International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 08, Issue 07, July 2023,
*https://doi.org/10.23958/ijirms/vol08-i07/1710*

**Case report**

# 24-Hour Ultramarathon and the Status of Thyroid Hormones: Case Report

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Received 15 June 2023; Accepted 05 June 2023; Published 08 July 2023

## Abstract

***Introduction:*** Thyroid hormones play a very significant role in metabolism, so any impairment of their levels may bring about a chronic disease of the thyroid gland. A question asked is whether continuous long-distance running can affect changes in TSH and T4 values in a person with Hypothyroidism. This Case report aims to explore the influence of high-intensity running (confirmed by the control of the CK) on the status of thyroid hormones. ***Case report:*** The female subject in this case report in an ultramarathon runner (40 years old) who has a diagnosis of the Hashimoto tyroiditis. From October to June 2022, she trained for the competition in running for 24 hours. To determine the status of thyroid hormones, some biochemical measurements of urine and blood were performed immediately before and after the race (competition). The imbalance of TSH hormone values was identified a day before (5.390U/ml) and a day after (5.700 U/ml) the race, while blood parameters increased after the race for AST (148 U/L), CK (2265 U/L) and CRP (7.51 mg/L). ***Conclusion:*** Analysis of the results of this case report showed that there were no significant changes in the TSH hormone after running for 24 hours.

**Keywords:** ***Thyroid hormones, Physical activity, Marathon.***

## Introduction

For healthy persons, the World Health Organization recommends doing aerobic physical exercises every day [1]. However, if there is a chronic disease or a high training workload, a recommendation is given for careful and correct exercising with regular doctor checkups. Every-day physical activity affects changes in an organism and the hormone status with it Body metabolism is significantly affected by thyroid gland hormones [2]. Insufficient secretion can affect metabolism decrease by about 45-50 % of the level of optimal reference values, whereas over-secretion of the hormone can affect metabolism increase by about 60-100 % above the optimal level of reference values [3].

Within sports activities performed at long distances, a marathon, i.e., an ultramarathon, is considered a demanding event just for its effect on the organism in terms of high energy consumption and the required specific mental self-control of the runner [4]. A study exploring the effect of exhausting ultramarathon swimming on the metabolic and reproductive status of a female swimmer reported that all metabolic and hormone parameters (except cortisol) indicated that great physiological stress occurred [5]. Also, the level of thyroid gland hormones in physically inactive and obese persons is imbalanced due to the change in their way of life or increased daily physical activity [3].

When dealing with specific situations such as pregnancy in a person with subclinical hypothyroidism, some studies report that continuous aerobic physical exercising does not have to have adverse effects on the level of thyroid gland hormones, provided that medical checks are regular and proper hormone therapy is administered [6]. Also, it is very important to lead a healthy way of life, which may have positive effects on the correct function of the thyroid gland, in addition to an optimal dose of synthetic hormone [7]. The aim of this study report was to check the changes in thyroid hormones after several months of extensive aerobic training after a full day's running in a person with Hashimoto's syndrome.

## Case report

This case report deals with a female subject 40 years of age who engaged in amateur races in endurance sports during the past 20 years (Marathon, triathlon, ski running). The subject was in good health. No chronic diseases were diagnosed during the past 13 years except Hashimoto thyroiditis, due to which she was administered hormone therapy (Levothyroxine sodium - Euthyrox 62.5 mcg).

Complying with the aims set, the health status of the subject in the Case report was monitored using biochemical parameters taken from urine and blood, as well as based on the assessment of parameters relative to morphological and functional space during the preparation period and the race itself. Biochemical analyses were carried out in two different laboratories, with reference values indicated for all obtained test results of particular parameters. The estimated morphological space was defined using the Bioimpedance method (body composition monitor Omron BF 511). The functional space relative to the workload assessment was identified using a finger Temp - IR Pulse Oximeter; for determining oxygen saturation and heart frequency, Accu-Chek Active meter was used to measure

blood sugar content and a Swiss Microlife monitor for blood pressure.

