athletes. The incidence and pathology of secondary amenorrhea and oligomenorrhea in athletes and dancers have been investigated and reported previously. Menstrual cycle irregularities observed in athletes have been statistically correlated to body weight and percent body fat (Frisch & McArthur, 1974), intensity of training (Feicht et al., 1978), age at menarche (Malina et al., 1978) and the level of plasma hormones (Bonen & Belcastro, 1978). In a similar way, though less extensively, amenorrhea and oligomenorrhea in athletes have been studied in relation to diet and nutrition (Dale & Goldberg, 1982). The present study attempted to compare and describe those gymnasts, dance-majors and non-athletes with regular menstrual cycles versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, body composition, diet and eating attitudes.

The major questions of this study thus became:

1. Is the incidence of amenorrhea and oligomenorrhea different in collegiate gymnasts, dance-majors and non-athletes?
2. Is there a relationship between secondary amenorrhea and oligomenorrhea, and dietary characteristics in collegiate gymnasts, dance-majors and non-athletes?

3. What are the differences between gymnasts, dance-majors and non-athletes regarding age at menarche, body composition, diet and eating attitudes?

Based on the data gathered, the incidence of secondary amenorrhea and oligomenorrhea was found to be more prevalent in collegiate gymnasts and dance-majors compared to non-athletes. Secondary amenorrhea in athletes involved in aesthetic sports may be related to dietary habits, in order to maintain a lean, linear appearance. In addition, this study highlights the differences between gymnasts, dance-majors and non-athletes regarding age at menarche, percent body fat, diet and eating attitudes.

Menstrual Cycle Status

The first research hypothesis of the present study predicted that the incidence of secondary amenorrhea and oligomenorrhea is greater in female collegiate gymnasts and dance-majors compared to non-athletes. This was in fact the case and is consistent with existing research dealing with the incidence of secondary amenorrhea and oligomenorrhea for different athletic groups. Previously, it has been shown that dancers and athletes are more prone to secondary amenorrhea and oligomenorrhea compared to non-athletes (Malina et al., 1978; Calabrese et al., 1983; Webb et al., 1979). Very few studies have concentrated on gymnasts, and those that have surveyed...
small samples. Webb et al. (1979) surveyed 5 gymnasts competing at the Montreal Olympics; 2 gymnasts reported menstrual irregularities such as missing their period and delayed onset of menarche. A search of the literature found no investigation which surveyed a large sample of active gymnasts older than 18 years. The mean age of the gymnasts surveyed in the present study was 20.35 years and all had been experiencing menses episodes for at least 3 years. Sixteen percent of the gymnasts surveyed were experiencing secondary amenorrhea and 32% of the gymnasts were experiencing oligomenorrhea at the time of the study. It can be inferred from these data that secondary amenorrhea and oligomenorrhea are far more prevalent in gymnasts than the non-athletic control sample.

Previous studies revealed a high incidence of menstrual irregularities in professional ballet dancers, manifested by secondary amenorrhea, oligomenorrhea and delayed onset of menarche (Calabrese et al., 1983). The present study found that 13.33% (2) of the dancers were experiencing secondary amenorrhea and 20% (5) were oligomenorrheic. By contrast, Calabrese et al., (1983) reported secondary amenorrhea in 44% of the professional dancers and oligomenorrhea in 50% of the dancers. Cohen et al. (1982) reported the incidence of secondary amenorrhea and oligomenorrhea in dancers to be 36% and 6% respectively. The incidence of secondary amenorrhea and oligomenorrhea for the collegiate dance-majors surveyed may be lower than professional dancers, yet more prevalent than the non-athletic control group.
Age at Menarche

In an attempt to further understand the menstrual cycle characteristics of the three groups, it was predicted that there would be a difference in the age at menarche of the gymnasts, dancers and non-athletes. As in previous studies, menarche was significantly delayed in the collegiate gymnasts and dancers when compared with the non-athletic control group.

The mean age at menarche for the non-athletes was 13.69 years. Though later than the menarcheal ages reported for American college age women, ranging from 12.20 to 12.65 years (Cagas & Riley, 1970; Anderson, 1965), it is not significantly delayed.

