ORIGINAL ARTICLE

Evaluation of the Metabolic Profile During a Two Week Period in a Balneary Resort

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Abstract

Introduction: The metabolic syndrome has become a public burden that raises numerous global healthcare issues, the search for new management strategies for these patients representing an ongoing concern. The study proposes the evaluation regarding the impact that therapeutic mineral waters and associated with dietary changes and adapted balneary programs may have over different metabolic conditions. **Methods:** We enrolled 237 patients with metabolic syndrome defined using 2017 IDF criteria that were monitored for a 12 day stay in the balneary resort. Biological levels were determined at admission and discharge. Additional anthropometric measures and nutrition aspects were determined. Crenotherapy was composed of different sources of mineral therapeutic waters with a composition that had a presence of hydrogen sulfide (sulphurous mineral waters), bicarbonate, calcium, magnesium mineral waters. **Results:** Body mass index and waist circumference and blood pressure determined at admission presented reduced values at the end of the balneary cure ($p<0.05$). Nutritional aspects in the studied group revealed a tendency towards an unhealthy eating behavior, 65.82% of the patients being on a high meat consumption, and an insufficient amount of fruit and vegetables. Diminished values of fasting plasma glucose and HDL-cholesterol were observed at discharge, while uric acid and tryglicerides did not present significant differences at the end of the cure compare to admission. **Conclusions:** Balneotherapy can provide a reduction of the parameters that define the metabolic syndrome. Due to its particular physical and chemical composition, mineral therapeutic waters used both internally and externally can represent an important tool in modulating the biological parameters responsible for the metabolic conditions.

Keywords: mineral therapeutic waters, metabolic syndrome, diabetes mellitus

Rezumat

Introducere: Sindromul metabolic reprezintă o problemă de sănătate publică ce necesită furnizarea continuă a unor noi soluții terapeutice. Studiul își propune evaluarea impactului pe care apele minerale terapeutice asociate cu modificări dietetice și programe balneare adaptate îl pot avea asupra diferitelor patologii metabolice. **Material și metode:** Au fost înrolați 237 de pacienți diagnosticați cu sindrom metabolic folosind criteriile IDF 2017 ce au fost monitorizați pe durata unei cure balneare de 12 zile. Parametrii biologici au fost determinați la începutul și la finalul curei. S-au realizat de asemenea măsurători antropometrice și ancheta nutrițională. Crenoterapia a fost compusă din diferite surse de ape minerale terapeutice sulfuroase, bicarbonate, calcice, magneziene. **Rezultate și discuții:** Indicele de masă corporală, circumferința abdominală și tensiunea arterială determinată la inițierea curei au prezentat valori reduse la finalul tratamentului balnear ($p <0,05$). Aspectele nutriționale din lotul studiat au evidențiat o tendință către comportament alimentar nesănătos, 65,82% dintre pacienți prezentând un consum ridicat de carne și o cantitate insuficientă de fructe și legume. S-au observat valori scăzute ale glicemiei și HDL-colesterolului la finalul tratamentului, în timp ce valorile acidului uric și ale trigliceridelor nu au prezintat diferențe semnificative. **Concluzii:** Apele minerale terapeutice pot oferi o reducere a parametrilor responsabili pentru definirea sindromul metabolic. Datorită compoziției fizice și chimice specifice, apele minerale utilizate atât în cura internă cât și externă pot reprezenta un instrument important în tratamentul diferitelor afecțiuni metabolice.

Cuvinte cheie: ape terapeutice minerale, sindrom metabolic, diabet zaharat

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INTRODUCTION

Metabolic syndrome (MetS) is defined as a cluster of elements represented by increased levels of fasting plasma glucose, raised tryglicerides, high blood pressure and modified values of HDL cholesterol associated with the presence of abnormal abdominal waist[1,2]. Due to this elements it represents a predicting factor regarding the development of type II diabetes and cardiovascular disease. Although insulin resistance[3] and central obesity[4] represent the main causative factors, there are still many unknown variables of its components that require further research.

