The evaluation of ioduria among people attending salt cave sessions

Ocena jodurii u osób korzystających z seansów w grocie solnej

Patryk Jendrysik, Aleksandra Kochańska-Dziurowicz

School of Pharmacy with the Division of Laboratory Medicine in Sosnowiec, Medical University of Silesia

SUMMARY

Introduction: Iodine is an element necessary for the proper functioning of the entire human body. It can be provided to the body by inhalation, i.e. on the salt cave sessions. The aim of the study was to investigate whether the supposedly contained iodine in the caves' air can contribute to the iodine's daily supply.

Material and methods: The study involved 20 students of the Medical University of Silesia - volunteers, obliged to attend salt cave sessions once a week for 10 weeks. The concentration of iodine has been estimated by modified PAMM in the early portions of urine collected at the settled fixed schema.

Results and conclusions: The studies have confirmed that the average ioduria in this group was at 108.53 ± 39.251 µg/l. The study highlighted that the average ioduria after the cave sessions is higher than the average initial ioduria. This increase has been maintained for at least two weeks after the end of the last session, then ioduria gradually decreases. The therapeutic effect is noticeable after at least 5 weeks. The alterations of ioduria during 10-week treatment vary, depending on the average initial ioduria. In addition, it was established that oral iodine supplementation should not be discontinued during the cave treatment, as no significant differences has been found in ioduria between students who had declared receiving such medicines, and those who had not used such treatments.

Key words: iodine, ioduria, salt cave

STRESZCZENIE

Wstęp: Jod to pierwiastek konieczny do właściwego funkcjonowania całego organizmu ludzkiego. Jest nieodzownym składnikiem hormonów tarczycy. Jedną z metod dostarczania jodu do organizmu jest droga wziewna.

Cel pracy: Celem pracy było zbadanie, czy jod zawarty w powietrzu grot może przyczynić się do zasilenia gospodarki jodowej ludzkiego ustroju.

Materiał i metody: Badaniami objęto 20 studentów Śląskiego Uniwersytetu Medycznego – ochotników, zobligowanych do uczęszczania na seanse groty raz w tygodniu przez 10 tygodni. Stężenie jodu było oznaczane zmodyfikowaną metodą PAMM w rannych porcjach moczu pobieranych w ustalonym schemacie.

Wyniki i wnioski: Przeprowadzone badania pozwoliły na stwierdzenie, że średnia wyjściowa joduria w grupie badanej wyniosła 108,53 ± 39,251 µg/l. Badania uwidoczniły również, że średnia joduria po zakończeniu korzystania z groty jest wyższa niż średnia wyjściowa joduria. Wzrost ten utrzymuje się przynajmniej przez 2 tygodnie od zakończenia ostatniego seansu, a następnie sukcesywnie maleje. Wykazano również, że efekt leczniczy kuracji w grocie, zaznacza się przy korzystaniu z seansów przynajmniej przez 5 tygodni. Stwierdzono także, iż przebieg jodurii w trakcie uczęszczania do groty różni się w zależności od średniej wyjściowej jodurii ochotników. Dodatkowo ustalono, że nie należy odstawiać doustnej suplementacji jodem w trakcie uczęszczania na seanse, gdyż nie zauważono istotnych różnic w przebiegu jodurii pomiędzy pacjentami deklarującymi przyjmowanie takich preparatów, a tymi, którzy takiej kuracji nie stosowali.

Słowa kluczowe: jod, joduria, grota solna

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INTRODUCTION

Iodine is an element which is crucial to proper functioning of human body. It is a component of thyroid hormones that as an endocrine organ has an influence on activity of other organs, tissues, cells, and processes in the whole organism. Disruption of the human iodine balance can have serious health consequences [1,2].

The iodine requirement alters and depends on the age, sex and lifestyle. According to the World Health Organization (WHO) an adult needs 150-300 µg iodine daily [3]. The minimal amount of iodine that adult should ingest daily is 50-70 µg, which is 1 µg of iodine per one kilogramme of body weight [4].

