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Running and Menstrual Dysfunction: Recent Medical Discoveries Provide New Insights into the Human Division of Labor by Sex

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In an earlier paper in *American Anthropologist*, van den Berghe and Barash (1977) argued that typical mammalian biological characteristics were sufficient to account for the human division of labor by sex. In a response to van den Berghe and Barash, I argued (Graham 1979) that some specifically human characteristics, in addition to general mammalian characteristics, were necessary to account for this division of labor. The specific characteristic offered in that response was the sexual difference in human pelvic structure, a difference intimately related to hominid bipedalism and brain size. Further, I implied that certain of the virtually universal aspects of this division of labor—the prohibitions against females as warriors and hunters with weapons—functioned to preserve female reproductive potential by prohibiting females from participating in high-risk activities at which they were at special risk because of uniquely human anatomical features. Recent medical discoveries demonstrating that distance running in females may lead to menstrual dysfunction and thus to decreased fertility suggest that the prohibition against female participation in big-game hunting functioned to preserve female reproductive potential not merely by preventing injury or death but also by reducing risks for decreased fertility.

Running and Menstrual Dysfunction

Since 1978, a variety of studies on the effects of strenuous exercise on menstrual function have appeared in the literature of obstetrics and gynecology and also of sports medicine (see, for example, Feight et al. 1978; Dale et al. 1979; Shangold et al. 1979; Warren 1980; Sanborn et al. 1982; Shangold and Levine 1982; Wakat et al. 1982; Warren 1983). The menstrual dysfunction usually found is either secondary amenorrhea, which is defined as follows: "In a woman who has been menstruating, the absence of periods for a length of time equivalent to a total of at least 3 of the previous cycle intervals, or 6 months of amenorrhea" (Speroff et al. 1983:142), or oligomenorrhea, defined as "a reduction in the frequency of menses; the interval must be longer than 38 days but less than 3 months" (Jones and Jones 1981:733).

Virtually all studies of female runners show high rates of oligo/amenorrhea. In a study of 168 women, Dale and colleagues (1979) found that 34% of distance runners, 23% of joggers, and only 4% of controls (women who exercised regularly but did not run) were oligo/amenorrheic. Shangold and Levine (1982) report that 24% of the 394 respondents who entered the 1979 New York City Marathon were oligo/amenorrheic. Feight and colleagues (1978) report that 35% of the middle-distance collegiate runners in their study experienced amenorrhea.

Sanborn and colleagues (1982) raise the very interesting question: "Is athletic amenorrhea specific to runners?" Their study included 237 runners, 197 swimmers, and 33 cyclists. They found that all three groups of athletes experienced rates of amenorrhea higher than the 2% they encountered for age-matched controls. The prevalence rate of amenorrhea for the runners was 25.7%, compared with 12.3% for the swimmers and 12.1% for the cyclists. Further, regardless of the number of miles trained per week, the rate remained close to 12% for both the swimmers and the cyclists. For the runners, however, the rate of menstrual dysfunction increased with miles trained per week, with the highest rate occurring among those who ran at least 60 mi per week. Feight and colleagues (1978) also found that the prevalence of amenorrhea increases with number of miles run per week, ranging from 6% among those running 5 mi per week to 43% of those running 45 mi per week.

Why should increases in training affect the menstrual function of runners but apparently not other athletes? Sanborn and colleagues (1982) found that the cyclists and swimmers did not lose weight as training increased, in contrast to the runners, whose weights did decrease with increased training. Several authors (Dale et al. 1979; Sanborn et al. 1982; Shangold and Levine 1982; Warren 1983) have examined the relation of body weight to menstrual dysfunction, with general but not total agreement that the athletes with higher weight/height ratios were less likely to suffer menstrual dysfunction than athletes with lower weight/height ratios. Perhaps at least as important is the amount of body fat. Frisch and McArthur (1974), for example, suggest that the maintenance of normal menses requires a certain amount of body fat, while Dale and colleagues (1979) point out that the female runners in their study averaged

17.14% body fat compared to 24.06% for their controls.

An interesting correlation between menstrual dysfunction and reproductive age at onset of training appears to exist. In the study by Wakat and colleagues (1982), the athletes with normal menstrual periods had begun training an average of 1.8 years after menarche, while those with oligo/amenorrhea had begun training before or at the menarche. Further, the age at menarche is greater in those who had intensive training before menarche (Wakat et al. 1982; Warren 1983). Wakat and colleagues (1982:267) suggest that the later date of menarche could "indicate that involvement of an athlete in heavy training prior to puberty may continually influence endocrine function in the young adult and possibly beyond."

Endocrine Changes in Runners

Normal menses require the complex interaction of the endometrium, the ovary, the anterior pituitary, and the hypothalamus. Under the influence of gonadotropin-releasing hormone (GnRH) from the hypothalamus, the anterior pituitary releases the gonadotropins FSH and LH, which are transported through the circulation to the ovary. FSH affects the granulosa cells of the ovary, LH affects the theca cells. Together they promote the production of estrogens, which stimulate the growth of the endometrium, modulate GnRH and gonadotropin release, and sustain follicular development. A marked rise in estrogen just before ovulation stimulates an LH surge, which in turn stimulates the release of the ovum from the follicle (ovulation). After ovulation (the luteal phase, normally 14 days long), the follicle produces progesterone as well as estrogens. When progesterone production decreases at the end of the luteal phase, the resulting degeneration of the endometrium leads to menstruation. A defect at any point in this cycle results in failure to ovulate. Amenorrhea occurs in 50% to 60% of cases of anovulation (Speroff et al. 1983:146). It is important to note that many cases of anovulation still result in menses, so that the occurrence of anovulation is greater than the occurrence of amenorrhea. Women who experience secondary amenorrhea do not ovulate, while those with oligomenorrhea ovulate sporadically. A woman who does not ovulate in any given month cannot, of course, become pregnant in that month. Such a woman can thus be said to experience decreased fertility. (For a detailed discussion of the physiology of normal menses and amenorrhea, the interested reader is referred to Speroff et al. 1983.)