The International Diabetes Federation (IDF) according to 2017 Diabetes Atlas expresses the fact the prevalence of MetS is continuously increasing, presently around 20-25% percent of the population worldwide is suffering from this condition, this adding to the existing population suffering from diabetes, and multiplying the risk of developing cardiovascular complications, most frequently being a heart attack[5]. The prevalence increases with age, especially during the six decade of life[6,7] the estimated risk of further developing diabetes being 5 to 7 times higher in these patients compared to patients absent of the pathology. In a meta-analysis[8] on longitudinal studies regarding the cardiovascular impact, a higher risk of developing cardiovascular events was observed in case of a preexistent cardiovascular pathology, and also an increased risk when associated with other metabolic conditions such as obesity[9].

Treatment options include lifestyle changes, which requires the adoption of a healthy diet, increased physical activity, smoking cessation plan and maintenance of a healthy body weight, physical exercise and pharmacological treatment of its different components if attempts to lifestyle changes are not adequate.

Balneotherapy has represented a useful tool of treatment in different chapters of pathology. Because of the diversity of its therapeutic factors it can cover a large area of treatment[10]. The use of mineral therapeutic waters have been proven beneficial due to both its physical and chemical particularities when administered internally, also through skin absorption when used externally[11]. In a study that observed the effectiveness of a three week cure in balneary resorts on weight loss, and it is suggested that balneotherapy associated with nutrition programs and phychological support can achieve a weight reduction in these patients[12].

MATERIAL AND METHOD

We realized a pilot observational descriptive study, that developed in the balneary resort in which we monitored the evolution of patients diagnosed with metabolic syndrome over a two week balneary program.

Including criteria regarded patients with age >18 years old previously diagnosed with metabolic syndrome using the IDF criteria according to the 2017 Diabetes Atlas. Exclusion criteria regarded patients with neoplasma, congestive heart failure, chronic kidney disease, diabetic complications. Anthropometric characteristics included body mass index (BMI) which was calculated dividing the body weight to the square height (kg/m^2) and waist circumference which was determined using a division centimeter. BMI ranges are 25 kg/m^2 – normal, 25-30kg/m^2 – overweight, and >30kg/m^2 – obese. Blood pressure (BP) was recorded manually at the beginning of the cure and at the end of the balneary treatment using a pressure manometer, on the right arm of the patients the targeted values being systolic BP ≥130 or diastolic BP ≥85 mm Hg. Blood samples implied the determination of fasting plasma glucose, tryglicerides, HDL-cholesterol, uric acid, which were taken at admission and discharge.

Nutritional aspects were assessed using a validated questionnaire that included 10 questions regarding meat consumption, milk and dairy products, sweets, hydration status, smoking status, salt consumption, number of meals per day, level of physical activity, consumption of fruits and vegetables, coffee drinking. The balneary treatment that lasted for 12 days was composed of particularized kinetotherapy and hydrokinetoterapy programs associated with different forms of electrotherapy, massage and thermotherapy. Crenotherapy was composed of different sources of mineral therapeutic waters with a composition that had a presence of hydrogen sulfide (sulphurous mineral waters), bicarbonate, calcium, magnesium or mineral waters.

Statistical Analysis

Results were expressed under the form of mean and standard deviation (SD). The distribution of the variables was assessed using the Shapiro Wilk test. Wilcoxon Rank test was used to determine mean differences between non parametrical data, while Spearman correlation test was applied to determine associations between variables. A p value less than 0.05 was considered significant. The statistical analysis was made using SPSS version 20.0. All participants signed an informal consent in which they understood and agreed upon the investigation that were to be made. The study was approved by the local ethical comission and received permission of the administration of the balneary resort.

RESULTS AND DISCUSSIONS

We enrolled 237 patients diagnosed with metabolic syndrome according to IDF criteria, 47.25% male/52.75 female, mean age 67.37 ± 8.69. Other metabolic pathologies were also evaluated. Diabetes mellitus was present in 62 of the patients (62.90% male/37.10 female) while 95 patients (28.4% male/71.60 female) presented obesity and hypeuricemia was present in 23 patients (73.91% male/26.09 female). Descriptive statistic regarding the socio-demographic characteristic of the evaluated group can be observed in Table 1 and Figure 1.