The most important source of iodine is food [5]. Approximately, half of this iodine is detected from plasma and gathered in thyroid where iodine plays its essential role [3, 6, 4].

The most effective way of iodine supplementation in human diet is the application of iodinated salt [4]. This is the Polish preventive iodine model that was introduced in 20th and 21st century. Those actions succeeded in significant depletion of iodine insufficiency in Poland among people who need it more [4, 7]. Currently, Iodine Deficiency Elimination Programme applies in Poland in 2012-2016 [8].

Consumption of the substantial amounts of kitchen salt is associated with bigger risk of hypertension and its complications as atherosclerosis, heart failure, heart attack, stroke and osteoporosis and some cancer-based illnesses [9].

That is the reason why people are looking for alternatives to provide iodine. It was proved that iodine can be given via respiratory system and skin [4, 5]. Such way of providing this element is possible to achieve i.e. by attending salt cave sessions.

There is such possibility because drug substances can be inhaled [10]. The medicine after the application goes to the respiratory system and reaches the alveoli where it has to deal with many biological barriers. The substance is absorbed mainly because of diffusion and it reaches blood [1, 11]. Attendance to salt caves can be considered as one way of providing drug substance to organism [12].

In many places in the world there are being created salt mist chambers which are being advertised as medical venues [13]. Still, there is no scientific evidence of how being in such salt caves can influence human iodine system.

The aim of the paper was to examine if iodine contained in salt caves' air can influence the human iodine system. In the research the analytical method was used – PAMM (Program Against Micronutrient Malnutrition) [14, 15] which evaluates indirectly iodine concentration in organism via measurement its concentration in urine. According to WHO specifications, it was concluded that ioduria levels typical to norm are 100-200 µg/l, for mild insufficiency are 50-99 µg/l, for moderate insufficiency are 20-49 µg/l and for serious insufficiency are <20 µg/l [16].

MATERIAL AND METHODS

The study involved 20 students of the Medical University of Silesia, volunteers aged 21 – 25 who were obliged to attend salt cave sessions in *Nemo – Wodny Świat* (Aquaworld Nemo) in Dąbrowa Górnicza. They were obliged to attend such cave regularly on a fixed day once a week for 10 weeks. They had 10 sessions, every session lasted 45 minutes. It was taken 12 morning urine samples without a meal from each person. Total number of urine samples was 240. They were gathered on a fixed schema that was established earlier. This is presented in the first table.

Table 1. Collection of urine samples scheme.

Sample number	The time of sample collection
1 – 3	three-fold collection of samples before attending salt cave session
4	in the morning of the first session
5	in the morning the next day after the first session
6	in the morning of the fifth session
7	in the morning the next day after the fifth session
8	in the morning of the tenth session
9	in the morning the next day after tenth session
10 – 12	during the next three weeks after the tenth session

Additionally, every participant of the research was asked to fill the anonymous survey. That survey gave the basis to proper interpretation of the results. Every participant received an individual number from A to U. The urine samples were indicated by those letters [12].

The researches were carried out with the agreement of the Bioethical Commision of the Medical University of Silesia (NN-013-535/99).

Ioduria was estimated by the modified PAMM method. This is: kinetic and colorimetric method of identifying iodine in the biological material with the Sandell-Kolthoff reaction where iodine is the catalyst [14, 15].

The Excel 2007 and Statistica 10.0 were used to establish the statistic measurement of the results.

The normal distribution of the gathered data was checked with the Shapiro-Wilk test. Normal distributions were regarded those with the level of relevance with range: $p>0,05$. After receiving positive result, the arithmetic means and standard deviations were counted and minimal and maximal amounts were given.

Then, t-Student test was used for dependent samples. The test gave the opportunity to assess the statistical significance between compared iodine concentrations in the examined student groups. It was assumed that median with range $p<0,05$ differs statistically significant.

On the basis of the mean urinary iodine concentrations that was gathered before beginning this research, the subgroups with normal and decreased ioduria were created. The ANOVA analysis was applied in those subgroups to analyse ioduria. The statistically significant differences are with range $p<0,05$.