The ultramarathon sports preparations (24-hour runs) began nine months before the planned race. On monthly intervals, the kilometer distance traveled ranged from a minimum of 370 km to a maximum of 461 km (402 km on average) (**Figure 1**). To monitor overtraining, an internal indicator of heart frequency variability was applied [8]. At the beginning of training preparations for an ultramarathon race, an analysis of thyroid gland hormones was performed, which showed the following results: T4-85 µIU/ml (ref. values 66-181 µIU/ml) and TSH-2.09 µIU/ml (ref. values 0.270-4.200 µIU/ml). The hormone status analysis was repeated three months later with the following results: T4-14.0 (ref. values 9.0-19.0 pmol/L) and TSH - 0.22 (0.35-4.94 mIU/L). The hormone analysis performed after six months indicated deviation from reference values as follows: T4-8.9 (ref. value 9.0-19.0) and TSH-8.34 (ref. value 0.35-4.94 mIU/L), whereas ultrasound of the thyroid gland indicated symmetric shapes of both lobes (sized 16x17x40 mm), heterogenous structure, altered pseudo node appearance, without clearly demarcated cysts and nodes in the parenchyma. Due to slightly changed hormone results, therapy increased from the original Eurothyrox 62.5 mcg to 75 mcg.

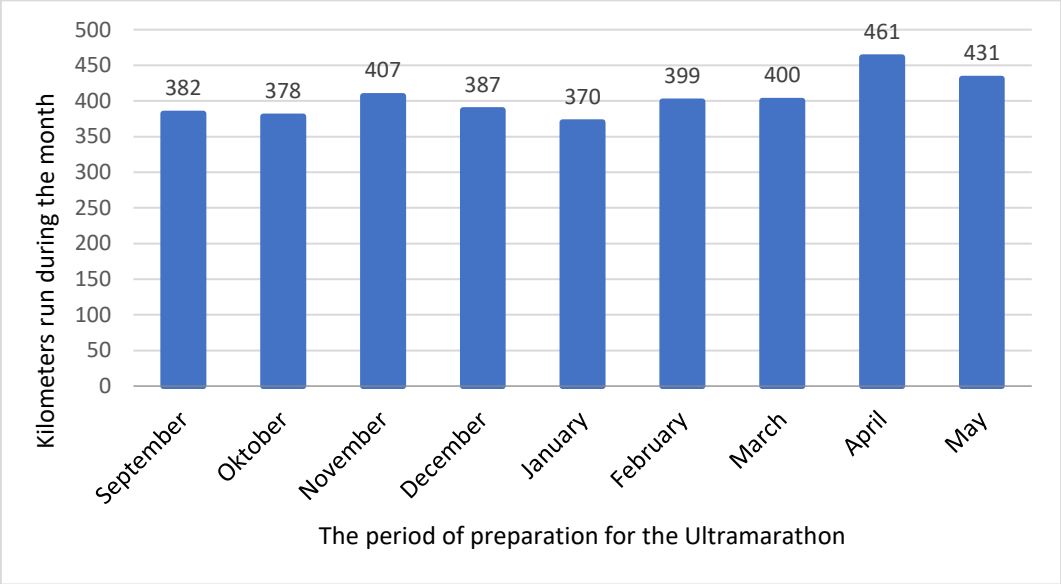


**Fig. 1: Training workload in the preparation period expressed monthly**

Following the end of the preparation period focused on the space of functional abilities, during which workload was monitored, one week before the race, the measured morning pulse rates ranged between 49-56, which did not indicate overtraining of the subject [9-11]. On the day of the race (24-hour race), before the start, during the race (after 12 hours), and after the end of the race, the following parameters were assessed: morphological characteristics (body mass, fat tissue %, and muscular tissue %), functional abilities (pulse, blood pressure, oxygen saturation), and a blood sugar indicator. Biochemical parameters taken from the urine and blood were analyzed a day before the race and a day after [12]. The following analyses were performed to find out the status of thyroid hormones: T4 and TSH, morning cortisol, an acute muscle damage indicator (CK), complete blood count (CBC), average blood sugar level (HbA1c), iron, aspartate aminotransferase (AST), minerals (sodium (Na), potassium (K), calcium (Ca) and reactive protein (CRP), as well as particular urine parameters (pH value, relative density, proteins, glucose, blood, erythrocytes, and salts).

