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Original Article

Relationships between Diet, Lifestyle and Blood Pressure to Crenotherapy Employees

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ABSTRACT

Purpose: A proper diet combined with a healthy lifestyle reduce the risk of heart disease. Prolonged exposure to sulfur thermal springs leads to modifications of blood pressure and general health status. Experimental approach: Questionnaires about the demographic characteristics, the exposure history, and cardiovascular disease history were applied on 129 volunteers; data about blood pressure were also collected. Findings and discussion: 90% volunteers occasionally consume spicy food and just a little part of studied groups drink different teas and practice physical activities. Lower blood pressure values were recorded in the case of volunteers exposed to hydrogen sulfide than the other volunteers and differences between the blood pressure at the beginning and the end of a working day were also observed. Conclusion: The experimental results exhibit good correlations between the diet, lifestyle, physical activity and blood pressure values.

Keywords: hydrogen sulfide; hypotensive; natural spring; occupational health; sulfur waters.

1. INTRODUCTION

The therapeutic mineral waters are those waters that come from the natural springs and/or mountain lakes and they present a mineral salts content (minimum 1 g/l), different dissolved gases with biological effects (around 1000 mg CO_2/l or 1 mg H_2S/l) or their temperatures are above 20°C; the therapeutic action must be scientifically recognized.[1]

Sulfur waters are recommended of both crenotherapy and external cure in the form of baths, inhalations and vaginal irrigation, due to the effects of hydrogen sulfide (H_2S), which rebounds through the skin, the gastric mucosa, the bronchopulmonary and upper airways and vaginal. The

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crenotherapy with saturated sulfide waters has effects of stimulating gastric secretion as well as intestinal peristalsis, cholestatic effects on the liver and gall bladder, antitoxic effects and lowering of glycemia in diabetics. Mixed sulfur-carbohydrates springs also have diuretic effects through CO_2 action. Indications for low concentration sulfur water crenotherapy are: hepato-biliary diseases, in particular biliary dyskinesias, biliary lithiasis and chronic cholecystitis, urinary tract infections, diabetes and heavy metal intoxications.[2]

Hydrogen sulfide is an inorganic weak acid with a good water solubility (around 2.58:1 v/v).[3] It can be found in different areas with natural gases, oil exploitations and around volcanoes craters. On the other hand, hydrogen sulfide is one of the most important degradation products and it can appear in the putrefaction processes of organic substances, in the intestine, the rubbish dumps etc.[4]

Nitrogen oxide (NO), carbon monoxide (CO) and hydrogen sulfide were reported as gasotransmitters in mammals; thus, the endogenous H_2S is responsible of the regulation of some physiological processes, including the vascular tone.[5] A. Stein and S.M. Bailey [6] wrote about the effects of H_2S on vasoactivity, angiogenesis and on cardiovascular disease; it seems that H_2S decrease the blood pressure and induce the relaxation of vascular smooth muscle cell, while the mechanism of H_2S-induced angiogenesis imply the activation of ATP-sensitive potassium channels.

However, it is important to remember that hydrogen sulfide is a colorless toxic gas generated by non-specific and anaerobic bacteria reduction of sulphur-containing organic compounds. Many H_2S incidents in geothermal and other industries were reported in the scientific literature.[7, 8]

The aim of this study is to evaluate the occurrence of diseases in the case of different employers of sulfur water baths from Baile Herculane, a spa resort from South-West of Romania, a place known for its therapeutic effects from the Austrian and Ottoman occupation (the 18th century), and to assess different associations between the life style, diet and the exposure period.

2. MATERIALS AND METHODS

Subjects of study

During the last year, we studied 129 volunteers from Baile Herculane. Participants were recruited through advertisement and personal invitation. We revealed the aim of this study to the participants, but they did not know the quantification protocol of the results. The study was performed in accordance with the principles of the Helsinki Declaration, respecting local jurisdiction, and it was previously studied and approved by the Ethics Committee of "Victor Babes" University of Medicine and Pharmacy Timisoara (Romania), under the supervision of Prof. Enache A, Approval No. 7 / 2016. In the first step, every volunteer read and signed an informed consent and a signed informed consent for publication of the research results was also obtained.

