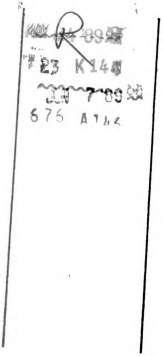

AGE AT MENARCHE OF SWIMMERS AND TRACK AND FIELD ATHLETES

By

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ABSTRACT

AGE AT MENARCHE OF SWIMMERS
AND TRACK AND FIELD ATHLETES

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This investigation was undertaken to determine the effects of participation in swimming or track and field training on the age at menarche of young women. Subjects for this study were obtained from two Olympic Development Program training camps. One training camp was composed of swimmers, while the other was composed of track and field athletes.

An individual interview was conducted with each subject in order to determine the age at menarche. Each subject was asked to recall her age at menarche to the nearest one-quarter of a year.

The age at menarche of both groups of subjects were normally distributed. The age at menarche of the swimmers was significantly later than that of the U. S. norm. The age at menarche of the track and field athletes was also significantly later than that of the U. S. norm. There was no significant difference between the two groups of subjects.

To my parents for their
love and support

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CHAPTER I

THE PROBLEM

The participation of women in intense training regimens has escalated in the past few years. With such a rapid increase in a short time-span, the exact physiological responses of the female to a stressful activity program are only now being discovered. Of especial interest are the effects of rigorous training on the female reproductive system.

With sports training at the intense level it has now reached, it is imperative that the direct and indirect physiological effects of exercise, both immediate and chronic, be known. In this way, problems resulting from activity may be predicted and avoided. If the possibility of serious impairment exists, as a result of intense exercise, then the participants should be aware of the potentialities.

The element of interest in this study has only recently come under close scrutiny. The linkage of a delay in the attainment of menarche with intensive training has been tentatively suggested and is currently being more thoroughly investigated.

It has been shown that menstrual disruptions may occur as a result of extreme physical and psychological stress, a low percentage of body fat, or a disorder of hormone levels. The phenomenon in athletes has been hypothesized to be the result of a combination of all three (9). However, current research has been more concerned with the clarification of the existence of a menstrual dysfunction in athletes, and the actual mechanism has yet to be resolved. This lack of information is understandable considering the recent increase in the intensity and duration of training for women. The proven existence of a menstrual dysfunction could lead to further questions regarding its causes and possible chronic effects.

As far back as 20 years ago, physicians and gynecologists declared that participation in physical activity during the menstrual period itself is not detrimental to females (34). The current data, taking a slightly different view, has shown that athletes often attain menarche at a later age than non-athletes (29, 31). Other studies have noted that athletes, especially those involved in endurance training, experience fewer menstrual periods per year than do controls (9, 10). Differences in the normal levels of certain hormones have been observed in subjects participating in exercise programs (9, 10); and, in one study, it was noted that athletes had lighter menstrual flow and fewer cramps (10). A further major area to be investigated is the effect of intense exercise upon the

body's future reproductive capacity.

Need for the Study

With increasing numbers of young women participating in heavy training programs, the effects of intense exercise upon the menstrual cycle should be known. The possibility of some future disruption of the reproductive system, or a chronic abnormality, is reason enough for critical examination of current trends. With the lack of research in this area, clearer insight into any existing problem would be valuable.

Statement of the Problem

The purpose of this study was to determine the effects of swimming or track and field training programs on the age at menarche. An interview method was devised to elicit the information deemed relevant to the study. The subjects were swimmers and track and field athletes, who were members of the United States Olympic Development Program in 1979. Consequently, a number of highly trained athletes from a diversity of training programs were surveyed.

Research Hypothesis

The research hypothesis that was tested in this study was that female participants in an intense training program will attain menarche at a significantly later age than the norm reported for U. S. women by the National

Center of Health Statistics for the United States (32).

Research Plan

The subjects for this study were participants in the 1979 United States Olympic Development Program. The data collection was included in extensive training-camp protocols designed to obtain a variety of information. Sixty subjects were swimmers; eighteen subjects were track and field athletes.