What are the endocrine changes that result in menstrual dysfunction in athletes? According to Bonen and Keizer (1984:78), "In the past five years descriptive studies have shown a relatively high incidence of menstrual cycle irregularity in athletes. However, the endocrine alterations that accompany such changes have been described in only a few reports." One endocrine difference between runners and nonrunners noted by Dale and colleagues (1979) is a higher serum testosterone level in the runners. They suggest two possible mechanisms for this: (1) increased androgen production by the ovary and/or adrenal cortex in response to stress, and (2) decreased peripheral aromatization of androgens to estrogens in runners because of their decreased body fat.

Other hormone levels also appear to be affected by running. Shangold and colleagues (1979) report an inverse relationship between miles run per week and both the length of the luteal phase of the cycle and mid-luteal progesterone levels. Dale and colleagues (1979) report that among the oligo/amenorrheic runners in their study, gonadotropin (FSH and LH) and serum estrogen values were consistently in the low-normal range. Based on these and other studies, Wakat and colleagues (1982:269) conclude that "The deficiency appears to lie above the pituitary and must interfere with the normal cyclic release of GnRH. Evidence implicating a specific anatomic or physiological location for this abnormality must still be obtained."

At the recent Seventh International Congress of Endocrinology, as reported by Ziporyn (1984:1258–1263), beta-endorphins were implicated by Lesley Rees to inhibit the normal pulsatile release of FSH and LH from the anterior pituitary by somehow inhibiting the pulsatile release of GnRH from the hypothalamus. Beta-endorphins are endogenous opioids released by the anterior pituitary and thought by some to be responsible for the so-called "runner's high" (Appenzeller 1981:578–579). Significantly, the opiate antagonist naloxone has been shown to cause an increase in the amplitude of pulsatile LH and FSH release in amenorrheic runners (McArthur et al. 1980). In a study of the effects of acute exercise in 15 women, Howlett and colleagues (1984) showed that plasma beta-endorphin levels increased early in training and remained high throughout the training period. While these studies are highly suggestive, the exact mechanism is not yet known, and much more research is needed before we know exactly the cause of athletic amenorrhea.

Running, Menstrual Dysfunction, and the Division of Labor by Sex

The emerging data on the effects of running on menstrual function shed new light on the evolution of the human division of labor by sex. One of the fundamental and virtually universal aspects of this division is the prohibition against females as hunters with weapons. It should be recalled that human hunters, unlike other mammalian predators, can seldom outrun their prey with speed. The human manner of hunting involves outrunning prey with endurance, chasing wounded prey sometimes for days, until the animal drops from exhaustion. It is not unusual for hunters to cover more than 30 mi per day on the hunt.

In an earlier paper (Graham 1979:357–360) I suggested that the division of labor functioned to protect female reproductive potential by prohibiting females from participating in high-risk activities in which uniquely human anatomical features placed them at special risk. The data demonstrating that menstrual dysfunction, and thus anovulation and decreased fertility, varies directly with distance run allows us to see that there may be a physiological basis to this prohibition as well. That is, females who did not participate in activities that required running, such as hunting with weapons, would possess a selective advantage over females who did participate in such activities.[1,2]

The human division of labor by sex, characterized partially by prohibitions against female participation in activities requiring long-distance running, can be seen as an adaptive behavioral response to general mammalian characteristics, specifically human anatomical characteristics, and also physiological characteristics that became important in the uniquely human style of hunting.

Van den Berghe and Barash (1977:821) stated that "a century after Darwin, we have learned enough biology to try to apply it to behavior in general, social behavior in particular, and human social behavior most especially." As the data on menstrual function and running indicate, new advances in medical knowledge can also contribute to an understanding of human social behavior.

Notes

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[1]Unfortunately, there is at present no data from hunters with which to test this hypothesis. One preliminary study of a group of hunter-gatherers, the San (Bushmen) of South Africa, is, however, suggestive. Van der Walt, Wilmsen, and Jenkins (1978:662) state:

> The single most important observation in our study is among the female San in whom, because of the low levels of plasma estradiol and testosterone, gonadal suppression may be postulated to exist. There is also a suggestion that ovulation may be irregular. On the basis of these observations we postulate a possible suppression of ovulation at certain times of the year. Unfortunately, little data pertaining to menstrual irregularities have been collected from these women. Anovulatory times may coincide with periods of the year when nutrition is less than opti-

> mal. . . . The number of births fluctuates sharply from season to season and is unimodaly distributed. The birth peak corresponds to that time of the year which falls 9 months after San weight is at a maximum.

Many more, and more complete, studies of hunters and hunter-gatherers by anthropologists are needed before we can answer definitively the anthropological issues raised by the recent medical research on running and menstrual dysfunction.

[5]One reviewer raised the question of the effects of running on males. At present, this is virtually unknown territory (see Wheeler et al. 1984:514–516). Pending definitive research in this area, it should be recalled that, in general, among the mammals it is the ovulatory cycle in females that is the limiting factor in population growth.

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