Study inclusion criteria

First, an exposed group (EG) of 67 volunteers (62.69% female) was included into the study, people who filled the criteria for occupational exposure to sulfur mineral waters. They were recruited from the employers of medical assistance department of thermal baths (65.67% volunteers are still working there, while the others have been retired). In the present study, other 62 volunteers (61.29% female), friends or family members of volunteers from exposed group, were recruited and they were used as blank group (BG). The following points were accepted as the inclusion criteria for the exposure group: employment at the worksite with a documented exposure to sulfur springs, the total time of work (minimum 10 years), and no current exposure to other chemical or physical factors. The studied volunteers inhabited the same area and they experienced the same size and quality of environmental exposure. Those subjects who admitted in anamnesis that they suffered important diseases such as heart failure, atherosclerosis, diabetes mellitus, renal insufficiency, hyper- or hypo-thyroidism, morbid obesity were excluded.

Protocol

Personal information about demographic characteristics (age, sex, age to start working, occupational history, current occupation, retirement age, etc.), diet and lifestyle were obtained using questionnaires. The main characteristics of the examined group are presented in Table 1.

Table 1: Main characteristics of volunteers

Characteristic	Mean value ±Minimal value SD	Maximal value
Age, years	57.4 ± 5.6	45	70
Height, m	1.66 ± 0.21	1.52	1.84
Body mass, kg	78.19 ± 6.73	55	112
BMI, kg/m^2	26.93 ± 4.11	22.74	36.94

BMI=body mass index

Measurements of blood pressure were done randomly twice a day at the beginning and end of the work program; all measurements were done in triplicate and average values were collected.

Statistics

Statistical analysis was performed using a trial version of IBM SPSS software (SPSS Inc., Chicago, Il, USA). Continuous variables were presented as mean values ± standard deviation; categorical variables were presented as frequencies and percentages. Comparisons between continuous variables were conducted with t test and F test. Correlations were analyzed with Pearson correlation analysis. The significance level was set to 5% ($p < 0.05$).

3. RESULTS AND DISCUSSIONS

Early detection of occupational disease caused by physical and chemical factors is very important for the education of workers in safety and health, self-care and healthy lifestyle for prevention of many disorders. Workers of thermal spa

industry are prolonged exposed to heat and different evolved gases. Hydrogen sulfide (known as sewer or swamp gas) is one of the main components that naturally occur in Baile Herculane springs. Its effects on workers' health depend its concentration and on the exposure period. But it is important to mention that many effects are seen even at low concentrations. Effects range from mild such as headaches or eye irritation, to very serious as unconsciousness and death.[9]

The employers of Baile Herculane thermal spa which were enrolled as volunteers of this study were exposed to S^{2-} concentrations between 36.9 mg/l (Diana source) and 41.2 mg/l (Diana 3 source) according to a report published by B.P. Onac *et al* [10]

Figure 1 presents other characteristics of the exposed and blank groups such as the working program (Fig. 1a), the residential type (Fig. 1b), and vicious habits (smoking, coffee, alcohol, Fig. 1c).

