Exercise, Sports, and Menstrual Dysfunction

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In 1972, Title IX of the Educational Assistance Act was passed by the United States Congress. The intent of this act was to require educational institutions to supply equal opportunities for womens' sports programs. There was already an increasing involvement of women in exercise programs at the competitive and recreational level. This congressional act was a further impetus, because it resulted in a dramatic increase in organized sports programs for women. The effect was far reaching in that it influenced high schools to develop nonexistent programs; it encouraged development and expansion of college level programs; it called immediate attention to women's programs on a nationwide basis. With this renewed awareness and the help of a variety of women's organizations, a rapid increase in the number of women participating in organized exercise programs occurred in the mid and late 1970s.

At the same time that Congress was requiring development of organized programs, the population of the United States was also becoming more aware of exercise in general and its effect on well-being. Programs of "wellness" strongly emphasize a good exercise program as a basic tenet. We began to see a large number of women participating in sports that were previously dominated by men, such as middle-distance running and marathons. Now, in the 1980s, it is unusual to not see active, vigorous participation by women in all areas of exercise and sports. As this participation has increased, the physician has been faced with an increasing number of questions regarding the effects of exercise programs on the female reproductive system. Unfortunately, there was, and still is, a scarcity of scientific literature on the subject. Much more research is needed to answer many of the questions. In this chapter an attempt will be made to explain what is currently known about the effect of exercise on menarche and menstrual cycle.

Menarche

The effect of exercise on the pubertal process has only recently become a concern to investigators. As a specific end point it is easy to measure, and therefore any effect that exercise might exert can be recorded, compared, and analyzed.

Malina, in 1973[1] compared the age of menarche of 66 track athletes with 30 controls. He found that the average age of the nonathletes was 12.23, while the athletes had

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an average age of 13.58 at the onset of menses. In 1978, Malina[2] surveyed high school, college, and Olympic athletes and compared their age of menarche. He found that the average age of 110 nonathletes was 12.29, while 59 high school athletes and 53 college athletes had an average age of 13.02 and 13.05, respectively. It was interesting that he found 18 Olympic athletes with an average age of 14.18 years. This was a significant difference from the other groups and led him to speculate that the physique of the girl with a later onset of menarche may be more conducive to becoming an athlete. In a study of the 1976 olympics, a further report on the age of menarche was performed again by Malina.[3] In this study he looked at a number of other factors, including the country, family size, and type of sport. His investigation found that in all of the countries studied, the age of menarche of the athletes were later than the age of menarche of the population as a whole. In addition, he noted that the larger the family, the more likely that the girl would have a later menarche, especially when compared with girls who had no siblings. He also reported that runners and gymnasts had a later menarche than swimmers. In reviewing these findings, the question is again raised as to whether being an athlete delayed menses or whether the linear physique associated with being an athlete is the result of a delayed menses. It was noted that when Malina[3] compared only United States athletes, the age of menarche of the Olympic athletes at Montreal was 14.3, but the age at the United States National Championship was 13.6.

Other authors also have observed the finding of a later age of menarche in athletes. Dale[4,5] even observed a different age of menarche in runners, based upon the type of running activity in which they participated. Those running more than 30 miles per week appeared to have a later menses age, 13.88, than those running less than 30 miles per week, age 12.25, or the controls, age 12.22. Frisch[6] and Warren[7] have studied ballet dancers, and they also found delayed onset of menses, 13.7 and 15.4, respectively, when compared with a control population of 12.8 and 12.5. Warren further studied the progression of pubertal changes and sexual development. She found pubic hair growth, adrenarche, was unaffected but that menarche and breast growth were delayed. She also found an increase in long-bone growth and speculated that the delayed menarche may influence this growth, because her dancers had an increase in their arm span. Both Frisch and Warren found that the mean body weight and calculated body fat percentages were less than those of controls. This loss of body fat was speculated to be one of the major etiologic factors in altering the time of onset of menses. The role of "energy drain" was also proposed, but the exact role is unknown at this time.

In a further attempt to investigate the effect of exercise on menarche, Frisch[8] evaluated runners and swimmers at Harvard. For the first time she attempted to correlate premenarchal training with the age of onset of menses. She found that the mean age of menarche with premenarche training was 15 years for swimmers and 15.2 for runners when compared with controls of 12.6 and 12.9 years. She calculated that the age of menarche was delayed, therefore, by 0.4 years per year of premenarchal training. Her conclusion was that intense physical activity does delay menarche. The mechanism of action is attributed to the lack of development of body fat and the subsequent effect upon short-term and long-term feedback mechanisms. Although this is an excellent report, we have not been able to duplicate the results.