RESULTS

From every participant there were received four urine samples before participation in the sessions and three urine samples after ending the therapy in salt cave. It was claimed that there were no statistical differences in individual ioduria concentrations in those collections of samples. Therefore, mean ioduria for every participant was counted, characterizing the iodine condition before and after participation in sessions.

Further in this paper, they are being called "before median" and "after all".

By using the Sapir-Wilk's test it was shown the normality of ioduria concentrations in the collection of: "before mean", in the morning in the day of the first session and the next day, in the morning in the fifth day of session and the next day, in the morning of the tenth day of the session and the next day and "after all" sessions.

The "before mean" in every participants was 108,53 ± 39,251 µg/l, and minimal was 30.271 µg/l, and maximum was 174,47 µg/l. The "after all" increased to 125,98 ± 45,433 µg/l (the lowest was 39,23 µg/l, and the highest 207,42 µg/l).

The process of mean ioduria within 10 weeks is presented in figure 1.

Immediately after the first session in salt cave there is a visible statistical mean growth of ioduria comparing to "before mean". From that moment, gradual decrease of iodine in urine is visible until the tenth session in cave.

Participating in ten sessions causes increase in ioduria but it is not statistically significant growth.

During three weeks after participating in the tenth session the decrease of ioduria occurred. That is connected with cease to attending salt cave sessions according to the earlier fixed scheme.

RESULTS AND DISCUSSION

The ioduria "before mean" was 108,53 ± 39,251 µg/l. This result is within normal ranges.

The received data were close to mean concentration of ioduria, in women pharmacy students, which were received in the academic year 2011/2012. The mean urinary iodine concentration was 103,5 ± 65,71 µg/l [17]. The reaserch, carried out by Sadulska in 2013 on 31 male subjects, showed that mean ioduria was 131,6 ± 51,52 µg/l [18].

The concentrations of initial ioduria were averaged for every student, however analyzing every particular amount of ioduria showed its variability. Mainly, it is connected with diet. Food is the main way of providing iodine to organism and also giving goitrogen substances which suppress the usage of iodine by thyroid.

In the research it was claimed that mean growths of ioduria are visible after the first session in salt cave. They were statistically significant in relation to concentrations "before" and "after" the tenth session. What is surprising is that the decrease of ioduria after the fifth session in relation to concentration of iodine in urine after the first session in salt cave. It may be caused by: saturation of iodine during the previous four sessions, unpredictable change of the