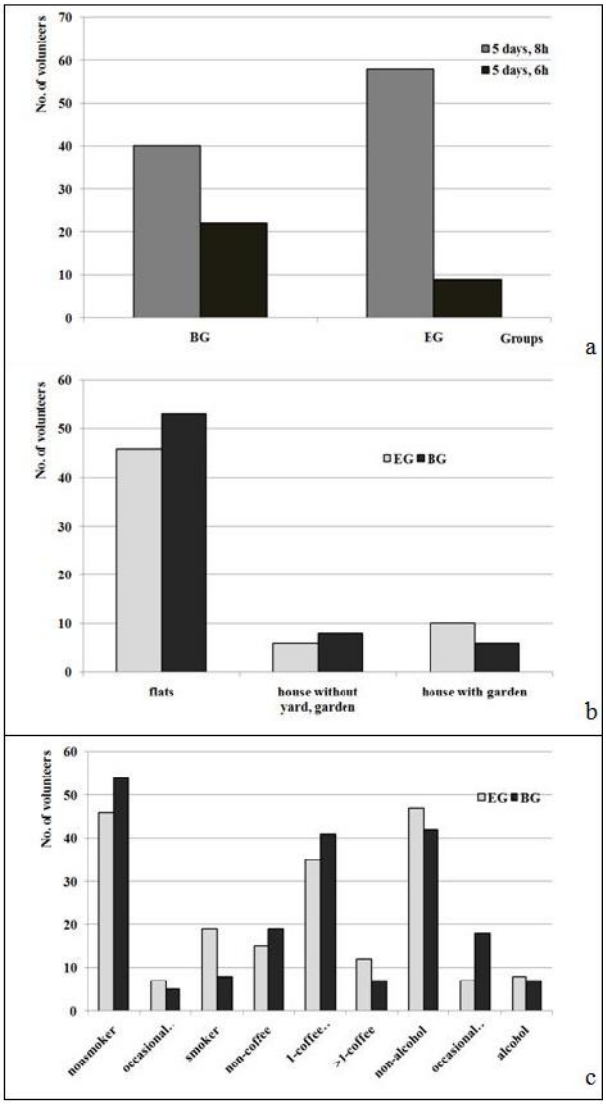

Fig 1: Comparative characteristics of exposed vs. blank group: (a) working program, (b) residential type and (c) vicious habits.

The diet and the meal plan are dependant of the monthly budget allocated for food. European Commission has published that a Portuguese person spent every month around 173 euros for a healthy diet, while German food basket amounts to 220 euros/person and Belgian to 206 euros/person in 2015.[11] The same source has revealed that Romanian food basket is based on a monthly budget around 128 euros/person and around 499 euros/family with two adults and two children for a healthy diet. This is the necessary budget reported by the authorities and related to the food costs in Romania, but important differences were observed between the people from large cities and from the villages. Another important aspect that must be mentioned is that the studied town, Baile Herculane, is one of the most important thermal spa of Romania and all prices are artificial increased compared to other towns. Figure 2 presents that the majority of our volunteers need between 50 and 100 euros every month just for food.

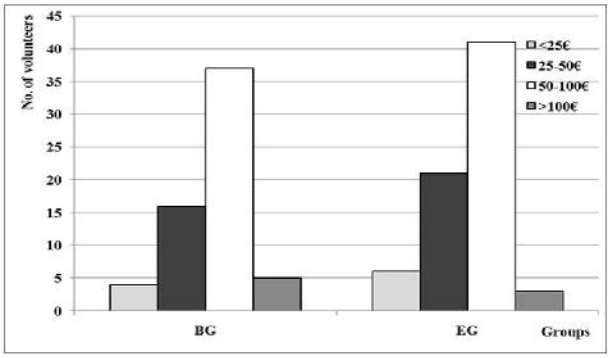

Fig 2: The comparative monthly budget for food per an entire household.

Eating too fast can lead to weight gain and to a poor digestion. The doctrine of "Slow Food" appears in opposition to the fast-food culture; the benefits of eating slowly are listed by A.M. Andrade *et al.*: it is easier to control the satiety before consuming too much food, the water consume is increased, while the total energy intake is lowered.[12] Figure 3 indicates that the majority of our volunteers spend between 15 and 30 minutes/meal and this is due to their age; it is known that fast-food culture is specific to the teenagers.

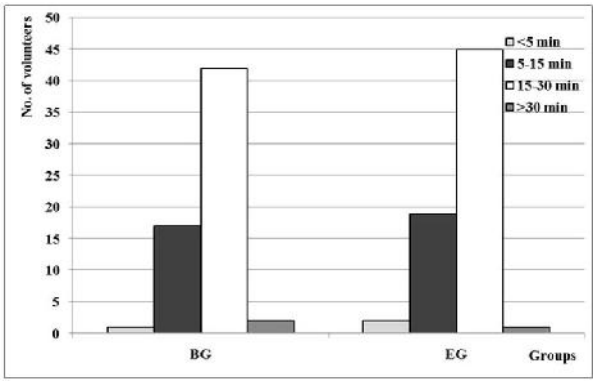

Fig 3: The comparative time spent for one meal.

The health impact of nighttime eating was described by A.W. Kinsey and M.J. Ormsbee.[13] They found that only for Type I diabetics and those with glycogen storage disease, it is essential to eat before bed for survival; the effects of pre-sleep nutrition in active individuals still represent a largely unexplored area and limited data are available. S. Eng *et al.*[14] published that the circadian rhythm of eating and body weight status are somehow in touch with one another based on a research over the childhood obesity. J.D. Coulthard and G.K. Pot [15] identified that the evening meal after 8PM cannot be associated with excess weight or increased energy intake. Figure 4 reveals that subjects of our study prefer to eat the last meal of the day between 7 and 8PM.