The data for the study were procured by means of an interview administered to the subjects. The primary purpose of the interview was to determine the age at menarche and the number of menstrual periods each subject experienced per year. Supplementary information regarding training, experience, competitive levels, and physical measures was obtained but was not used in this investigation.

Rationale

The potential serious implications of early menstrual dysfunction include the possibility of a future disruption in reproductive capacity. For this reason, the present study was conducted to determine if a delay in menarche is associated with participation in programs of intense exercise. However, no attempt was made to relate the findings to later reproductive function.

Olympic development athletes were chosen as subjects in this study because of their high quality of athletic performance and, therefore, their participation in strenuous

training programs. Two different sports, track and field and swimming, were included in order to get more complete insight into the effects of different types of activities.

An interview method of data collection was used because of the ability of the interviewer to clarify questions and responses.

Limitations

1. The results of this study can be applied only to swimmers and to track and field athletes.

2. There was no control over the training in which each subject participated. In fact, the athletes studied were products of a wide variety of training programs. Certain training regimens may be more likely to produce a delay in menarche than others.

3. The subjects were residents of a number of states, and no attempt was made to obtain a geographically representative sample. Environmental and other unknown biases may have affected the results.

4. The data collection required the subjects to recall and estimate ages and dates. The responses of subjects may have been inexact and, therefore, the results may have been biased in one direction or another.

5. All of the swimmers were white, while most of the track and field subjects were black. Therefore, racial biases may have affected the results.

Significance of the Study

The demonstration of a delay in menarche with the presence of intense training regimens may pave the way for further study in this area. The short-term and long-term effects of heavy training on the reproductive system may be ascertained, and further problems with the menstrual functions of future athletes may be predicted and perhaps alleviated.

In addition, further insight into the physiological adaptations of the body to the stress of exercise may be gained. Future investigations may lead to improvements in training programs which could result in higher quality athletic performances.

Definition of Terms

Amenorrhea--abnormal absence of menstruation

Dysmenorrhea--the occurrence of pain with menstruation in the form of abdominal cramps

Menarche--time of the first menstruation marking the beginning of the menstrual function

Premenstrual syndrome/symptoms--the occurrence of dysmenorrhea, backaches, and/or headaches directly preceeding or coinciding with menstruation

CHAPTER II

REVIEW OF RELATED LITERATURE

A few studies have been conducted to determine the age at menarche in athletes. Of those studies which have been reported, most were completed within the last 10 years.

Malina (29) reported in 1973 that a group of college-age track and field athletes had a significantly later age at menarche than did college non-athletes of the same age. The mean age at menarche for athletes was 13.58 years, while that of the non-athletes was 12.23 years.

In a later study Malina (31) compared the age at menarche of athletes at different competitive levels and in different sports. High school, college, and Olympic-level athletes were included as subjects in such sports as basketball, volleyball, swimming, tennis, gymnastics, golf, and track. The results of the study indicated that the athletes attained menarche at a significantly later age than the non-athletes. In addition, the Olympic-level athletes attained menarche at a significantly later age than the high school and college athletes. Malina hypothesized that "the physique characteristics associated with later maturation in females are perhaps more suitable for successful athletic performance." Malina further linked the socialization

process to the phenomenon of a late age at menarche in athletes by suggesting that the early-maturing female could be socialized away from athletics by peer-related factors.

In a study of athletes at the 1976 Montreal Olympic Games, Malina (27) found that the athletes, on the average, had a later age at menarche than the general populations of their countries. It was noted that, of all the athletes surveyed, the swimmers attained menarche earliest. A mean age at menarche of 13.10 years was reported for the swimmers, as compared to the overall mean for the athletes of 13.66 years.

Other studies have reported no significant differences in age at menarche between controls and athletes (9, 10, 30). Furthermore, in contrast to some of the more-recent studies, Astrand (3) reported in 1963 that a group of Swedish swimmers attained menarche at a mean age of 12.88 years which was early compared with the ages at menarche obtained from other studies of Swedish schoolgirls.