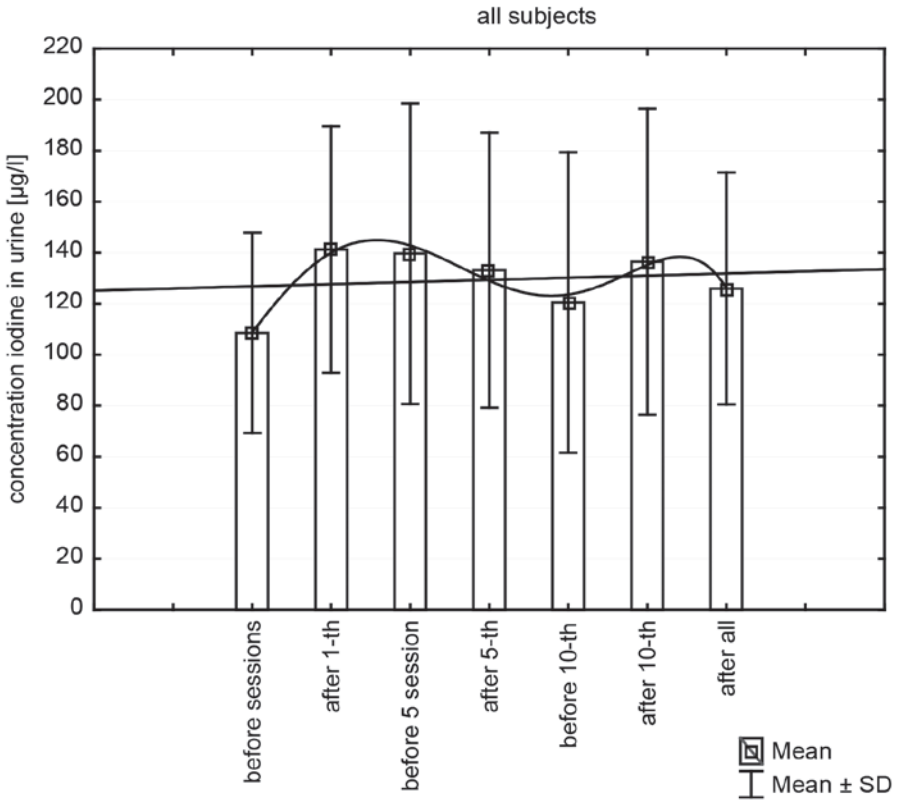

Figure 1. Changes of ioduria concentrations during salt cave sessions.

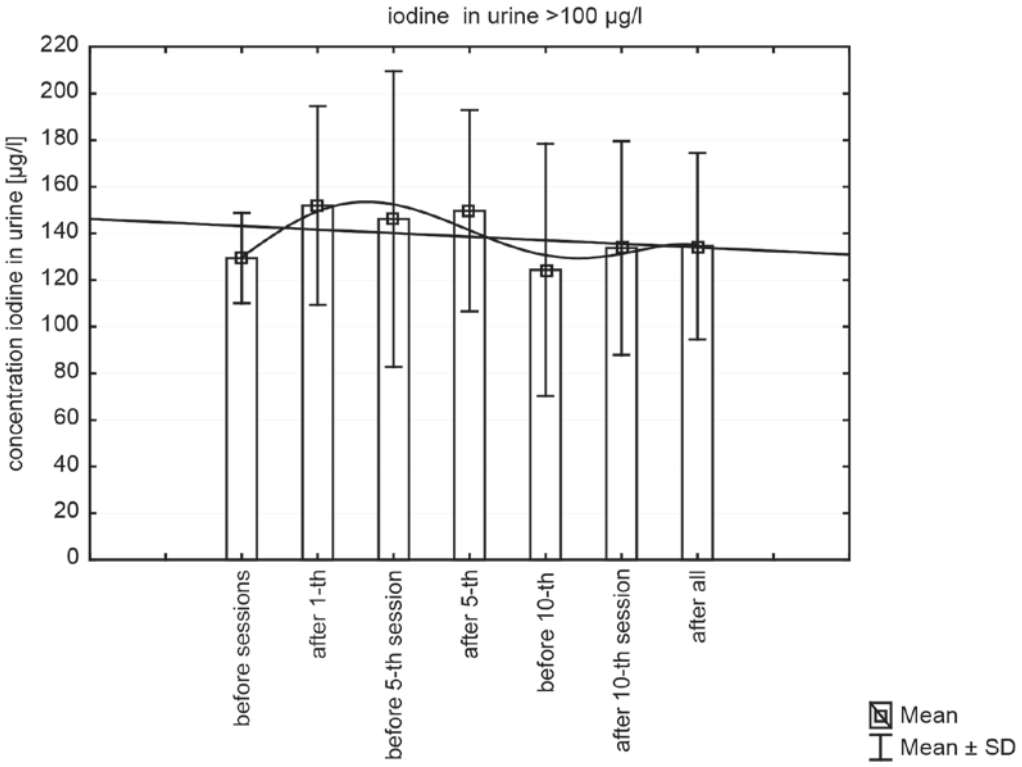

Figure 2. Changes of mean ioduria concentrations in students subgroups with normal initial ioduria.

composition of the atmosphere in salt cave, change of diet during attendance to the research. It can be assumed that decreasing of ioduria after the fifth session is connected with long lasting supply and iodine absorption via respiratory system.

The decrease of ioduria within 3 weeks after finishing sessions is justifiable, however, mean ioduria "after" still was higher than "before mean". But that difference was not statistically significant. The mean iodine in urine within three weeks after attending salt cave sessions has been decreasing successively, although still it was statistically higher than ioduria "before mean".