The content of the last daily meal is quite similar between the two studied groups: fresh plates of appetizers or cereal milk (66.13% of BG and 70.15% of EG), cooked food (32.26% of BG and 26.87% of EG) and just 1.61% of BG and 2.98% of EG prefer a fruit or a slice of bread and tea. 86.15±3.09% of every group replied that the main reason why they are not paying attention to the importance of food is the fatigue, while the others replied that lack of time is the main reason.

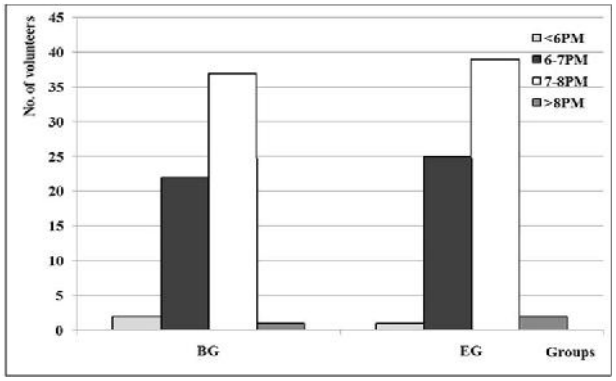

Fig 4: The comparative time of dinner

A. Finguroa *et al.*[16] found that milk proteins may have an antihypertensive effect by improving arterial function. Very similar results were obtained in terms of type of meat and cheese: 67.69±1.17% often prefer pork, 18.20±2.83% eat chicken meat, while 12.31±1.44% occasionally choose beef and fish; on the other hand, 53.84±2.14% often prefer homemade cheese, 37.54±1.78% eat milk, yoghurt and sour cream and just 4.62±0.75% occasionally choose cheddar.

X. Liu *et al.*[17] found that bradykinin induces a hypertensive response, while capsaicin induces a hypotensive response. Ginger effects over the cardiovascular system were presented in a review of T. Arablou and N. Aryaeian;[18] they noticed the decrease of apolipoprotein B with a role in alleviating the risk of some chronic complications of diabetes, the decrease of serum total cholesterol with a role in the effective treatment for prevention different complications and the decrease of serum triglycerides with an influence over the attenuated systemic inflammation and blood lipids in overweight women with breast cancer. In the present study, we found that 93.84±1.92% frequently eat horseradish, hot pepper and garlic, while just 4.62±1.21% rarely prefer to eat ginger root. Unfortunately, spicy food can cause inflammation of the stomach tissues and can even lead to gastritis; it may also be guilty of bad breath and this is the reason why many researchers develop new formulations based on phytochemicals entrapped inside drug delivery systems.[19] The following types of tea are drink by the volunteers of this study: 35.38±3.19% hawthorn, 27.69±1.49% linden flowers, 19.35±2.83% forest fruits, 12.31±0.81% chamomile and just 4.62±0.75% peppermint; 12.31±1.44% of both groups have replied that they do not drink any tea.

B.L. Pergola *et al.*[20] reported that both deficient and excessive sleep duration were significantly associated with a cardiovascular condition. On the other hand, H.V. Cole *et al.*[21] found a positive association between sleep duration and cardiovascular disease risk; they demonstrated that the positive relationship between sleep period and cardiovascular disease risk was not explained by selected lifestyle characteristics or sleep disturbance. In our study, 83.58±1.13% of EG and 80.65±1.76% of BG sleep 6-8 hours each night, 12.94±0.97% of every group sleep 4-6 hours, while just 1.24±0.61% sleep below 4 hours or more than 8 hours every night.