Table 1. Demographic characteristics of the studied group

Variables	N (%)
Age (mean±SD)	67.37 ± 8.69
Male	47.25%
Female	52.75%
Urban	37.55%
Rural	62.45
Employed	39.66%
Retiree	60.34%
Primary school	3.79%
Gymnasium	10.97%
High school	55.69%
Post High School	5.90%
Faculty	23.62%
Smoker	34.59%
n=237	

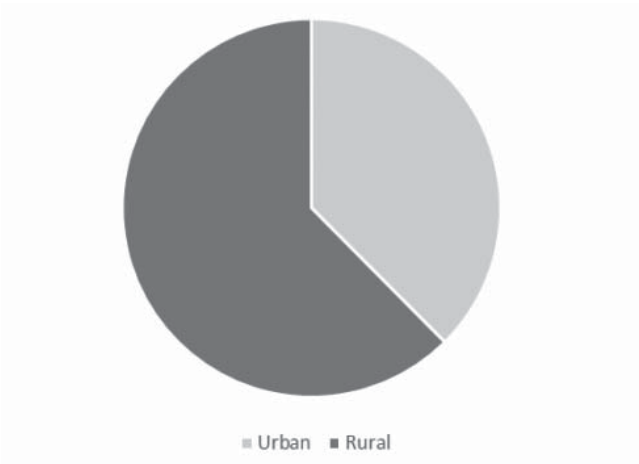

Figure 1. Urban/Rural status of the studied group.

Body mass index and waist circumference determined at admission presented reduced values at the end of the balneary cure (p<0.05). Blood pressure determined at admission (mean SBP 147.37 ± 14.68; mean DBP 89.32 ± 12.28) presented a reduction at the end of the balneary cure without intervention in the pharmacological treatment (mean SPB 135.21 ± 7.19 mean DBP 73.49 ± 8.93; p<0.05) Table 2.

Table 2. Determinations of the studied group

Variables (mean/ 95% C.I.)	Admission	Discharge	*p*
SBP	147.37 ± 14.68	135.21 ±7.19	<0.05
DBP	89.32 ± 12.28	73.49 ±8.93	<0.05
BMI	28.39±2.37	28.26±2.49	<0.05
Waist circumference	93.56±10.56	92.24±10.21	<0.05
n=237			

Nutritional aspects in the studied group revealed a tendency towards an unhealthy eating behavior, 65.82% of the patients being on a high meat consumption, 70.46% having daily salt diet and 40.92% consuming an insufficient amount of fruit and vegetables. Physical exercise was not reported regularly by the patients but was expressed through physical activity more than 30 minutes through daily activities in 78.48% of the patients. 76.37% of the patients consumed more de 1.5l of liquids per day, 64.97% had high salt intake, 40.51 % consumed insufficient milk and dairy products, 36.2% consumed a large amount of sweets and 73.83% had more than 2 meals/day.

From the studied group, the biological profile was evaluated in 37 patients (45.94% male/54.06% female), blood samples being determined at admission and at discharge. Mean FPG presented lower values at the end of the cure (102.16 ±7.77) compared to admission (103.93 ±8.80) p<0.05 (Figure 2) while a reduction regarding triglycerides value was detected, but not statistically significant (167.95±33.12 vs 167.11± 31.63; p= 0.17). HDL cholesterol obtained better values at discharge compared to admission (49.17±4.76 vs 47.93±6.11; p<0.05) (Figure 3) while uric acid presented a small reduction at the end of the cure but without statistical significance (6.07±1.05. vs 6.08±1.09; p=0.15). Results can be observed in Table 3.

Table 3. Biological values in the studied group

Variables (mean±SD)	Admission	Discharge	*p*
FPG (mg/dl)	103.93 ±8.80	102.16 ±7.77	<0.05
Triglycerides (mg/dl)	167.95±33.12	167.11± 31.63	0.17
HDL-cholesterol (mg/dl)	49.17±4.76	47.93±6.11	<0.05
Uric acid (mg/dl)	6.07±1.05	6.08±1.09	0.15
n=37			