**Table 1: Biochemical analysis of parameters from the serum and urine**

| Parameters in serum and urine | I Measurement The day before the competition (08:00) | II Measurement The day after the competition (08:00) | Units | Reference value |
|---|---|---|---|---|
| Serum | | | | |
| Erythrocytes | 4.68 | 4.27 | 1012/L | 3.50 - 5.00 |
| Hemoglobin | 134 | 127 | g/L | 120 - 165 |
| TT4 | 85.10 | 88.80 | nmol/L | 66.00 - 181.00 |
| TSH | 5.390 | 5.700 | µIU/ml | 0.270 - 4.200 |
| Cortisol - morning | 505 | 367 | nmol/L | 171 - 536 |
| HbA1c | 5.1 | 5.0 | % | Healthy people: 4-6, Diabetics: <7.6 |
| HbA1c - IFCC | 32 | 31 | mmol/mol | Healthy people: 20-42, Diabetics: <59 |
| Iron | 30.6 | 25.0 | µmol/L | 5.8 - 34.5 |
| AST | 28 | 148 | U/L | 10 - 35 |
| CK | 115 | 2265 | U/L | 26 - 140 |
| Sodium (Na) | 138.7 | 139.3 | mmol/L | 135.0 - 145.0 |
| potassium (Ka) | 4.70 | 4.19 | mmol/L | 3.50 - 5.10 |
| Total Calcium (Ca) | 2.44 | 2.29 | mmol/L | 2.15 - 2.50 |
| CRP | <0.60 | 7.51 | mg/L | <5.0 |
| Urine | | | | |
| U-Blood | negative (-) | positive (+) | | negative (-) |
| Fresh erythrocytes | does not have | 5 - 7 | | < 2 |
| * Research technique - ECLIA | | | | |

The subject completed the 24-hour ultramarathon race successfully with a 173 km total distance traveled. Changed hematological values of CBC a day before the race suggested the good health status of the female subject. Urine analysis did not indicate any deviation in measured parameters; however, fresh erythrocytes were registered in urine after the race. Thyroid gland hormones reached slightly higher TSH values before the race (5.390 U/ml) and after (5.700 U/ml), whereas T4 hormone values were within the range of reference values both on the day before and the day after the race. Biochemical analysis of serum and urine parameters (a day before and day after the race) is shown in Table 1. Measured values of body composition and physiological functions of the organism (before, during and after the race) are shown in Table 2.

**Table 2: Measurements of body composition and physiological functions of the organism: before, during, and after the race**

| Parameters | I Measurement before the competition (around 11:00) | II Measurement During the competition (around 24:00) | III Measurement After the competition (around 12:30) |
|---|---|---|---|
| Medical scale | | | |
| Mass (kg) | 59,4 | 56,9 | 55,6 |
| BMI (kg/m²) | 19,1 | 18,3 | 17,8 |
| Fat tissue (%) | 16,1 | 16,8 | 12,3 |
| Muscle tissue (%) | 36,6 | 35,5 | 37,9 |
| Functions of the organism | | | |
| Blood pressure (mmHg) | 112/69 | 124/69 | 135/81 |
| Pulse (beats per minute) | 73 | 85 | 88 |
| Saturation (%) | 98 | 98 | 96 |
| Sugar in blood | 5,8 | 6,8 | 6,3 |

## Discussion

In this case report, with the optimal training workload, the female subject successfully ran a 24-hour ultramarathon. The results obtained based on an external distance indicator (monthly distance traveled - km) [13,14], and an internal indicator of heart frequency (based on the morning pulse rate) suggest that month-long training preparations were well done and that the female subject was not exposed to overtraining in any single training cycle [15]. The good training level was also confirmed by heart pulse and blood pressure values (not higher than 140/90 mmHg) [16] and oxygen saturation (not lower than 95%) [17] since the above values before, during, and after the race were in the range that indicated good physical preparation. A study dealing with 20 marathon runners who traveled between 140 and 157 km in 24 hours reported considerable body mass loss and blood pressure drop [18]. However, in this case report, increased values of systolic and diastolic blood pressure were recorded immediately after the ultramarathon finish, as was expected, even though the values did not exceed the reference limits (**Table 2**).