The examined group consisted of students with initial ("before mean") normal and decreased ioduria. That is why the analysis of ioduria concentrations was carried out in such subgroups. The two examined subgroups were created, one with normal ioduria (fourteen participants, 70% of the whole group) and second group with decreased ioduria (six participants, 30% of the whole group).

To assess the statistical differences between ioduria in those groups, the ANOVA analysis (Analysis of Variance) was used.

In the first subgroup "before mean" was 129,45 ± 19,289 µg/l (minimal: 106,45 µg/l, maximal: 174,47 µg/l). After the research the "after all" was 134,56 ± 40,005 µg/l, and minimal concentrations were 72,98 µg/l and 207,42 µg/l, respectively (Fig. 2).

The increases of ioduria are visible after the first, fifth and tenth session. That mens that in interim system of using salt cave (once a week) positive results on health can be observed after five sessions. Moreover, mean concentrations of ioduria in urine samples increase slightly (in comparison to the previous result in the same subgroup). It is visible after the completion of the salt cave sessions.

However, the course of ioduria that is presented in the second figure is decreasing, but "after all" in relation to "before mean" is higher. The changes of mean ioduria concentrations are different during attending sessions in the second subgroup (Fig. 3). It consisted of six students whose "before mean" is lower than 100 µg/l and is 59,74 ± 28,38 µg/l. In three students from this subgroup (50% of the whole group) a mild deficiency of iodine can be confirmed and in the next three (also 50% of the whole group) – a moderate deficiency of this element.

The analysis of individual ioduria concentrations results (Table 2) in that every case ioduria increases after the first session in salt cave even from 38,416 µg/l to 207,69 µg/l (student F). However, frequent increase of ioduria in relation to prior amount can be observed before the fifth session (four of six students, that is 66,7%) as well. It indicates a big role of diet to provide iodine to organism or supposedly a significant role in providing iodine to organism because of salt cave session. It can be said that on the condition that students were attending salt cave sessions for four weeks. It is surprising that five students the day after the fifth session have ioduria concentrations decreased. This is differently than in the subgroup of people with normal ioduria concentration. In four students (despite of their initial ioduria) ioduria is not decreasing below 100 µg/l. It can be established that attending salt cave sessions gave