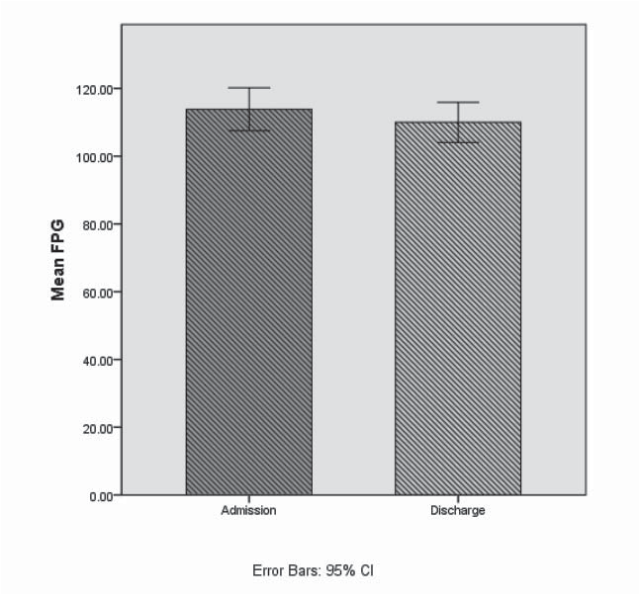

Figure 2. Comparison between FPG levels at admission and discharge.

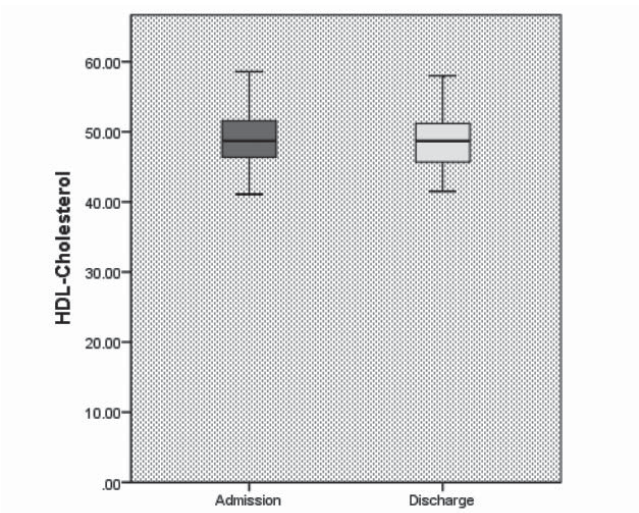

Figure 3. Comparison between HDL-cholesterol levels at admission and discharge.

Hypertension was present in 80.59% of the patients from the evaluated group. In a study that developed in the balneary resort which evaluated the development of selected cardiovascular parameters in patients with type II diabetes, the authors used different sources of mineral waters that include free CO_2 dissolved in water in a dissociated form both internally and also associated with other balneary forms of treatment and dietary interventions, the authors observed a reducing of the sympathoadrenal system activity in patients with poorly controlled diabetes type II, associated with an improvement of the electrical stability of the myocardium and heart rate variability without an overload of the cardiovascular treatment. Immersion in mineral waters containing high concentration of CO_2 might activate parasympathetic nerve activity in humans and could induce peripheral vasodilatation[13].

Balneotherapy has been associated with an improvement of sleep quality. Sleep deprivation is considered to be responsible for mood changes, mostly due to the fact that it involves modifications in autonomic modulations, sleep deprivation along with the modification of circadian rhythm being held responsible for occupational stress[14,15]. Studies suggest that prudent dietary programs consisting mostly of vegetables and fruit could be beneficial for sleep architecture[16]. Multiple hypothesis have emerged regarding the mechanism of action in case of balneary cure on anxiety manifestations, including reduction of salivary cortisol levels after spa bathing[17], modifications regarding the platelet serotonin transporter, and also of the symphatetic tone in case of warm footbath the authors concluding that balneotherapy is more effective in stress reduction compared to the control group[18].