Mean age at menarche for the gymnasts and dancers were 15.21 years and 14.35 years, respectively. The data indicate that the age at menarche of the gymnasts was significantly delayed (p<.05) in comparison with the non-athletes and dance-majors. The age at menarche for the dancer-majors is similar to that previously reported for professional dancers. Cohen et al. (1982) and Calabrese et al. (1983) reported the menarcheal age of professional dancers to be 14.3 years and 14.2 years, respectively. The mean age at menarche for the gymnasts is much later than previous menarcheal data for gymnasts. Malina et al. (1978), and Farmosi (1983) reported the menarcheal age of gymnasts to be 13.21 years and 13.69 years respectively. The difference between previous studies and the present study may reflect the small sample size of the previous studies.
Malina et al. (1978) surveyed 13 gymnasts in comparison to the present study's sample size of 31 gymnasts. The age at menarche for the gymnasts surveyed in the present study is almost identical to the 15.01 years reported for 38 pre-menarcheal trained college athletes (Frisch, 1982a). Malina et al. (1978) suggested that the cause of delayed onset of menarche, in the athletic population, was related to training prior to menarche. This conclusion was based on ex post facto research, therefore a cause and effect relationship cannot be substantiated. Malina (1978; 1981) proposed that natural selection was central to the delay of menarche in certain athletic groups. The physical characteristics associated with delayed maturation in females have been documented by Malina (1978) and the lean, linear physique associated with late maturation is indeed an advantage for success in aesthetic sports.

Frisch (1982a) and Frisch and McArthur (1974) proposed that fatness and optimal nutrition are necessary for the onset of menarche. A critical body weight for height has been associated with menarcheal age by Frisch and McArthur (1974). Closely aligned with the critical weight for height theory is the association between undernutrition and delayed menarche (Frisch, 1983). The age at menarche of girls living in countries where nutrition is not optimal was reported to be older than that observed in developed countries. Sidhu and Grewal (1980) surveyed the menarcheal age of Punjabi girls and found the mean menarcheal age of the Punjabi girls
to be 14.05 years compared to the younger menarcheal age of 12.20 years for American girls reported earlier. Unfortunately none of the explanations of delayed menarche can be supported by this study as training intensity, body weight and nutrition at menarche were not surveyed.

Wakat et al. (1982) investigated the reproductive status of women cross-country runners, and suggested that delayed menarche may offer a suggestion as to why some women develop menstrual irregularities. They have hypothesized that delayed menarche may indicate fragility of the endocrine system, thus late maturers may be more susceptible to menstrual cycle irregularities. The present study does not support Wakat et al. (1982). Indeed, no significant difference (p<.05) was found for age of menarche between the secondary amenorrheic, oligomenorrheic and regularly cycling subjects.

Body Composition

The hydrostatic weighing results revealed the gymnasts to average 17.26% body fat, lower than the 18.24% for the dance-majors and 22.43% for the non-athletes. The gymnasts and dance-majors did not differ significantly (p<.05) for percent body fat; however, both groups were significantly (p<.05) lower for percent body fat compared to the non-athletic control group. The results showed the gymnasts were the leanest group, and the non-athletes were the fattest. None of the groups surveyed equaled or exceeded the average percent body fat of 25% for college age females (Katch &
McArdle, 1973; Sloan, Burt & Blyth, 1962). The non-athletic group, is the only group surveyed to have a percent body fat which approached the reported 25% body fat for the average American college female.

When comparing the data presented in this study to previous studies utilizing hydrostatic weighing of gymnasts, differences were noted. The mean percent body fat of 17.26% for the collegiate gymnasts was greater than the 15.34% reported by Sinning (1978). Although the mean skinfold measurements obtained during the present study were comparable with that obtained by Sinning (1978), the percent body fat measured by hydrostatic weighing was different. The difference was probably due to the method used to determine residual volume. The present study estimated residual volume from vital capacity out of the water. Sinning (1978) employed the nitrogen dilution technique during the underwater weighing procedure. Measuring lung volume at the moment of immersion is an advantage, as no assumptions are made about the amount of air remaining in the lungs at the time of measuring body density. The higher percent body fat obtained for the gymnasts of the present study may be attributed to the protocol used to estimate residual volume, and the assumption that a full expiration was made at the time of the underwater weighing.