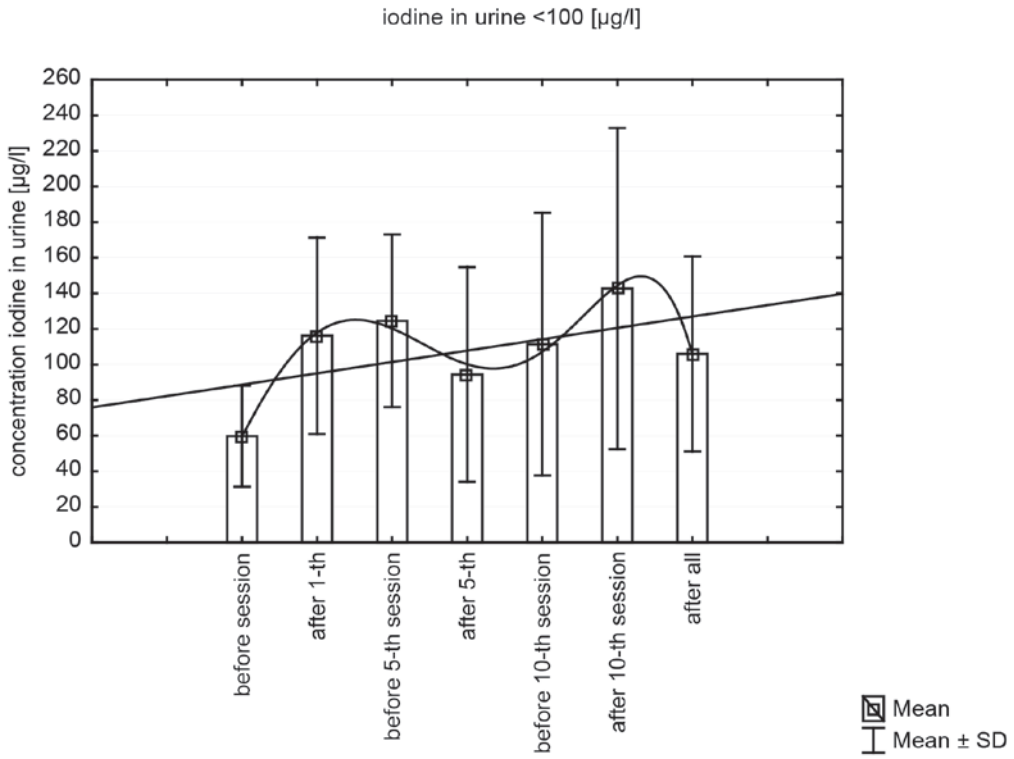

Figure 3. Changes of mean ioduria concentrations in students subgroups with decrease of initial ioduria.

positive result. However, in two students (H and R) iodine deficiency is increasing. After the tenth session we can note the highest iodine concentrations in urine, almost 235,54 µg/l and this happens with student F whose initial ioduria was 38,42 µg/l which indicated a moderate deficiency. Almost in every case the final ioduria is higher than the initial one. In 50% of the cases the problem of deficiency was solved. Ioduria "after all" is lower than "before median" only in student P.

In this subgroup "before mean" was 59,74 ± 28,38 µg/l, with minimal concentration 30,271 µg/l and maximal concentration 99,71 µg/l. The amounts representing ioduria after finishing ten salt cave sessions are: mean ioduria is 105,97 ± 54,74 µg/l, minimal is 39,23 µg/l and maximal is 174,70 µg/l.

The character of ioduria changes in this subgroup is similar to the character of ioduria changes in the whole examined group but fits in different concentrations.

As it was in previous results (applicable to all examined subjects and the first subgroup) ioduria after salt cave sessions in the second group has been increasing in comparison to the situation before taking part in salt cave sessions (Fig. 3).

To easier comparison of mean ioduria changes in student subgroups with normal and decreased ioduria it was decided to show the results from Figure 2 and Figure 3 in Figure 4.

The subgroup with normal ioduria characterizes in more homogenous results, where the abrupt and dynamic increases or decreases of ioduria concentrations in urine are

Table 2. Individual changes of ioduria in subgroups of students with decreased initial ioduria.

Student	before session	after 1-th	before 5-th	after 5-th	before 5-th	after 10-th	after all
F	38,42	207,69	128,29	173,51	166,44	235,54	155,91
G	89,46	146,05	158,48	111,44	159,19	185,16	127,33
H	37,67	69,83	74,00	13,35	38,98	34,11	60,16
M	99,71	101,30	198,20	133,17	203,07	209,84	174,70
P	55,02	56,44	113,82	100,09	70,93	165,12	39,23
R	30,27	115,77	74,57	34,89	29,96	26,48	78,50

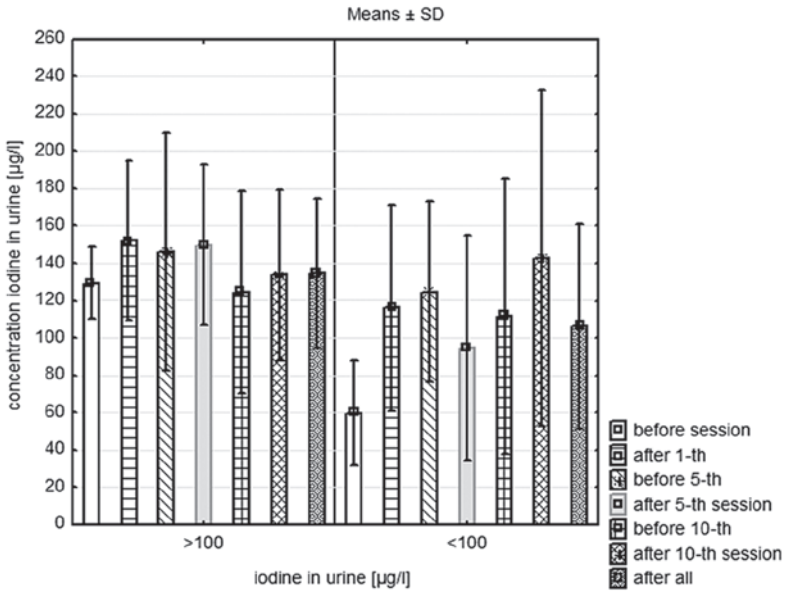

Figure 4. Changes of ioduria in two subgroups.