The values based on which AST and CK parameters got identified were significantly above the reference values. Increased serum concentration was due to long-lasting intensive physical activity that does not affect changes in terms of health damage [19-21]. Namely, in addition to the factors of intensive physical activity that affect the values of AST and CK, there are also the effects of climate conditions, i.e., a daily temperature that contributes to the changes in serum concentration, along with the long-lasting physical activity. An optimal daily temperature of 10-15°C provides favorable conditions for the marathon race, which was not the case in this study [22]. Morning temperature of 14-20°C and the daily of 28-33°C, together with efforts required for an ultramarathon race, affected increased AST and CK values, as confirmed by a study of a group of soldiers [23,24]. Actually, the level of creatine kinase in the serum (CK) gets increased under the influence of continuous and strenuous sports activities (training, race), especially in endurance activities such as triathlon, Marathon, and ultramarathon [18,25]. It is worth pointing out that the increased CK values can be treated as a consequence of actual muscle damage or the loss of muscular cells integrity [20], however, with ultramarathon runners, these increased values are asymptomatic, and they do not suggest changes in health status nor the need for medical intervention [26]. Increased values may sustain for 72 hours following the completion of intensive continuous efforts [27], after which they become normal again, as was the case with this study. More exactly after race completion, CK values went up from 115 U/L to 2265 U/L (reference values 26-140 U/L), but following the next 72 hours, they were within reference limits [28]. Since the above changes suggest metabolic deviations, especially those related to the loss of muscular cell integrity, the presence of the acute inflammatory process of the organism in this case report was also evident from the values of C-reactive protein (CRP 7.51 mg/L).

Concerning variability of morphological characteristics in this case report, the identified values in all three measurements (before, during, and after the race) for evaluation of body composition suggest their decrease, as also proved by the study of 50 ultramarathon runners by Rust and associates [29]. Namely, there was a loss, i.e., the decreased percentage value of muscular and fat tissues, which was also evident at the level of total body mass (**Table 2**). On the other hand, the values of parameters relative to the levels of iron, potassium, sodium, and overall calcium indicate that there was no change during or after the ultramarathon race; however, the values of blood sugar got higher (6.8 during, and 6.3 after the race) [21].

## Conclusion

Leveled values of TSH hormone in this case report (before and after 173 km traveled in 24 hours) suggest that all-day physical effort did not affect the change in thyroid hormone. Nevertheless, an increased level of TSH value identified both before the race and after its completion during the last three-month training period gave rise to therapy modification. Accordingly, those values indicate the need for a more regular hormone check during sports preparations and properly changed hormone therapy. Thus, future research should tackle the following issues. It remains unclear how thyroid gland disorder can affect sports performance and results in sports races of female athletes engaged in amateur sports, who have longer-lasting Hashimoto thyroiditis. Definitely, there is a question about how changed levels of thyroid hormones may affect the realization of training preparations and achievement of sports results. The values of thyroid gland hormones, predominantly in studies, indicate that women suffer from hypothyroidism more often than men and take hormone therapy more frequently than men [30]. A study that dealt with differences related to gender and training level of 20 runners at the distance of 10 km showed that a 30-minute run at 80 % maximum heart frequency did not have any effect on the change in thyroid hormones T3 and T4 nor did the differences related to gender and training level [31]. Research of 16 marathon runners that encompassed the analysis of the thyroid gland showed that T4 value

increased during longer physical exercise, whereas the TSH hormone showed a significant increase immediately after the race but a significant decrease 22 hours after the race. T3 hormone showed the results of opposite values [32]. A study that followed nine highly trained female runners reported that, after the period of a complete stop of the training, there was an increase of TSH hormone in the serum, whereas T4 hormones remained unchanged [33-35]. Complying with the above, the results of this case report indicate that the values of T4 thyroid hormone before, during, and after the race remained within reference limits, but the TSH level was slightly increased both before (5,390 μIU/ml) and after the race (5,700 μIU/ml).

## Ethics approval and consent to participate

The paper presents information that is brought to the table with the presentation of the case study. Confirmation of the Ethics Committee is attached.

## List of abbreviations

AST: Aspartate aminotransferase
BMI: Body mass index
Ca: Calcium
CBC: Complete blood count
CK: Acute muscle damage indicator
CRP: Reactive protein
ECLIA: Electrochemiluminescence immunoassay
HbA1c: Average blood sugar level
HbA1c - IFCC: Average blood glucose (sugar) levels for the last two to three months
K: Potassium
Na: Sodium
T3: Triiodothyronine (Thyroid hormones)
T4: Thyroxine (Thyroid hormones)
TSH: Thyroid-stimulating hormone
U-Blood: Blood in the urine

## Conflicts of Interest

The authors declare that there is no conflict of interest. They confirm by signing in the copyright transfer agreement form.

## Authors' contributions

Ksenija Bubnjević: Prepared the introductory part, the case study part and searched the papers for introdaction part of this paper
Dragan Grujičić: Prepared measurement data on race day
Romana Romanov: Prepared part of case studies and discussion
Vladimir Miletić: Prepared the conclusion and literature
Boris Glavač: Prepared the conclusion and literature

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