Exercise and Menstruation

Other alterations in the menstrual cycle, besides that involving the age at menarche, have been reported. Erdelyi (14) has recently stated that athletes training in strenuous sports such as rowing have high incidences of amenorrhea and irregular menstruation.

In another recent study, Dale (9) found that women

participants in endurance-running programs had significantly fewer menstrual periods per year than did other athletes and sedentary controls. Differences in the serum hormone levels between runners and non-runners were also obtained. These results were complicated, however, by the subjects' use of contraceptives (9).

In a survey of women participants in endurance training, Dale (10) found that the females who had been training the most intensely, and for the longest time, had fewer menstrual periods than did other athletes and controls. In addition, the women runners in the study had significantly lighter flow and fewer cramps than did the controls. Dale concluded that "menstrual dysfunction appears to be a real phenomenon in long-distance runners." Dale attributed the menstrual disturbances to the possible influences of training schedules, competitive events, intensity of training, loss of total body weight, and a low average percentage of body fat.

Some early incidences of menstrual disruption with training have been noted. In a survey of 65 women athletes who participated in the Tokyo Olympics, four subjects reported irregular cycles, and one 19-year-old participant in track and field did not menstruate at all. In addition, five of the subjects had intervals of more than 31 days between menstrual periods. It was further noted that changes in the menstrual cycle and menstrual period as a result of training occurred in 41% of the subjects. It was

concluded, however, that the menstrual cycle and period were normal for this group of athletes, as were any disturbances (41).

Astrand (3) surveyed a group of Swedish girl swimmers and found that 2 of the 27 subjects who had reached menarche had a prolonged interval between menstrual periods when engaged in intense training. Another subject reported more-frequent menstruations.

Erdelyi (13) found, in a survey of female Hungarian athletes, that 16% of the subjects noted some change in the menstrual cycle with participation in sports competition. It was further stated that these changes occurred most often in athletes who were 15 - 17 years of age.

In contrast, Malina (31) compared the occurrence of dysmenorrhea and irregularity of menstruation in non-athletes, college athletes, and Olympic volleyball players and found no significant differences between the groups.

The American College of Sports Medicine (1) concedes in an opinion statement that disruption of the menstrual cycle is a common problem for female athletes. However, the statement also includes the observation that no indication of harm to the female reproductive system has been shown.

Age at Menarche

Various studies have been conducted to determine the mean age at menarche in certain geographical areas and

at different points in time. It has been concluded from medieval sources that the probable age at menarche ranged from 12 to 15 years of age during the 6th to the 15th century A. D. (2).

Recent studies conducted in a variety of countries report more-precise ages at menarche ranging from 12.40 years to 13.16 years (6, 7, 8, 12, 20, 22, 25, 26, 33, 40). In 1973 the United States Department of Health, Education, and Welfare reported that the mean age at menarche for U. S. females was 12.76 years (32).

In addition, further evidence indicates a decline in age at menarche over the span of a generation. Damon (12) conducted a longitudinal study in which the ages at menarche of the mothers was 14.38 years while that of the daughters was 12.88 years. Wildholm (37) found that the mean age at menarche of Finnish girls in 1969 was 13.16 years while that of the mothers of the subjects was 13.88 years.

Body Fatness

The percentage of body fat has been hypothesized to be an influencing factor in menstrual function. Wilmore (38) suggested that amenorrhea may be a consequence of low total body weight and lowered levels of body fat. He also observed that menstruation usually returns after the subject under consideration decreases training intensity.

Malina (28) observed that controls have more body fat and are broader in build than are track and field

athletes. This may be conceived as evidence of a characteristic of athletes which could lead to menstrual disturbances.

Amenorrhea is regarded as a characteristic feature of the disorder anorexia nervosa which involves severe weight loss (36). This information further corroborates a linkage between body fat and menstrual dysfunction. Simple weight loss has been conpared with anorexia nervosa, and the suggestion has been made that a marked weight loss may cause a hypothalamic disturbance and thus a menstrual dysfunction (39).