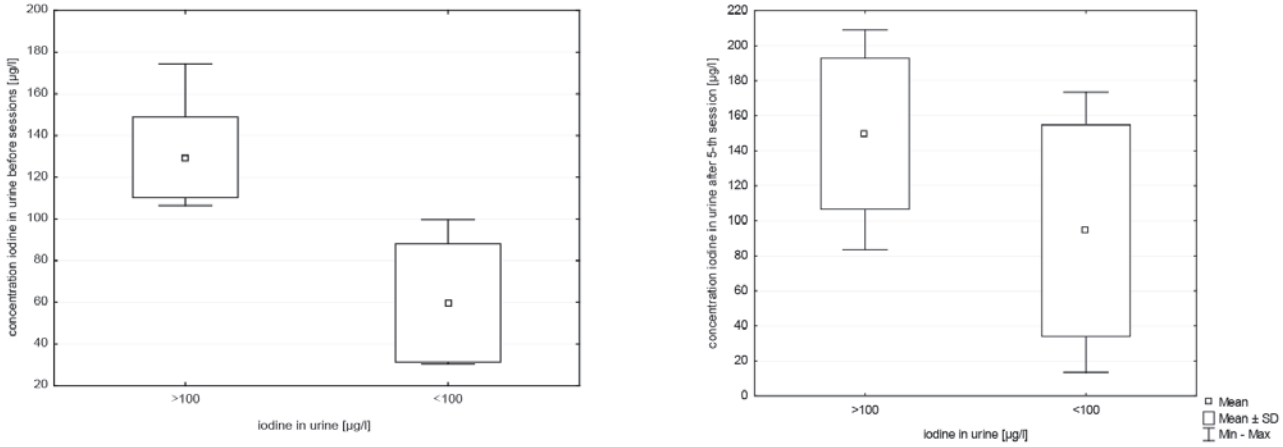

Figure 5. Mean ioduria concentrations in subgroups before and after the fifth session.

not present. The increases in this subgroup, despite that they are not as drastic as in the group with deficiency of iodine, they are mainly connected with attending salt cave sessions. On the contrary, the subgroup of iodine deficiency has increased independently on the circumstances of attending salt cave sessions. The single increase of iodine concentration in urine is visible before the fifth session and decrease just after the session. However, this is the excess because during the next days ioduria acts the same as in the first subgroup.

In both subgroups ioduria "before mean" was lower than "after all", which means that attending to salt cave increased mean concentration of iodine in urine, and even sustained for two weeks. The average results of ioduria indicate that, for the subgroup with deficiency of initial iodine for next three weeks after finishing salt cave sessions: 110,67, 129,9 and 77,34 µg/l.

In the second subgroup "before mean" is the lowest from all, although it is different within the first subgroup: "before mean" is not the lowest but "before the tenth session" is. So that during carrying out the research ioduria decreases below the initial amount. This is statistically not insignificant to decrease ioduria from 129,45 ± 19,289 µg/l to 124,36 ± 54,088 µg/l.

The comparison of ioduria in those subgroups according to the ANOVA analysis demonstrated that statistically significant differences occur only between two urine samples: "before mean" (Fig. 5A) and sample "after 5th" (Fig. 5B).

They confirmed that the differentiating factor that was taken to assessment, which is: normal or decreased initial ioduria, influences the ioduria results during the research. It means that staying in salt caves will influence differently the iodine management of people with decreased ioduria and with normal ioduria.

Additionally, the research considered the oral supplementation where iodine was an ingredient and that was indicated in survey by participants.