In a survey of the 13 members of the 1981 United States Women's Water Polo Team, the average age of onset of menses was 12.92, with a range of 11-16. All of these girls were competitive swimmers for 1-4 years before the onset of menses, and several were still swimming at the college level, as well as playing water polo. A review of the records of swimmers at the University of Hawaii for the last 5 years revealed that their average age of menarche was likewise only minimally

TABLE 1. Age of Menarche

Author	n	Sport	Average Age	n	Control
Dale[5]	90	Runners	12.88	54	12.22
	24	Joggers	12.25		
Dale[4]	11	Marathoners	12.9	13	13.0
	8	Joggers	12.3		
	9	Other sports	14.2		
Frisch[6]	67	Ballet dancers	13.7		
Frisch[8]	21	Swimmers	13.9	10	12.7
	17	Runners	13.8		
Malina[1]	9	Shot putters	13.44	30	12.23
	24	Sprinters	13.54		
	12	Distance runners	13.58		
	11	Jumpers	13.73		
	10	Discus/javelin	13.60		
Malina[2]	59	High school athletes	13.02	110	12.29
	53	College athletes	13.05		
	18	Olympic volleyball	14.18		
Malina[3]	32	Olympic swimmers	13.1		
	11	Olympic jumpers	13.4		
	59	Olympic rowers	13.7		
	17	Olympic runners	14.3		
	11	Olympic gymnasts	13.1		
Warren[7]	15	Ballet dancers	15.4	30	12.5
Hale	13	U.S. Water Polo	12.92		
Total	601		13.32		12.34

later than the age reported for the general population, 12.9 years.

It is apparent that active physical exercise may be an influence delaying the onset of menses in some athletes. It is not apparent that this is a significant health factor, and, in fact, there are no reports that indicate any harmful results because of this delay. All investigators indicate that menses does occur either spontaneously or when physical activity is reduced. Therefore, if a young, physically active girl is seen with primary amenorrhea and all other secondary sexual characteristics are normal, we would wait until a period of reduced activity had occurred. If they do not start menses at this time or if there are no signs of secondary sexual characteristics, then an investigation is warranted.

A further question that still must be resolved is the concern of whether the body types that are preferential for athletic performance are also in some way linked with the presence of primary amenorrhea. Until this research is performed and the results obtained, parents should be told that the menarche of their prepubertal daughter may be later if they are involved in an intense exercise program. On the other hand, this delay has not been shown to have any detrimental effects upon the child, and it may improve her ability to perform.

Menstrual Irregularity

One of the major findings associated with women who exercise has been an alteration in their menstrual bleeding patterns. This is not a universal finding and appears to be related to several factors. However, when it does occur it can be frightening to the patient and confusing to the physician who fails to understand the underlying physiologic changes.

The normal endocrinology and physiology of menstruation has been explained in the article by Dr. Speroff in this issue. This complex interaction can be and is often altered by exercise. However, it is important for the physician to remember that women who are exercising can have problems with their menstrual cycle that are unrelated to exercise. Recently a 54-year-old active female who had three episodes of intermenstrual bleeding after vigorous tennis matches came to our office. An endometrial biopsy revealed adenocarcinoma, grade 2. The patient herself had assumed the bleeding was a result of the exercise and had only come in for a checkup because she was due for a semiannual examination.

Oligoamenorrhea is the only bleeding abnormality that is currently known to be associated with vigorous exercise. Intermenstrual bleeding, hypermenorrhea, or other bleeding abnormalities should be very carefully evaluated by the physician in all patients, including those in an exercise program.

The incidence of oligoamenorrhea varies with the type of exercise the woman is performing, the intensity of her exercise program, as well as other factors including diet, stress, etc. Because of these variables, it has been difficult to establish any type of profile that can be used to determine the patient who is the most susceptible to changes in her cycle. As a result, the physician must evaluate each patient on an individual basis. In defining the patients, most authors suggest that a patient who has less than two menstrual periods in a consecutive 12-month period should be classified as having secondary amenorrhea, whereas a patient with less than six menses in the same time span would be classified as having oligomenorrhea.

In 1962, Erdelyi[4] first reported that intensive physical training before menarche would result in menstrual dysfunction after menarche. His review of 577 Hungarian athletes was one of the first indications of the effect of training on menses. In 1967, Foreman, in an unpublished study,[4] observed an increased incidence of menstrual irregularity in long distance runners. In an interview with Foreman, Bloomberg[9] reported that in questioning 47 runners at the Amateur Athletic Union national championship in 1971 and 1973, nine had irregular menses (1-4 week variations) and 11 had only 1-2 menses per year.