In further support of this theory, Frisch (16, 17, 18, 19) hypothesized that a critical weight is necessary for menarche to occur. Evidence indicated that early and late maturing subjects attained menarche at the same mean body weight (18, 19). It was further found that the mean weights at menarche of undernourished subjects and normal subjects did not differ, but the undernourished subjects attained menarche two years later than normal controls (16). Frisch suggests that a minimum level of stored, easily mobile energy is necessary for ovulation and menstrual cycles in the human female and that a minimum of 22% body fat is needed to maintain regular ovulatory cycles (18).

Stress

The element of stress, both physical and mental, has been suggested as an additional contributory factor in

menstrual disturbances. Jokl (23) observed that females who were forced to perform heavy physical work during World War II had major abnormalities of the menstrual cycle. Keys (24) notes that amenorrhea can be caused by psychic or mental stress as well as by undernutrition. If this is so, the mental effects of participation in intense competition could be a factor of consideration and an additional significant influence on the menstrual state of the individual.

CHAPTER III

METHODS AND MATERIALS

The occurrence of menses is a vital element in female reproductive physiology. The first occasion of menstruation marks the beginning of menstrual function and the ability to initiate reproduction. As with the musculoskeletal and cardiovascular adaptations which take place as a result of participation in intense exercise, it would seem possible for alterations in the reproductive system to occur during heavy training. This study was designed to investigate the effects of swimming or track and field training regimens on the age at menarche of female athletes.

Sample

Seventy-eight participants in the United States Olympic Development Program were surveyed as part of a training camp procedure. Sixty of the subjects were swimmers who were invited to be members of a camp at Colorado Springs, Colorado. Eighteen of the subjects were track and field athletes who participated in a camp in East Lansing, Michigan. The track and field athletes ranged in age from 14 to 24 years, while the swimmers were 13 to 22 years old. The athletes originated from different areas of the country and

were competitors from a variety of teams.

Interview

An interview was administered to all 78 subjects by the same research technician. The responses of each subject were recorded on separate data sheets (Appendix A). Although only data concerning age at menarche were to be included in the current investigation, additional information was obtained during the interview for other studies.

Training

Initially, a differentiation between track and field and swimming, as the subject's competitive sport, was made; and the training-camp site was noted. The interview continued with an inquiry into the subject's participation in other sports. Next, in order to determine the extent of training and the subject's experience, each athlete was asked to state the age at which initial training began and to give a subjective estimation of the age at which participation in serious competition started. Later, the number of years of training each subject had undertaken prior to age 12 was derived from this data.

To estimate training volume, each subject was asked to recall the average number of yards or miles per day which she had trained during a series of four three-month periods. In this manner an overall average of the yardage or mileage trained per day for a year's time could be derived, and the number of months per year spent in training was noted.

Menstruation

In order to obtain a clear concept of each subject's menstrual experiences, a number of questions regarding menstruation and menarche were posed. First, the subject was asked to recall, to the nearest one-quarter of a year, the age at which menstruation began (5, 11, 12). Following this, the subject was asked to predict the number of menstrual periods which typically would occur in a series of four three-month time spans. The responses to this question gave an estimation of the number of menstrual periods the subject would experience during a year's time. A further question determined the characteristic length of the menstrual period in days. If menstruation had begun before the subject became involved in a heavy training program, the subject was asked to recall the number of menstrual periods per year which were experienced in the time prior to training and the typical length of these periods.

Premenstrual Symptoms

Finally, the subject was questioned regarding the presence of premenstrual symptoms. The occurrence of headaches, cramping, or backaches prior to the menstrual period were specifically noted.

Supplementary Data

In addition to the interview items, the following supplementary data concerning each subject were obtained

from other parts of the testing program. These data were not intended for inclusion in the present investigation; rather, they were to serve as the basis for other studies.