The mean percent body fat of 18.24% for the dancers is greater than the 16.9% fat reported by Calabrese et al. (1983) and 12.86% body fat reported by Cohen, Potasnak, Frank and Baker (1985) for professional ballet dancers. The differences probably reflect
methodological differences, the standard and intensity of training, and the degree of dedication to dance. The college dance-majors trained, on the average, 5 days per week for 4.9 hours per day. In comparison the professional dancers reported by Schantz and Astrand (1984) trained at least 6 days per week for 7.5 hours per day.

Frisch (1982a) suggested that the etiology of secondary amenorrhea and oligomenorrhea of athletes is due to a critical body weight/lean body mass ratio. While some studies on menstrual cycle dysfunction support the critical body weight theory (Frisch, Wyshak & Vincent, 1980; Cohen et al., 1982), other studies do not provide support (Calabrese et al., 1983; Plowman & McSwegin, 1981).

When the percent body fat for the regular, secondary amenorrheic and oligomenorrheic subjects were compared, no significant difference (p<.05) was found. In addition, regular menstrual cycle patterns were reported by gymnasts and dancers with extremely low percent body fat. As such, the present study does not support the theory that a critical body weight for height ratio is necessary for the maintenance of menstrual cycle function.

The lower percent body fat observed for the gymnasts and dancers compared to the non-athletes can be explained in terms of training and diet. Contingent with the increased energy demand of gymnastics and dance training, the gymnasts and dancers as a whole consumed equal or fewer calories per day compared to the non-athletes. The combination of more physical activity and fewer calories would enable the gymnasts and dance-majors to attain and maintain a low percent body fat.
Diet

Analysis of the 5 day dietary diary revealed significantly different (p<.05) dietary intake patterns between the gymnasts, dance-majors and non-athletes. Comparison of group means for daily caloric, carbohydrate, protein, fat and iron intakes revealed significant differences (p<.05) for the aforementioned nutrients. The dance-majors consumed significantly (p<.05) fewer calories per day compared to the gymnasts and non-athletes. Carbohydrate, fat, protein, and iron intakes were significantly (p<.05) lower for the dance-majors compared to the gymnasts and non-athletes. The gymnasts and non-athletes did not differ significantly for protein, fat, carbohydrate and iron intakes. The major point from the dietary data is that those individuals committed to 3 to 4 hours of physical training per day consumed equal or less calories per day compared to their sedentary controls. This indicates that a caloric deficit may exist in the dance-majors and gymnasts.

The mean daily iron intake of gymnasts, dance-majors and non-athletes was found to be 9.79, 6.58 and 8.83 milligrams, respectively. This was well below the recommended daily allowance of 18 milligrams per day for post-menarcheal females. Sub-optimal intake of dietary iron is not uncommon in post-menarcheal females. Indeed, iron deficiency afflicts approximately 25% of college age women in the United States (Scott & Pritchard, 1973). The Committee on Iron Deficiency (1968) attributed the high incidence of iron
deficiency to three factors: (a) a low dietary intake of iron; (b) menstrual blood loss; and (c) limited iron absorption. Haymes (1973) reported that iron deficiency may be higher among women athletes. The results of the present study provides limited support for this view. The gymnasts and dancers consumed 9.79 and 6.58 milligrams of iron per day: this low iron intake is further complicated by an increased need for iron as a result of physical exercise (Yoshimura, 1970).

Although a number of nutritional investigations have been done on dancers and marathon runners, no substantial nutritional survey could be obtained for collegiate gymnasts. Dale and Goldberg (1982) investigated the relationship between nutrition and menstrual cycle status in marathon runners. The major finding of Dale and Goldberg (1981) indicated that those individuals participating in vigorous training consumed more calories per day compared to the sedentary controls, however, the increased caloric intake was not sufficiently high to pay for the caloric cost of the exercise program. Dale and Goldberg (1982) concluded that a caloric deficit may exist for the marathon runners.

Previous studies of the nutritional patterns of dancers, by Calabrese et al. (1983) and Cohen et al. (1982), reported sub-optimal nutrient intakes. This is consistent with the observations for the dance-majors in the present study. The
dance-majors consumed the lowest daily intakes of calories, protein, fat, carbohydrates and iron.