Dale,[5] in 1979, reported on a group of runners that his group had studied. This group of women were running more than 30 miles per week, and Dale and his associates found that 51% of the multiparous runners and 21% of nulliparous runners had developed an irregularity of their cycle. They also found 52% and 32%, respectively, had consulted their physician for the problem. In an attempt to evaluate the causative factor, they studied serum follicle-stimulating hormone (FSH), luteinizing hormone (LH), estradiol, and testosterone. These results are shown in Table 2. Although the testosterone levels were within normal range, the authors theorized that they were high normal and could exert an effect. He further studied the percentage of body fat and found that runners had a 17.14% when compared with 24.06% for controls and 21.26% for joggers.

Shangold[10] also studied the hormonal profile of six healthy runners and found that chronic exercise increased the levels of prolactin by 19-398% and testosterone, from 12-61%. These changes were corrected for hemoconcentration and were not due to the effects of cortisol. In a similar unpublished study of women who just finished the 1980 Honolulu Marathon, we found that levels of prolactin and testosterone were markedly elevated. These elevations were far beyond what would be expected with hemoconcentration.

The exact role that these hormones play and the exact cause of these changes is still to be discovered. There is no doubt, however, that vigorous exercise can and does alter the normal reproductive hormone profile of

TABLE 2. Hormone Profiles in Exercise

	Controls	Joggers	Runners
FSH (mIU)	12	13	8
LH (mIU)	16	15	11
17-β estradiol (pg/ml)	187	180	129
Testosterone (ng/ml)	0.33	0.38	0.41
Progesterone (ng/ml)	9.4	9	5.1

From Dale F., et al.[5]

women. One of the known factors in these hormone changes is the percentage of body fat. Fishman[11] has shown that when the percentage of fat decreases, there is a corresponding increase in 2-hydroxyestrone and a decrease in estriol. Other authors have also shown that when the percentage of body fat decreases, there is a subsequent alteration in estrogen metabolism. This decreased estrogen activity can have a variety of actions in the woman, not the least of which is oligoamenorrhea.

A number of investigators are now studying the results of this fat loss. Wentz[12] has found that a 30% decrease in body fat would result in menstrual dysfunction. Frisch[13] has described a critical weight and determined that it is equivalent to approximately 22% fat as a minimal weight to height ratio necessary to initiate menses or to maintain menses.

For the 1977 Portland Marathon, Speroff[14] reviewed questionnaires of 900 female participants. In his review of the data, he found that menstrual irregularity is common in women who are less than 115 lb. and that most amenorrheics weighed less than 120 lb. He further concluded that if weight loss was greater than 25 lb, he could correlate it with menstrual irregularity. The number of women who had secondary amenorrhea develop increased as weight loss increased. For example, 15.8% of women who lost 11-20 pounds after they started running had amenorrhea develop and in 17.5% of those who lost 20 pounds or more their menses ceased.

Frisch[8] studied swimmers and runners at Harvard and found that women who lost 10-15% of their body weight or about one-third of their fat weight would develop amenorrhea. She further stated that an increase in weight of 2.3 kg above the threshold resulted in restored menses. In her study of swimmers, she found a greater percentage of irregular cycles than with runners. This has not been our experience with the United States Women's Water Polo Team or in my survey of swimmers at the local, national, or international level. Although an occasional swimmer will have irregularity, it has not approached the incidence that occurs with running. Likewise, our evaluation of body-fat percentage indicate that swimmers continue to have a high percentage of body fat when compared with that of runners.

Frisch[6] also studied ballet dancers and concluded that hard training and low dietary intake resulted in a change in the fat-lean ratio, which resulted in irregular cycles. On the other hand, Warren[7] also studied ballet dancers and found different results. She noted that the dancers had a mean body weight and body-fat percentage that was less than their controls. However, in the dancers who were amenorrheic and had a 2-month layoff because of injury or for rest, menses resumed with minimal or absent weight gain and no significant change in body composition. She proposed an "energy drain" as an influencing factor.

Other studies have also reflected other factors. Rebar[15] concurred with Warren in stating that an energy drain would be significant enough to alter menses. He also noted that amenorrheic runners had a reduced percentage of protein in their diet. This, he speculated, would also have an effect on menses. In his study, Speroff also questioned the possible effect of elevated body core temperature as a factor. We have seen numerous runners in our marathons with temperatures of 105°-106° due to severe dehydration and heat exhaustion. It is theoretically possible that these temperatures could affect ovarian steroidogenesis, as well as alter the feedback mechanisms in women runners.

It has become apparent that the number of miles run per week may also increase the problem. Speroff was unable to develop a correlation, but his numbers were small. Dale[5] and Foreman[9] found a direct positive correlation between the weekly mileage and the incidence of irregular menstrual flow. Feicht[16] studied track and field athletes and also reported that the incidence of amenorrhea was increased on a linear scale with the miles run per week. He found that up to 43% of women running 60 miles per week had amenorrhea.