People who practice irregular physical activity over long periods of time are those people who have a sedentary lifestyle. Most of them do not practice any sport, due to lack of time and because their jobs does not involve too much physical activity. Sedentary lifestyle can cause a number of health problems, such as: metabolic disorders, inactivation of triglyceride decomposition enzymes, increased risk of developing cancer, obesity, postural and spinal cord injury, decreased muscle toning, osteoporosis, sleep disturbances, increased risk of diabetes and limitation of cardiovascular system function. D.J. Jakovljevic [22] studied the relationship between physical activity and cardiovascular aging; in this review, there were described the effects of age on cardiac and vascular changes and their adaptations to exercise, providing physiological, molecular and cellular mechanisms that underlie diminished cardiovascular response in older age. In our research, 64.18% of EG and 66.13% of BG have a moderate level of physical activity (3-4 times a week), 32.31±1.71% of every group just 1-2 times a week, while just 3.08±0.49% are sedentary or on the contrary, have an intense physical activity. Approx. 63.08±2.02% walk long distances daily, 19.78±1.19% use the personal car, 13.85±1.42% take a bus and just 1.54±0.61% ride a bicycle.

Figures 5 and 6 present the differences of blood pressure between the volunteers of the two groups, respectively between the beginning and the end of a working day. The lower values of systolic and diastolic blood pressure observed in the case of EG volunteers give important information about the action of hydrogen sulfide on cardiovascular system.

The quantitative relationships are regression or classification models often used in the biological sciences. Healthy

lifestyle, BMI, low-fat and low-sugar food consumption were correlated by I. Kuster and N. Vila.[23] On the other hand, S. Avram and her research group [24-27] developed different computational models based on quantitative structure-activity relationships (QSAR) in order to estimate the uncertainty in the prediction of novel molecules used in the treatment of Alzheimer's disease, bipolar disorders or as antidepressants, antipsychotics.

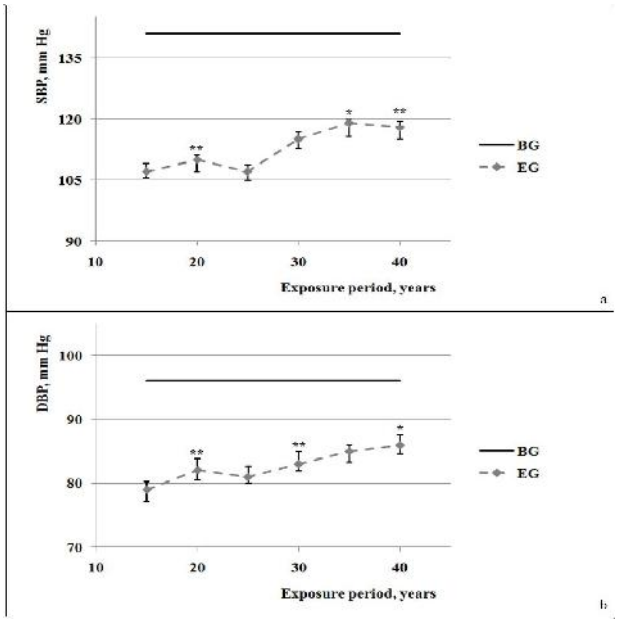

Fig 5: Correlation between (a) systolic blood pressure, (b) diastolic blood pressure and exposure period for exposed and blank groups.

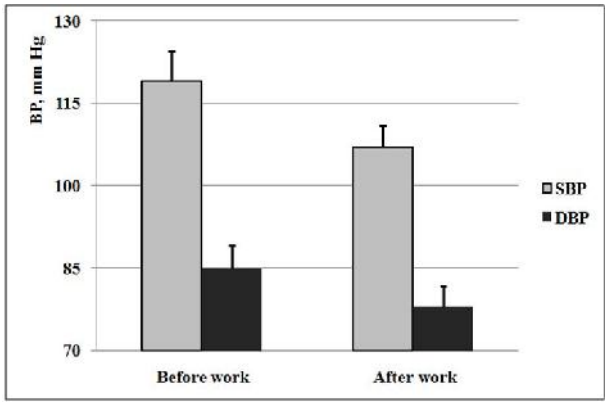

Fig 6: Evolution of blood pressure before vs. after working program of EG volunteers

The following formulas were obtained by correlations of different parameters:

MBP = 125.9376 – 7.9032*Sm + 3.5216*Co – 11.3279*Al (Eq. 1)

MBP = 67.8911 + 12.2417*Ti + 19.3072*La – 1.0702*Sl + 5.7221*Ph (Eq. 2)

MBP = 49.1202 + 29.6064*Sp + 3.4159*Me + 22.7451*Fr (Eq. 3)