A relationship between nutrition and reproductive function was reported by Frisch (1982b). Female populations of undernourished societies tended to reach menarche 2 to 3 years later and experienced a shorter reproductive life-span compared to females from well nourished societies (Frisch, 1982b). Other conditions such as post-partum infertility and amenorrhea due to anorexia nervosa further suggest a close relationship between nutrition and reproductive function (Frisch, 1982b).

Examination of the daily caloric, protein, fat, carbohydrate and iron intakes for the main effect of menstrual cycle status, showed significant differences (p<.05) for caloric and fat intake. As a whole, the amenorrheic groups consumed fewer calories and fat per day compared to the regularly cycling subjects.

A significant interaction effect was found at the .05 level of probability for caloric intake. The amenorrheic and oligomenorrheic dance-majors consumed fewer calories than the regular cycling dance-majors, gymnasts and non-athletes. Although the secondary amenorrheic gymnasts consumed more calories per day compared to the secondary amenorrheic non-athletes, 4 of the 5 secondary amenorrheic gymnasts consumed fewer calories per day than indicated by their recommended daily allowances. The sub-optimal caloric intake and the low percent body fat indicate that the gymnasts may be using more calories than they are consuming. The gymnasts may be experiencing a caloric deficit.
Secondary amenorrhea associated with simple weight loss and anorexia nervosa, has been related to hypothalamic dysfunction (Vigersky et al., 1977). Whether the hypothalamic dysfunction was due to weight loss per se or undernutrition is unclear. Katz et al. (1978) observed that anorexia nervosa patients who gained weight but retained their abnormal eating behaviors continued to show signs of hypothalamic dysfunction and secondary amenorrhea. It may be inferred from the data of the present study that dietary restriction and sub-optimal nutrition may be contributing factors in the incidence of secondary amenorrhea in gymnasts and dance-majors.

EAT-score

In order to determine the subjects' attitudes toward diet, food, body image and clandestine behavior, the Eating Attitudes Test was employed. A statistically significant difference (p<.05) was found between the groups. The EAT-score was highest for the gymnasts, second highest for the dance-majors and lowest for the non-athletes. An EAT-score of 30 or above indicates abnormal eating attitudes such as that observed in anorexia nervosa patients.

The mean EAT-score of 21.47 obtained for the non-athletic control group was within normal limits for college females (Garner, Olmsted, Bohr and Garfinkel, 1982). The gymnasts scored significantly higher than the non-athletes and dance-majors; this indicates more concern for weight control and fear of being overweight.
A review of the questionnaires indicated that the majority of the dance-majors and gymnasts were obsessed with the desire to be thinner, engaged in dietary control and feared being overweight. Although most subjects did not display the classic emaciation of anorexia nervosa patients, the gymnasts and dancers may be part of the sub-group of chronic dieters who display abnormal eating attitudes without the excessive weight loss. Bruch (1973) has called this group "thin-fat" people.

The higher EAT-score observed for the gymnasts and dancers was probably due to the emphasis placed on thinness for efficiency and aesthetic purposes. Of the three activity groups, the gymnasts as a whole were more concerned with the need to be thinner, as was reflected by the high EAT-score. In view of the dietary information and the EAT-scores collected it may be inferred that the gymnasts are a high-risk population for abnormal eating attitudes and behaviors.

The results of the EAT-score provide further insight concerning the relationship between diet and reproductive functioning. The secondary amenorrheic gymnasts and dance-majors obtained a mean EAT-score of 42.6 and 29.0, respectively. Indeed, the 5 secondary amenorrheic gymnasts, and 1 secondary amenorrheic dance-major obtained an EAT-score above 30. These abnormally high EAT-scores reflect an obsession with dietary control, an abnormal body image, inconsistent eating patterns and a fear of being overweight. On reviewing the dietary diaries of the amenorrheic gymnasts and
dancers, it could be observed that they engaged in behaviors such as skipping meals, one day binging followed by one day starvation and eating similar food day after day.

It is unclear whether the concern for diet and weight control is a behavior/attitude that reflects the expectation and social structure of gymnastics and dance, or whether individuals with such predispositions continue to be involved in the activities for social acceptance and positive reinforcement of their behavior and attitudes.