There are other factors that we cannot measure. Fries[17] found that psychological stress was an important factor and that there was a higher incidence of amenorrhea in unmarried women. Speroff[14] found that shorter women, 48-55 in., had amenorrhea, and that younger women appeared to have a greater incidence than older women.

Some additional insight has been obtained into this complex problem by observing the menstrual behavior of women admitted to the United States Military Academy. Anderson[18] has carefully reviewed the menstrual cycles of these women and has shown an interesting pattern (Table 3). In addition to the secondary amenorrhea, for those women who continued menstruation, up to 75% reported irregularity, and, in the 1977 class, 23% were still irregular at the end of 13 months. Anderson further reported that these women maintained an average of 19% body fat, so he could not correlate the amenorrhea with a change in the lean-fat ratio. Instead, he feels that stress is the major factor.

Women who are physically active may have alterations of their menstrual cycle varying from irregularity to amenorrhea. The etiologic factors are multiple and perhaps not interrelated. Regardless of the cause, the physician needs a plan of management for these women. First, the patient needs a complete physical examination performed to rule out systemic disease or reproductive system abnormality. Unless this generates some other concern, there is no reason to do any further evaluation at this time on the woman with oligomenorrhea who bleeds, even though it is infrequent, while she is still exercising vigorously. The amenorrheic patient should resume her flow after 2-3 months of reduced activity, usually during the interval between seasons. If she does not bleed at this time, a serum prolactin level should be obtained. If the prolactin is elevated, the patient needs an evaluation. It is critical that this prolactin be drawn after several days of not exercising in order to get a valid result. If the prolactin is normal, we will perform a progesterone withdrawal. If

TABLE 3. Menstrual Cycle of Women at the United States Military Academy

	Class of 1976	Class of 1977
July	86% normal	82% normal
August	73% amenorrhea	75% amenorrhea
November	—	45% amenorrhea
January	41% amenorrhea	
March	29% amenorrhea	
July	20% amenorrhea	
October	7% amenorrhea	

From Anderson JL.[18]

the patient bleeds, we will do no further evaluation at this time. If the patient fails to bleed, then a serum estrogen is obtained. Although there is currently no evidence to suggest that low estrogen can cause a problem, it is a possibility. As a result, if the estrogens are low, we will give supplemental estrogens until such time as the patient reduces her physical activity. To assure that our levels are adequate, we will continue to periodically withdraw the patient with progesterone. If the patient's level of estrogens are normal and she fails to withdraw, then an evaluation of the reproductive tract is indicated.

Menstruation

Erdelyi[19] was one of the first investigators to indicate that women can and should continue participation in exercise programs during menstruation. In a review of athletes of the University of Hawaii, we found little if any difference in the performance of an athlete during menses when compared with performances during other phases of the menstrual cycle. It has been observed that performance records, including national and olympic records, have been established by women while having their menses.

Exercise for some women also appears to have a beneficial effect. Erdelyi[19] reported less premenstrual tension. We have also observed this and believe it results from a reduction in antidiuretic hormone levels, which we found were reduced by exercise. In his study, Dale[5] observed that runners reported a reduced flow and less pain and cramping when compared with controls.

Anderson[18] reported that 55% of women undergoing what they describe as a favorable change in their menses had less flow, less cramps, and shorter duration. On the other hand, Malina[2] found that olympic athletes had a greater incidence of dysmenorrhea when compared with high school athletes or controls.

In our review of national caliber athletes at the university and college level, we have found little difference in the amount of dysmenorrhea. What we have found is a difference in perception of the effect of dysmenorrhea on performance. The higher the caliber of competition, the greater the perception that dysmenorrhea is a potential problem. It is, however, theoretically possible that the more intense the training program of the athlete, the more prostaglandins that will be released. Because prostaglandins are known to have a contractile effect upon the uterus, they could increase dysmenorrhea. (See Dawood in this issue.) For a number of years we have been using antiprostaglandins for dysmenorrhea with good results.

Summary

With the increasing involvement of women in exercise programs, the physician is faced with more and more questions regarding the effect of exercise upon the reproductive system. Currently, it appears that premenarchal training may have the effect of delaying the onset of menses in some girls. There is no evidence that it delays the other stage of puberty or that it causes any harmful development by this delay.

In the postmenarchal woman, strenuous exercise can definitely alter her bleeding pattern. The usual result is oligomenorrhea progressing toward amenorrhea as the exercise increases. This is not a universal phenomenon, however, and other factors such as percentage of body fat, stress, diet, and energy drain also play a role. The menses will usually resume its preexercise pattern after a period of rest.

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