Event

Each subject's main event and best time for that event were obtained. In the case of the swimmers, the stroke which was used in the subject's main event and whether the event was swum short course or long course were recorded. Additionally, the swimmers were given quality rankings according to the percentage of the American or World record which their best times achieved.

Personal Data

Each subject's age in months was calculated. In addition, height in centimeters and weight in kilograms were measured.

Anthropometric Data

A measure of the percentage of body fat for each subject was calculated by the Sloan-Weir method (35). An additional subjective estimation of the percentage of body fat was made for each of the swimmers. The somatype of each subject was derived by the Heath-Carter method (21).

Strength and Power

Peak torques for knee extension, elbow extension, shoulder-joint extension, and shoulder joint inward rotation were determined through the use of a Cybex machine at speeds

of 30^{o}/second, 180^{o}/second, 240^{o}/second, and 300^{o}/second. From this information, relative power values for each of the four joint movements at each of the four speeds were calculated (15).

An adaptation of the standard vertical jump test was administered to each subject, and an additional relative power measure was calculated from the results.

Energy Metabolism

Each subject's VO_2 max, maximum heart rate, and 15-minute net debt values were obtained by means of a tethered swim test for the swimmers or a treadmill test for the track and field athletes (4). An additional measure of the 60% VO_2 max value was obtained for the swimmers.

Analysis of Data

The age at menarche data were tested for normality using a Chi-square test. A t-test then was used to evaluate the significance of the differences between means.

CHAPTER IV

RESULTS AND DISCUSSION

The material in this section is organized into three main sections. The first part covers the age-at-menarche results from the swimmers. Next, the age-at-menarche results from the track and field athletes are discussed. The final section of this chapter is devoted to a discussion of the findings.

Age at Menarche of Swimmers

The age-at-menarche data for the swimmers are presented in Figure 1 and Table 1. For the analysis, the swimmers were compared to a normative sample of U. S. women which was obtained from the United States Health Survey by the United States Department of Health, Education, and Welfare. This normative sample was deemed to be representative of all United States women who were between 18 and 34 years of age. A Chi-square test showed that the age-at-menarche data for the swimmers could be assumed to be distributed normally. A t-test then indicated that there was a significant difference between the mean age at menarche of the swimmers and that of the United States sample (Table 1). The swimmers attained menarche at an average age which was