Although the EAT-scores of the secondary amenorrheic gymnasts and dance-majors were high, no relationship was observed between abnormal eating attitudes and nutritional intake. A possible reason for this may be that the dietary diary acted as a monitor for their food intake and the subjects need to deny their behavior to others (Garner & Garfinkel, 1979). Further research is obviously needed to substantiate this statement.
CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study investigated the incidence of regular menstrual cycles, secondary amenorrhea and oligomenorrhea in female collegiate gymnasts, dance-majors and non-athletes. In addition, this study described those individuals, in each group, with regular menstrual cycles versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, dietary status, eating attitudes and body composition.

Thirty-one gymnasts, 15 dance-majors and 29 non-athletes were surveyed. Menstrual cycle characteristics were surveyed using a questionnaire. The dietary attitudes were surveyed using the Eating Attitudes Test (EAT). Garner and Garfinkel (1979) reported the concurrent validity of the EAT as R=.72 (p<.0001). Dietary status was determined from a 5 day dietary diary and body composition was measured by hydrostatic weighing. Statistical analysis of menstrual cycle status was performed using a Chi-square contingency table. Statistical comparison of the activity groups by menstrual cycle status for age at menarche, percent body fat, caloric intake, carbohydrate, protein, fat, iron intake and EAT-scores were performed by Analysis of Variance (ANOVA). The Tuckey Honestly
A significant difference test was used for all pairwise comparisons. The significance level was set at .05.

A significant difference ($p<.05$) was found for the main effect of activity group on the frequency of regular menstrual cycles, secondary amenorrhea and oligomenorrhea. The gymnasts reported the highest incidence of secondary amenorrhea (16%) and oligomenorrhea (32%). Analysis of the subjects' menstrual cycle characteristics reveals normal trends for duration and interval of the cycle.

A significant difference ($p<.05$) was found for the main effect of activity group on the variables of age at menarche, percent body fat, daily caloric intake, carbohydrate, protein, fat and iron intakes and EAT-scores. The menarcheal age of the gymnasts was significantly ($p<.05$) delayed compared to the dance-majors and non-athletes. The caloric intake, carbohydrate, fat, protein and iron intakes of the dance-majors were significantly lower than the non-athletes and gymnasts. The gymnasts scored significantly higher on the EAT compared to the non-athletes and dance-majors. Notably, the mean EAT-score for the gymnasts was 29.69.

Statistical analysis of the main effect of menstrual cycle status showed a significant difference ($p<.05$) for caloric intake, fat intake and eating attitudes. The amenorrheic subjects consumed significantly less calories and fat, and scored significantly higher on the EAT compared to the regularly cycling subjects. The mean EAT-score for the amenorrheic subjects was 32.37. A score of 30 or above on the EAT indicated abnormal eating attitudes.
A significant interaction effect between activity group by menstrual cycle status for caloric intake was found at the .05 level of probability. The secondary amenorrheic and oligomenorrheic dance-majors consumed fewer calories per day compared to the regular, secondary amenorrheic and oligomenorrheic gymnasts and non-athletes.

A summary table describing the regular versus secondary amenorrheic and oligomenorrheic gymnasts, dance-majors and non-athletes in relation to dietary status and eating attitudes revealed that the secondary amenorrheic gymnasts and dance-majors obtained an EAT-score of 30 or above and consumed fewer calories than their individual recommended daily caloric intake.

Conclusions

The problem under investigation was to determine the incidence of regular menstrual cycle patterns, secondary amenorrhea and oligomenorrhea for collegiate female gymnasts, dance-majors and non-athletes and the relationship to age at menarche, percent body fat, dietary status and eating attitudes. The major findings of this study can be divided into the following two categories:

1. A description of the incidence of menstrual cycle irregularities, age at menarche, body composition, dietary status and eating attitudes of collegiate gymnasts, dance-majors and non-athletes.

2. A description of those individuals in each activity group
with regular versus secondary amenorrhea and oligomenorrhea in relation to age at menarche, body composition, dietary status and eating attitudes.

The conclusions of this study will be presented in two parts.