Crenotherapy may provide a modulation of the parameters that define obesity and diabetes, due to the fact that these conditions can occur as a result of the interference of gastric pathology, associated with hepato-biliary, and pancreatic manifestations. Our research suggests an effect over the lipid profile of the patient. In a study that evaluated the effect of sulphate-bicarbonate-calcium water on risk factors for atherosclerosis, weight control, and gallstone disease over a 12 day cycle in patients with functional dyspepsia and constipation, in which the authors evaluated total/low density lipoprotein and high density lipoprotein, bile acid, and the fasting gallbladder volume using the ellipsoid formula on the average of 2 sonographical gallbladder measurements, the authors observed an improvement intestinal transit and allows maintenance of a stable body weight despite a high food intake. Fasting gallbladder volume was significantly smaller at the end of the study than at baseline in the mineral water group (15.7 ± 1.1 mL vs 20.1 ± 1.7 mL) compared to tap water group (19.0 ± 1.4 mL vs 19.4 ± 1.5 mL). There were no significant difference regarding biological profile at the end of the cure compared to baseline - total cholesterol (mg/dL)- mineral water 178.7 ± 5.8 vs 182.4 ± 6.3, control 181.5 ± 7.6 vs 177.4 ± 6.5-HDL cholesterol (mg/dL) -mineral water (62.3 ± 4.7 vs 63.7 ±4.7), control water (56.7 ± 5.0 vs 59.4 ± 6.1)- LDL cholesterol (mg/dL) - mineral water (100.4 ± 8.0 vs 101.9 ± 8.7), control water (103.6 ± 8.5 vs 93.9 ± 7.7)- triglycerides (mg/dL) mineral water (79.9 ± 7.5 vs 84.0 ± 10.2), control water (106.1 ± 11.4 vs 120.7 ± 17.9)[19].

In another study on 19 healthy patients regarding the effect of bicarbonate-rich mineral water over glycemic control the authors evaluated fasting plasma glucose, serum glycoalbumin, insulin, total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides, sodium, chlorine, calcium, and magnesium, observing a reduction of serum albumin levels and a significant increase in blood calcium levels possible due to the waters high calcium concentration (177 mg/kg)[20].

The use of balneary cure in patients with obesity can be obtained through adapted programs that imply both the use of mineral therapeutic waters in intern cure for its physical and chemical characteristics, and also externally in hydrokinetotherapy programs. Another influence can be manifested by the bioclimate, which depending on the selected resort has either sedative, or tonic-stimulating effects, which can be added to the global effect provided by the balneary resources[21,22].

The encouragement of physical exercise over the two week period can be considered a premise for further implementation of weight loss programs and adherence contribute to weight loss in patients with obesity and when associated with dietary modifications and nutritional counselling can improve weight status for these patients. In a study[12] that evaluated the effect of a balneary program in weight reduction in patients with obesity, the authors observed a comparable efficiency in the group that received crenotherapy with mineral therapeutic waters, hydrokinetotherapy and dietary compared to the control group that received only pharmacological treatment with agonists of 2C receptors of serotonine- Lorcacerin- and lifestyle modifications.

Limitations of the study

One of the major limitations of the study is the small sample of patients, the absence of a control group and the lack of randomization. Although nutritional aspects and lifestyle aspects were assessed through a questionnaire, due to the fact that they were made in a cross-sectional matter an cannot comply to a larger prospective analyses they are at risk of bias, and also depend on the reliability of the patient. Another aspects regards the fact that not all lifestyle parameters were taken under considerations, and also that the balneary program included multiple treatment options and not only the administration of MTW, therefor an individual effect cannot be separated.

CONCLUSIONS

Diminished values of fasting plasma glucose and HDL-cholesterol were observed at discharge, while uric acid and tryglicerides did not present significant differences at the end of the cure compare to admission. Anthropometric determinations and blood pressure were modified at discharge compared to beginning of treatment. Nutritional evaluation of the studied group revealed a tendency towards unhealthy patterns.

Mineral therapeutic waters can achieve a correction of the biochemical parameters that define the metabolic syndrome. Due to its particular physical and chemical composition, mineral therapeutic waters can be used both internally and externally and can represent an important tool in modulating the biological parameters responsible for the metabolic conditions.

Conflict of interests: The authors express the fact that there are now conflicts of interest regarding the publication of this article.

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Abbreviations:

iDF	International Diabetes Federation
MetS	Metabolic Syndrome
MTW	mineral therapeutic water
BMI	Body Mass Index
WC	Waist circumference
BP	Blood pressure

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