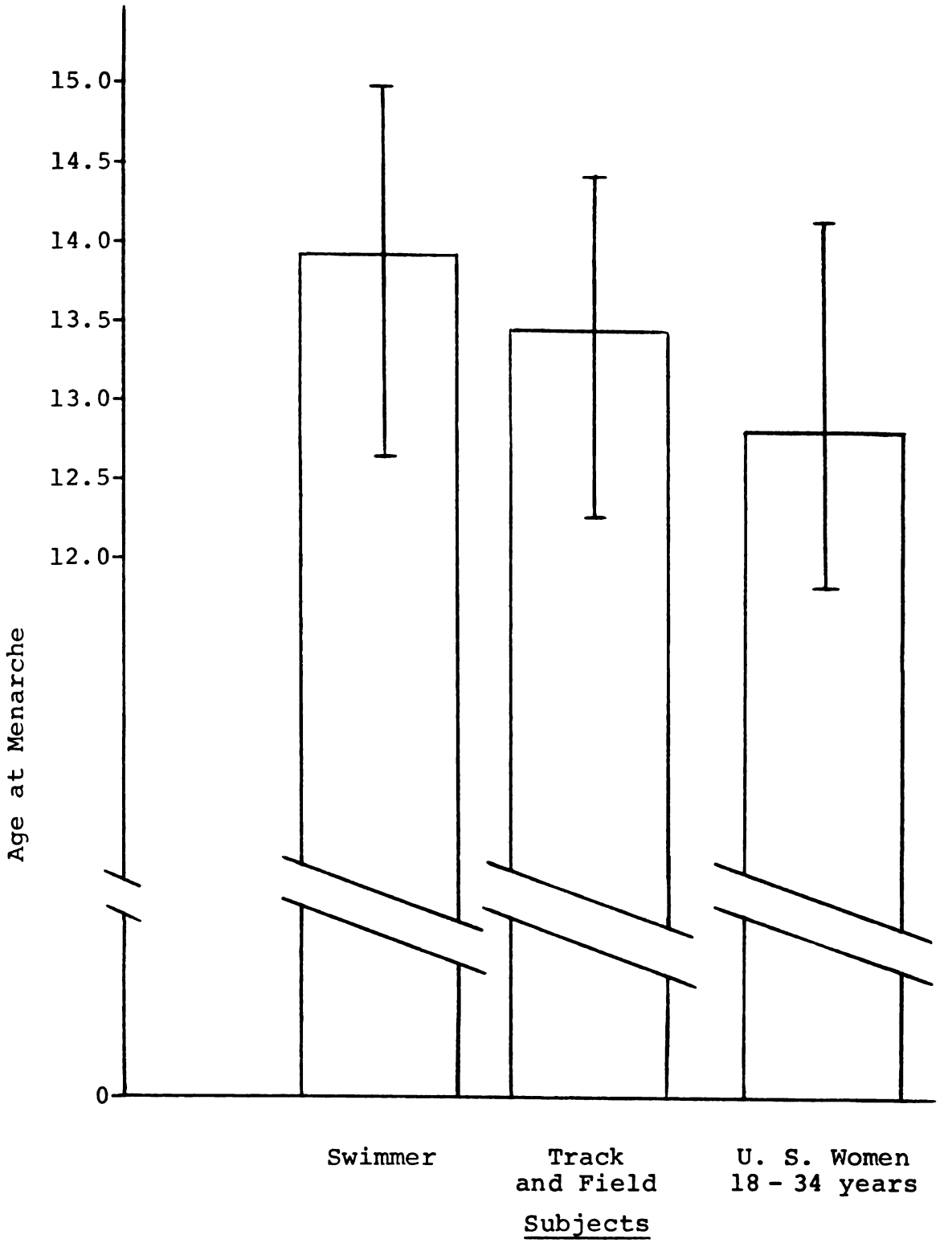

Figure 1. Age at Menarche Results

TABLE 1

STATISTICAL RESULTS: SWIMMERS

Group	$\bar{X}$	S. D.	t-test
Swimmers, n = 57	13.74	1.27	t = 14.00, P .01
U. S. Women, n = 1280	12.76	1.41	

TABLE 2

STATISTICAL RESULTS: TRACK AND FIELD ATHLETES

Group	$\bar{X}$	S. D.	t-test
Track and Field, n = 18	13.36	1.18	t = 1.79, P .05
U. S. Women, n = 1280	12.76	1.41	

slightly less than one year later than the U. S. norm.

Age at Menarche of Track and Field Athletes

A Chi-square test showed no significant deviation from normality in the age-at-menarche data for the track and field subjects. These subjects attained menarche at a mean age which was earlier than that of the swimmers but was still significantly later than the U. S. norm (Table 2 and Figure 1). The two groups of subjects, the swimmers and the track and field athletes, did not differ significantly from each other in the mean age at menarche.

Discussion

The results of this study reinforce the hypothesis that a delay in the attainment of menarche is produced by participation in intense training. The mean age at menarche of subjects who are swimmers or track and field athletes is significantly later than that of the United States sample which is deemed to be representative of all U. S. women. This corroborates results obtained from previous studies (27, 29, 31).

Although the two groups of subjects did not differ significantly, the track and field athletes did attain menarche at an earlier age than the swimmers. A possible explanation might be extracted from a more in-depth examination of training schedules, intensity of work-outs, and age at the start of training.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was undertaken to determine the effects of intensive training programs on the age at menarche of females. The subjects for this study were obtained from two United States Olympic Development Program training camps. The first training camp consisted of swimmers, while the second training camp was composed of track and field athletes. The protocol was identical for both groups of subjects with regard to obtaining information on the age at menarche. During the course of an interview conducted with each subject, the subject simply was asked to recall the age, to the nearest one-quarter of a year, at which menarche was attained.