Menstrual cycle irregularities defined as secondary amenorrhea and oligomenorrhea occur at a significantly higher frequency in collegiate gymnasts and dance-majors compared to non-athletes. It may be inferred from the data that the collegiate gymnastic population sampled is a high risk group for secondary amenorrhea and oligomenorrhea. The collegiate dance-majors are a moderately high risk group with respect to secondary amenorrhea and oligomenorrhea.

The data indicate that the groups who experience a high incidence of secondary amenorrhea and oligomenorrhea display certain characteristics that may contribute to the increased frequency of reproductive dysfunction. The following characteristics significantly differentiated (p<.05) the collegiate gymnasts, dance-majors and non-athletes:

1. Age at menarche was significantly (p<.05) delayed in the collegiate gymnasts beyond that of the dance-majors and non-athletes.

2. Percent body fat was significantly different (p<.05) for the collegiate gymnasts, dance-majors and non-athletes. The gymnasts measured lowest for percent body fat.

3. The caloric intake was lowest for the dance-majors, while the mean caloric intake of the gymnasts was comparable to the non-
athletes. Considering the greater energy expenditure for physical training experienced by the gymnasts compared to the non-athletes, a caloric deficit may exist for the gymnasts. This caloric deficit would enable the gymnasts to maintain a lower percent body fat which the data reflected.

4. Protein, fat and carbohydrate intake of the gymnasts was comparable to that of the non-athletes. The dance-majors obtained the lowest intake of fat, carbohydrates and protein and iron.

5. The gymnasts, dance-majors and non-athletes consumed less than the recommended daily allowance for iron.

6. The most significant difference between the gymnasts, dance-majors and non-athletes was reflected in the EAT-score. This suggests that the gymnasts were concerned about diet and weight control.

The findings of this study that seem particularly useful, as they describe those individuals with regular menstrual cycles versus secondary amenorrhea and oligomenorrhea, relate to dietary status and eating attitudes. Previous studies have suggested that women who are involved in strenuous physical training experience "exercise-induced" amenorrhea (Bonen, 1983); however, the results of this study suggested that sub-optimal nutrition and abnormal eating attitudes may be contributing factors in the secondary amenorrhea experienced by gymnasts and dance-majors.

No significant differences (p<.05) were found between the regularly menstruating group, the secondary amenorrheic group and
the oligomenorrheic group with respect to age at menarche, percent body fat, protein intake, carbohydrate intake and iron intake.

A significant interaction was found for caloric intake. Caloric intake was lowest for the secondary amenorrheic dance-majors. The secondary amenorrheic gymnasts and non-athletes consumed fewer calories compared to their regularly cycling counterparts. This suggests that the secondary amenorrheic females were engaging in a low calorie diet. A low calorie diet has been related to hypothalamic dysfunction in spite of a normal body weight (Russell & Bearlwood, 1970).

The findings of this study that seemed most alarming relate to the EAT-score which screens for abnormal eating attitudes. The secondary amenorrheic gymnasts, dance-majors and non-athletes scored above the mean score for college age women reported by Garner et al. (1982). All of the secondary amenorrheic gymnasts scored above 30 on the EAT-score. This indicates that the secondary amenorrheic gymnasts may be a high risk group for anorexia nervosa, although caution must be taken in labelling women as such. Furthermore, considering the sub-optimal caloric intake of the secondary amenorrheic gymnasts and dance-majors combined with the above average EAT-score, the secondary amenorrhea experienced by the gymnasts and dance-majors may be of the type defined as hypothalamic chronic anovulation; this is experienced during anorexia nervosa and malnutrition (Loucks and Horvath, 1985). To substantiate such a
diagnosis, endocrinological and gynecological examinations would have to be performed.

No clear pattern was found for the oligomenorrheic subjects with respect to age at menarche, body composition, diet or eating attitudes, although they did score higher than normal on the EAT and had slightly lower percent body fat. It cannot be stated that the oligomenorrhea is a mild form of secondary amenorrhea or a mutually exclusive condition. Further study is indicated.

Recommendations for Further Study

This study indicated that secondary amenorrhea in gymnasts and dancers is related to dietary status and eating attitudes. What appears to be needed at this point is a combined endocrinological and dietary study of these two groups. This would further clarify whether the secondary amenorrhea observed in gymnasts and dancers is due to exercise per se versus nutrition and eating attitudes.

