Thermoregulation and menstrual cycle

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The aim of the study was to assess if autonomic thermoregulation and thermal perception in women exposed to cold are different during follicular and luteal phases of the menstrual cycle. Although core temperature remained higher in the luteal phase, cold perception was similar.

The monthly menstrual cycle in women is accompanied by rhythmic changes in core temperature. Matsuda-Nakamura et al.1 tested the hypothesis that the menstrual cycle affects thermoregulation during exposure to cold, including autonomic and behavioral responses. It is speculated that both progesterone and estradiol affect core temperature.2 The luteal phase is characterized by higher plasma level of progesterone. On the contrary, estradiol gradually increases and reaches the highest level during the follicular phase. Kolka and Stenfson3 explained that the core temperature rhythm reflects a change in the set-point temperature (meaning balanced point of core temperature) of thermoregulation. Indeed, the 2 hormones affect autonomic thermoregulatory processes, reflected by an increase in threshold core temperatures for shivering and sweating as well as an increase in skin vasodilation during the luteal phase. However, the analyses seem inadequate to confirm that the balanced point is shifted. It is plausible that other thermoregulatory processes are also influenced during the menstrual cycle, such as skin vasoconstriction and non-shivering thermogenesis in cold temperatures. In addition, we must consider the influence of behavioral thermoregulation such as using an air conditioner and wearing thicker clothes or thermal perception that would drive the behavioral responses.

Cunningham and Cabanac4 compared thermal pleasantness of the hands between the follicular and luteal phases. The hand temperature at which women felt pleasant was higher during the luteal phase. Kim and Tokura5 assessed how women experienced unpleasantness in the whole body during cold exposure, by evaluating dressing behavior. Women put on thicker clothes in the luteal phase. Based on the above-mentioned 2 studies, it is speculated that, during the luteal phase, women prefer higher skin temperature and/or being in a warmer environment. In other words, women in the luteal phase may maintain higher skin temperature, if behavioral responses are available. However, thermal perception of the hands does not reflect that of the whole body. In addition, because dressing also influences thermal perception of the environment (i.e., the outside of the clothing), whole-body thermal perception cannot be quantitatively estimated. Therefore, in the study by Matsuda-Nakamura et al.,1 women were exposed to mildly cool environment, and changes in autonomic cold-defense responses (i.e., skin vasoconstriction and metabolic heat production) and thermal perception were observed without a change in core temperature.

Young, healthy women showing regular menstrual cycle with fluctuations of >0.5°C in basal core temperature (estimated by sublingual temperature) participated in clinical trials conducted separately during their luteal and follicular phases. Dressed in a T-shirt and short pants, they sat in a climatic chamber where the ambient temperature decreased from 29.0°C to 23.5°C for 40 min and was maintained at 23.5°C for another 80 min. Core temperature remained unchanged in the cold during both phases; however, it was always higher in the luteal phase than in the follicular phase. Mean skin temperature and chest (body trunk) skin temperature were similar, at 29.0°C, which decreased during exposure to cold, with no difference between the 2 phases. Skin temperature at the fingers (periphery) also decreased with no difference between the 2 phases. Skin blood flow assessed by laser-Doppler flowmetry at the chest and fingers also decreased in the same manner as the skin temperature. Metabolic rate was similar in both phases, and tended increase during exposure to cold. Thus, during environmental cold, a response attenuating the autonomic heat-loss mechanisms only may function to maintain core temperature in both phases.

Thermal perception could be divided into 2 categories: thermal sensation and pleasantness.6 Thermal sensation is perception of the thermal state of external objects or the environment, whereas thermal pleasantness is an emotional experience, which is influenced by core temperature.7 Subjects were asked to report thermal sensation in the whole body and the hands as well as extent of comfort in the whole body by marking their response on a 15-cm linear rating scale. Cold sensation and unpleasantness in the whole body increased during both phases without any difference. Linear correlations were observed between mean skin temperature and thermal sensation as well as unpleasantness in the whole body, and between hand temperature and the sensation. These results indicate that the difference in core temperature between
The 2 phases had no influence on thermal perception. In addition, thermal perception of cold is similarly determined by skin temperature during both phases. Since core temperature remained unchanged during cold exposure, the reduction in skin temperature could be a trigger for skin vasoconstriction and perception. Thus, the results from this study show that autonomic thermoregulatory responses and thermal perception to decrease in skin temperature does not change during the menstrual cycle. The menstrual core temperature rhythm is therefore, a regulated phenomenon.

Figure 1 illustrates difference in thermoregulation during a cold exposure between the luteal and follicular phases, based on the study by Nakamura-Matsuda et al. (solid lines) and my speculation (dotted lines). Core temperature is maintained higher in the luteal phase at 29°C and during cold exposure (A). Metabolic rate (B) and mean skin temperature (C) at 29°C were similar between the 2 phases. This suggests greater thermal gradient between body core and shell in the luteal phase, which may be maintained by higher vasoconstrictor activity of the skin (D). However, because the vasoconstrictor activity is limited in cold, metabolic heat production is activated to maintain higher core temperature in the luteal phase. Thus, the difference in core temperature between the 2 phases is maintained by altered autonomic thermoregulation. On the contrary, thermal perception of the environment, which drives behavioral thermoregulation, changes little during the menstrual phases.

Disclosure of Potential Conflict of Interest

No potential conflicts of interest are disclosed.

References

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Figure 1. Difference in thermoregulation during a cold exposure between the luteal and follicular phases. Based on the study by Matsuda-Nakamura et al. (solid lines) and my speculation (dotted lines), thermoregulatory responses to cold in the luteal and follicular phases are illustrated. Core temperature (A), metabolic rate (B), mean skin temperature (C), skin vasoconstriction activity (D), and the strength of thermal perception during a cold exposure are shown. Red and blue lines denote the luteal and follicular phases, respectively.