Comparisons of the mean age at menarche of the two sport groups indicated that the female athletes attained menarche at a significantly later age than the United States norm.

Conclusions

The results of this study have led to the following conclusions:

1. Subjects who participate in swimming training programs have a significantly later age at menarche than the United States norm

2. Subjects who participate in track and field training programs have a significantly later age at menarche than the United States norm

3. The mean ages at menarche of the two sport groups are not significantly different from each other

Recommendations

1. Further studies should be conducted in this area which will include subjects from a variety of different sports and other strenuous activities such as dance

2. More-extensive studies are needed to determine the influence of intensive training on the hormone levels in the female athlete and the relationships of hormone levels to menstrual alterations

3. A longitudinal study should be undertaken in order to determine if there are any delayed reproductive effects of intensive training

4. Investigation of training program types should be conducted to determine possible differential influences on the menstrual cycle

5. A further study should be conducted, which will include as subjects a geographically and racially representative sample. This will ensure results which may be generalized to a greater number of athletes.

6. More-extensive studies are needed to clarify the possible influences of body fatness, age at the start of training, years of training prior to menarche, training volume, and premenstrual symptoms.

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APPENDIX

APPENDIX

INTERVIEW

1. What is your date of birth? _____

2. What type of sport are you competing in:
   ___ Swimming
   ___ Track and Field

3. List your main events and best time in each event:

EVENT	TIME	DATE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. How old were you when you started training particularly for this sport? _____. How long was it before you began participating in what you consider to be serious, high-level competition? _____. How old were you then? _____.

5. Have you participated in any other sports within the last year? _____. If so, please list the sport, the number of weeks per year in which you participated, the number of sessions per week--including practices and actual competition, and the amount of time spent at each session.

SPORT	WK/YEAR	SESSIONS/WK	TIME/SESSION
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

6. Have you participated in any other sports prior to the last year? _____. If so, please list the sport, the number of weeks per year in which you participated, the number of sessions per week--including practices and actual competition, and the amount of time spent at each session.

SPORT	WK/YEAR	SESSIONS/WK	TIME/SESSION

7. In terms of running/swimming, what is your estimate of your average yardage/miles of training per day:

_____ a. during the months of December, January, February;
_____ b. during the months of March, April, May;
_____ c. during the months of June, July, August;
_____ d. during the months of September, October, November.

8. During which of these times do you consider yourself to be in the best condition as far as competition is concerned? In other words, list, in order, the time periods in which you feel you will run/swim your fastest times:

_____ a. during the months of December, January, February;
_____ b. during the months of March, April, May;
_____ c. during the months of June, July, August;
_____ d. during the months of September, October, November.

9. What was your age when you started menstruating? (to the ¼ year): _____.

10. Please indicate the number of menstrual periods which you will have during each of the following time periods:
_____ a. during the months of December, January, February;
_____ b. during the months of March, April, May;
_____ c. during the months of June, July, August;
_____ d. during the months of September, October, November.

How many days do your menstrual periods last when they occur? _____.

11. Did you menstruate before you became involved in a heavy training program? _____. If so, please indicate the number of menstrual periods which you used to have during each of the following time periods:
_____ a. during the months of December, January, February;
_____ b. during the months of March, April, May;
_____ c. during the months of June, July, August;
_____ d. during the months of September, October, November.

How many days did your menstrual periods last when they occurred before heavy training? _____.

12. Do you experience headaches before or during your menstrual period? _____. If so, how often? _____.

13. Do you experience cramping before or during your menstrual period? _____. If so, how often? _____.

14. Do you experience backaches before or during your menstrual period? _____. If so, how often? _____.

15. Do you have any sisters? _____. If so, how many? _____. Can you recall their average ages when they started menstruating? (to the ½ year): _____. Do any of them menstruate less often than once a month? _____. How many? _____. If so, is that sister or those sisters involved in a heavy training program? _____; in what sport or sports? _____.