In order to fully understand the impact of diet and dietary status on reproductive function in female athletes, an experimental design utilizing a manipulation of diets, and physiological and endocrinological monitoring over an extended period of time is needed. Such a study would be difficult due to the commitment needed by the subjects and the modification of human behavior; however, it would definitely add to the present knowledge and understanding of reproductive function and its relationship to nutrition.
An investigation into the eating attitudes and behaviors of gymnasts and dancers is also indicated by the present study. What appears needed at this point is both a cross-sectional and longitudinal study of gymnasts and dancers at various levels. A longitudinal study could trace girls who enter gymnastics and dance to determine whether eating attitudes are influenced by the social expectations of the dance and gymnastic worlds, or whether individuals with a predisposition to excessive dieting, weight control and low body image enter and remain in activities which emphasize linearity and a lean body image.
MENSTRUAL CYCLE STATUS, BODY COMPOSITION AND DIETARY CHARACTERISTICS OF FEMALE COLLEGIATE GYMNASTS, DANCERS AND NON-ATHLETES

INFORMED CONSENT FORM

I understand that:

1. I am participating in a study which is investigating the relationship between menstrual cycle irregularities and dietary characteristics.
2. I will be asked to be underwater weighed and complete surveys related to dietary attitudes and menstrual characteristics.
3. The information I supply will be used for the purpose of the study and my name will not appear in the text of the study or elsewhere in relation to this study.
4. The information will be retained by the Department of Health, Physical Education and Recreation, Western Michigan University and will not be released for any purpose other than the investigation.

I have carefully read the above, understand the purpose of the study, and the activities I will be asked to undertake during the data collection. I agree to participate in the study.

Signed: __________________________ Date: ____________
APPENDIX B

Menstrual Cycle Pattern Questionnaire
QUESTIONNAIRE

NAME: ______________________________________

AGE: ______

AGE WHEN TRAINING BEGAN? __________________________

HOW MANY HOURS DO YOU TRAIN PER DAY? ______

Please place an X beside the response which best applies to each of the numbered questions. All the results will be strictly confidential. Most of the questions directly related to menstrual cycle pattern. Please answer each question carefully. Thank you.

1. Are you presently taking oral contraceptives?  yes  no

2. A. Have you ever taken oral contraceptives? yes no

2. B. When were you taking the oral contraceptives?
   within the past 6 months
   6 to 12 months ago
   1 to 2 years ago
   more than 2 years ago

3. A. Age when menses began? _____ yrs. _____ mths.

3. B. I would describe my early menstrual cycle as: regular__

   irregular__

4. Age at which period became regular: 9 years or under ____
   10-13 years ___
   14-17 years ___
   over 17 years ___
   still not regular ___

5. Average interval of early menstrual periods (i.e. interval between each menses):
   less than 21 days ___
   21-24 days ___
   25-30 days ___
   21-30 days ___
   over 30 days ___

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6. Average duration of early menses (bleeding):
   less than 3 days ___
   3 to 6 days ___
   upto 8 days ___
   over 8 days ___

7. Average loss of blood of early menses: heavy ___
    moderate ___
    slight ___
    varying ___

CHARACTERISTICS OF RECENT MENSTRUAL CYCLE

8. At present I would describe my menstrual cycle as:
   regular ____
   irregular ___

If you answered irregular go to question 10.

9A. Average interval between each menstrual period:
   less than 21 days ___
   21-24 days ___
   25-30 days ___
   21-30 days ___
   over 30 days ___

9B. Average duration of menses (bleeding):
   less than 3 days ___
   3 to 6 days ___
   upto 8 days ___
   over 8 days ___

9C. Average loss of blood during each menses:
   heavy ___
   light ___
   moderate ___
   varying ___

10A. When your menstrual period is fairly regular, what is the
    average interval between each menses:
    less than 21 days ___
    21-24 days ___
    25-30 days ___
    over 30 days ___
    do not know ___
10B. What is the duration of menses (bleeding) when your cycle is regular:
- less than 3 days ___ 
- 3 to 6 days ___ 
- upto 8 days ___ 
- over 8 days ___ 

10C. Average loss of blood during each menses:
- heavy ___ 
- light ___ 
- moderate ___ 
- varying ___ 

12. Have you ever missed your period? yes ___ no ___

If your answer to question 12 was no go to question 14.

