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ORIGINAL ARTICLE

Decreased basic metabolic rate may reflect pituitary secretion disturbance in elite female athlete

Réduction du taux métabolique de base chez les athlètes féminines élite et perturbation de l'activité hypophysaire

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KEYWORDS
Basal metabolic rate;
Menstrual disorders;
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Summary
Aim. — To evaluate the relationship between basal metabolic rate, energy balance and hormones level in young female athletes with menstrual disorders.
Materials and methods. — Thirty-three well-trained young female athletes, aged 18.4 ± 2.9 years, with menstrual disorders due to hypothalamic-pituitary dysfunction, participated in the study. Evaluation of nutritional status was based on analyses of body composition using the BIA method (fat mass [FM], fat-free mass [FFM]). Basal metabolic rate (BMR) was assessed with a portable indirect calorimeter. Serum luteinizing hormone (LH), folliculate-stimulating hormone (FSH), estradiol (E2), TSH, testosterone (T), prolactin (PRL) and sex-hormone binding globulin (SHBG) and leptin levels were measured. Total energy expenditure (TEE) was evaluated using the HR-Flex method. Dietary records for 7 consecutive days were used to evaluate the athletes' energy and nutrient intakes.
Results. — Depending on the measured BMR value and comparing with the Harris-Benedict equation, female athletes were assigned to one of the two groups: LBMR group with low BMRs and HBMR group with high BMRs. Serum leptin ($P < 0.016$) and LH levels ($P < 0.003$) were significantly lower in the LBMR group. In the LBMR athletes, a tendency towards negative energy balance was observed ($P < 0.032$). Significant correlations were found between BMR and LH level ($P < 0.021$)

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and between LH and leptin levels ($P < 0.001$) in the entire sample. Decreased BMR may reflect pituitary secretion disturbance in elite female athlete.

MOTS CLÉS
Taux métabolique de base ;
Troubles menstruels ;
Athlètes féminines d'élite

Résumé
Objectifs. — Évaluer un lien entre le taux métabolique de base, l'équilibre énergétique et taux d'hormones chez les jeunes athlètes féminines présentant des troubles menstruels.
Sujets et méthodes. — Trente-trois jeunes athlètes féminines bien entraînées avec troubles menstruels à cause d'un dysfonctionnement hypothalamo-hypophysaire, âgées de 18,4 ± 2,9 ans, ont participé à l'étude. L'évaluation nutritionnelle était fondée sur des analyses de la composition corporelle mesurée à l'aide de méthode BIA (masse grasse [FM], masse maigre [FFM]). Le taux métabolique de base (TMB) a été mesuré à l'aide d'un calorimètre indirect portable. Les taux sériques de : hormone lutéinisante (LH), hormone folliculostimulante (FSH), oestradiol (E2), TSH, testostérone (T), prolactine (PRL) et globuline se liant aux hormones sexuelles (SHBG), ainsi que leptine ont été mesurés. La dépense énergétique totale (DET) a été mesurée à l'aide de méthode HR-Flex. Afin d'évaluer les apports énergétiques et nutritionnels des athlètes, nous avons utilisé des dossiers diététiques pendant 7 jours consécutifs.
Résultats. — Selon les TMB mesurés et après avoir comparé des valeurs à l'aide d'une équation Harris-Benedict, des athlètes féminines ont été assignées à l'un des deux groupes : groupe LBMR avec un TMB bas et groupe HBMR avec un TMB haut. Le taux sérique de leptine ($p < 0{,}016$) et les taux de LH ($p < 0{,}003$) étaient sensiblement inférieurs dans le groupe LBMR. La tendance vers l'équilibre énergétique négatif a été observée dans le groupe LBMR ($p < 0{,}032$). Rapporté à l'ensemble de l'échantillon, des corrélations significatives entre le TMB et le taux de LH ($p < 0{,}021$) et entre les taux de LH et leptine ($p < 0{,}001$) ont été trouvées. Le TMB réduit chez les athlètes féminines d'élite peut indiquer un problème de la sécrétion hypophysaire.

1. Introduction

Physical activity is associated with many health benefits, but when excessive it may lead to serious health problems. Female athlete triad has been defined by the American College of Sports Medicine as an interrelationship between energy availability, menstrual function and bone mineral density, which may have clinical manifestations including disordered eating, functional hypothalamic amenorrhea and osteoporosis [1,2].

Low energy availability (< 30 kcal/kg FFM^{-1}/day) as a result of undernutrition, not rarely secondary to eating disorders, excessive physical exercise and emotional stress lie at the background of menstrual aberrations [1—3]. This problem has increased significance in specific disciplines which demand low body mass and low fat mass and in which intensive exercise starts before puberty. Torstveit et al. [4] noted menstrual disorders in 34.5% of female athletes practicing esthetic disciplines. In endurance disciplines the rate was 30.9%, in weight disciplines 23.5%, in anti-gravitation disciples 17.6%, in technical disciples 16.7% and in ball game and power sport disciplines 12.8%. Nicholas et al. [5] state that female professional athletes in disciplines demanding the maintenance of very low body mass may possess insufficient levels of adipose tissue to maintain adequate estrogen levels. The hypothesis of Frish et al. [6] proposes the existence of a ''critical fat content'' at around 17% of body mass, necessary to start menstruation, and a fat content of 22% to maintain regular menstruation. This statement has been challenged over the years. Sanborn et al. [7] have shown that it is possible to maintain regular menstruation with even 4% of body fat.

Metabolic and psychogenic stress attenuate the gonadotropin-releasing hormone (GnRH) drive (pulse frequency and amplitude are both decreased), leading to reduced pituitary secretion of FSH and LH and resulting in anovulation and hypoestrogenism. Suppression of the hypothalamic-pituitary-ovarian (HPO) axis in professional athletes is concomitant with activation of the hypothalamic-pituitary-adrenal (HPA) axis, hypercortisolemia and hyperandrogenemia. Besides, athletes with exercise-induced menstrual disorders frequently exhibit suppression of the hypothalamic-pituitary-thyroidal (HPT) axis, hypoglycemia and hypoinsulinemia, as well as low levels of leptin. The main role of leptin is the regulation of hunger and adipose tissue levels [2]. It has additionally been suggested that leptin translates nutritional information about the body's energy stores into neuroendocrine responses, essentially by active stimulation of GnRH secretion [8]. Many reports suggest that amenorrheic athletes are in a calorically depressed state [9,10]. Low serum leptin levels may be a consequence of long-term restrictions on energy intake and of negative energy balance [11,12]. In amenorrheic athletes with very low fat mass, low serum leptin levels were also associated with decreased resting metabolic rates [12].

The aim of this study was to determine whether changes in the BMR are related to energy balance and hormones level in professional female athletes with menstrual disorders.