Three subjects (students: B, O, T) during the research were taking three different medicines which were supposed to fill the diet with vitamins and minerals which contained iodine. The doses of iodine were at 50, 100 and 150 µg. The decreased mean ioduria in this group was not found before attending salt cave sessions.

With the ANOVA analysis it was examined if the supplementation of those medicines influenced concentrations of iodine in urine during the attendance to salt cave sessions.

The result of statistical test did not prove the presence of differences between variances. The character of iodine changes in urine among those students is similar, as in the case of the whole examined group. That is why it is not recommended to discontinue the oral supplementation of iodine during the attendance to salt cave sessions.

To sum up, the attendance to salt cave sessions results in increase of iodine concentration in urine, so it raises the amount of iodine in the human organism. Salt cave sessions can be counted as the additional sources of providing iodine to organism. It is connected with anatomic features of respiratory system places, mainly the substances that can filter to squamous epithelium, capillaries and have a big surface of absorption.

One of the potential problem that distracts iodine absorption from the atmosphere of salt cave is the amount of dry chemical aerosol of cave that is changing. To provide the richness of substances composition it is crucial to: use proper amounts and types of salt, create the aerosol with proper size of particles and its even distribution over the salt cave and provide proper temperature and humidity of the air in those places [38].

However, ground-based salt caves can moderate many medical conditions and supply iodine deficiency. The research itself and specification of the place allow to claim that. Staying in such places allow patients to relax in good microclimate especially in such times we live in. Such conditions of salt caves can have an influence on depth and speed of breathing and have positive influence on absorbing iodine from the air of salt cave, as well.

However, ioduria changes during the attendance to ground-based salt cave are different for different initial median ioduria. Repeatedly, people who decides to spend time in salt cave does not know if such sessions are recommended for them. To attend salt cave sessions to fill the deficiency of iodine the earlier medical examination is necessary. The doctor will examine and assess ioduria, concentrations of creatinine, FT4 (free thyroxine) and TSH (thyroid-stimulating hormone).

Perhaps, the research should be continued by broadening the number of subjects to at least 100 participants or considering different, more detailed way of collection the samples scheme. The research was carried by Pawełek B and they included the assessment of ioduria concentrations in people who were regularly attending salt cave sessions (every day within ten days) [19].

From our research it can be observed that standardization of the particular microelements in aerosol in salt caves is necessary. It would cause more efficiency and repetitiveness of iodine acquiring in different salt caves.

The creation of larger numbers of salt caves can have hope for reduction of kitchen salt in future or even could become an "urban equivalent" of relaxation at seaside areas. Above all, salt caves have an occasion to decrease still occurring deficiencies of iodine in Poland, especially among people of endemic areas.

Also, using the graduation towers can decrease deficiency of iodine apart from salt caves. In Poland they are located in Ciechocinek, Konstancin, Grudziądz [20]. Medical treatment consists of conducting the course of treatment that medical effect can be observed after some time [21]. The similar effect of iodine increasing in organism appears by attending salt cave sessions under regime that is described in this paper.

However, diet is the most important way of supplying the deficiency of iodine and salt cave sessions can be only considered as an additional way of supplying iodine.

CONCLUSION

Attending salt caves sessions once a week for ten weeks causes statistical increase of ioduria in comparison to the amount before attending sessions. This increase sustains even throughout two weeks after finishing salt cave sessions.

The minimal period necessary to see positive results of ioduria increase is five weeks.

The character of ioduria changes in the subgroup with deficiency of iodine is similar to the character of ioduria changes in the whole examined group. However, concentrations are different.

It was demonstrated that oral supplementation of iodine cannot be replaced via sporadic attendance to salt cave sessions.

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ADDRESS FOR CORRESPONDENCE:
Patryk Jendrysik
Zakład Diagnostyki Izotopowej i Radiofarmaceutyków
Wydział Farmaceutyczny z Oddziałem Analityki Medycznej SUM
ul. Jagiellońska 441-200 Sosnowiec
p.jendrysik@gmail.com