13A. Have you missed your period in the last 6 months? yes ___ no ___

13B. How many times have you missed your period?
- once ___ 
- 2-3 times ___ 
- more than 3 times ___ 

13C. Have you experienced an absence of your period for more than 6 weeks but less than 3 months? yes ___ no ___

13D. Have you recently (within the past 6 months) experienced this condition? yes ___ no ___

13E. Have you ever experienced an absence of your period for more than 3 months? yes ___ no ___

13F. Have you recently (within the past 6 months) experienced this condition? yes ___ no ___

13G. To what do you attribute the absence of your period?
- emotional stress ___ 
- weight loss ___ 
- physical training ___ 
- other ___ 
- Unsure ___ 

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13H. When do you experience this condition?
   exam period __
   heavy training/rehearsal __
   performance/competition __
   other __

14. Do you gain weight 1 to 7 days before your period?
   yes __
   no __

15. Do you experience pre-menstrual tension?
   yes __
   no __

If you answered no to question 15 go to question 17.

16. How would you describe the pre-menstrual tension?
   severe __
   moderate __
   varying __
   light __

17A. Do you experience a change in the level of hunger 1 to 7 days before your period?
   yes __
   no __

17B. Do you experience a change in the level of hunger during your period?
   yes __
   no __

17C. How would you describe the change in the feeling of hunger?
   severely increases __
   increases __
   decreases __
   severely decreases __

18A. Do you experience a change in the type of foods you want to eat 1 to 7 days prior to your period?
   yes __
   no __

18B. Do you experience a change in the type of foods you want to eat during your period?
   yes __
   no __

18C. Do you have cravings for food prior to your period?
   yes __
   no __
19. What type of food do you want to eat prior to your period?
   Fruit/Vegetables ___
   Sugar/candy ___
   Carbohydrates/starch ___
   Meat ___
   Dairy food ___
   Anything/everything ___
APPENDIX C

Eating Attitudes Questionnaire
QUESTIONNAIRE

EATING ATTITUDES TEST

Please place an (X) under the column which applies best to each of the numbered statements. All the results will be strictly confidential. Most of the questions directly relate to food or eating, although other types of questions have been included. Please answer each question carefully. Thankyou.

1. Like eating with other people.
2. Prepare foods for others but do not eat what I cook.
3. Become anxious prior to eating.
4. Am terrified about being overweight.
5. Avoid eating when I am hungry.
6. Find myself preoccupied with food.
7. Have gone on eating binges where I feel that I may not be able to stop.
8. Cut my food into small pieces.
9. Aware of the calorie content of foods that I eat.
10. Particularly avoid foods with a high carbohydrate content (e.g. bread, potatoes, rice, etc.)
11. Feel bloated after meals.
12. Feel that others would prefer if I ate more.
13. Vomit after I have eaten.
14. Feel extremely guilty after eating.
15. Am preoccupied with a desire to be thinner.
16. Exercise strenuously to burn off calories.
17. Weigh myself several times a day.
18. Like my clothes to fit tightly.
20. Wake up early in the morning.
21. Eat the same foods day after day.
22. Think about burning up calories when I exercise.
23. Have regular menstrual periods.
24. Other people think that I am too thin.
25. Am preoccupied with the thought of having fat on my body.
26. Take longer than others to eat my meals.
27. Enjoy eating at restaurants.
28. Take laxatives.
29. Avoid foods with sugar in them.
30. Eat diet foods.
31. Feel that food controls my life.
32. Display self control around food.
33. Feel that others pressure me to eat.
34. Give too much time and thought to food.
35. Suffer from constipation.
36. Feel uncomfortable after eating sweets/candy.
37. Engage in dieting behavior.
38. Like my stomach to be empty.
39. Enjoy trying new rich foods.
40. Have the impulse to vomit after meals.

(Garner & Garfinkel, 1979)


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Malina, R. M., Spriduso, W. W., Tate, C. & Baylor, A. M. (1978). Age at menarche and selected menstrual characteristics in athletes at different competitive levels and in different sports. Medicine and Science in Sports and Exercise, 10(33), 218-222.