Where MBP represent mean blood pressure equal with (SBP+DBP)/2 (systolic and diastolic blood pressure). Sm is smoking (0 for non-smokers, 1 for occasionally and 2 for smokers), Co means coffee (0 for non-drinkers, 1 for 1 coffee daily and 2 for more than 1 coffee daily) and Al is alcohol (0 for non-drinkers, 1 for occasionally and 2 for alcoholics). Ti represent time/meal (0 for <5 min, 1 for 5-15, 2 for 15-30 and 3 for more than 30 min), La represent last meal hour (0 for <6PM, 1 for 6-7, 2 for 7-8 and 3 for after 8PM), Sl represent sleeping period (0 for < 4 hours, 1 for 4-6, 2 for 6-8 and 3 for more than 8 hours) and Ph is physical activity (0 for no sedentary, 1 for low level and 2 for moderate activity). Sp means spicy food, Me is meat and Fr represent fruit (where 0 is for non-consumers, 1 for occasionally and 2 for frequent).

The correlation coefficients (q^2 (cross-validated r^2) and fitted correlation r^2) were also calculated for the three relations and the values are: Eq. 1 (q^2 = 0.81 and r^2 = 0.93), Eq. 2 (q^2 = 0.70 and r^2 = 0.89) and Eq. 3 (q^2 = 0.67 and r^2 = 0.92).

4. CONCLUSION

Many experts agree that diet, lifestyle and exposure to different chemical compounds play an important role in the cardiovascular disease. This study describes some life aspects of crenotherapy employees. Significant results (cross-validated correlation q^2 and correlation coefficient r^2) used in the correlation of diet, smoking, physical activity and blood pressure were obtained. Our findings indicate that exposure to hydrogen sulfide lead to decreased blood pressure values.

5. REFERENCES

1. C. Munteanu. Ape minerale terapeutice [Therapeutical mineral waters]. Ed. Balneara; Bucharest, Romania, 2013.
2. Alexandru I. Ape minerale sulfuroase [Sulfur mineral waters]. Balneo-Res J 2011; 2(3): 6–8.
3. Hydrogen Sulfide MSDS. Radnor (PA): Airgas USA [cited 2018 Aug 23]. Available from: https://www.airgas.com/msds/001029.pdf.
4. Singh SB, Lin HC. Hydrogen Sulfide in Physiology and Diseases of the Digestive Tract. Microorganisms 2015; 3: 866–889.
5. Beltowski J, Jamroz-Wisniewska A. Hydrogen Sulfide and Endothelium-Dependent Vasorelaxation. Molecules 2014; 19: 21183–21199.
6. Stein A, Bailey SM. Redox biology of hydrogen sulfide: Implications for physiology, pathophysiology, and pharmacology. Redox Biol 2013; 1: 32–39.
7. OECD. Analysis of H2S – incidents in geothermal and other industries. Reykjavík: Occupational Safety and Health Agency [cited 2018 Aug 23]. Available from: http://www.vinnueftirlit.is/media/greinar-og-skyrslur/2009_oecd_analysis_of_h2s-incidents.pdf.
8. Jones K. Case studies of hydrogen sulphide occupational exposure incidents in the UK. Toxicol Lett 2014; 231: 374–377.

9. Hydrogen sulfide. Washington DC: US Dept. of Labor [cited 2018 Aug 23]. Available from: https://www.osha.gov/SLTC/hydrogensulfide/index.html.
10. Onac BP, Sumrall J, Tamas T, et al. The relationship between cave minerals and H2S-rich thermal waters along the Cerna Valley (SW Romania). Acta Carsologica 2009; 38: 27–39.
11. Comparative price levels for food, beverages and tobacco. Bruxelles: Eurostat [cited 2018 Aug 30]. Available from : http://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_for_food,_beverages_and_tobacco.
12. Andrade AM, Kresge DL, Teixeira PJ, et al. Does eating slowly influence appetite and energy intake when water intake is controlled? Int J Behav Nutr Phys Act 2012; 9: 135.
13. Kinsey AW, Ormsbee MJ. The Health Impact of Nighttime Eating: Old and New Perspectives. Nutrients 2015; 7: 2648–2662.
14. Eng S, Wagstaff DA, Kranz S. Eating late in the evening is associated with childhood obesity in some age groups but not in all children: the relationship between time of consumption and body weight status in U.S. children. Int J Behav Nutr Phys Act. 2009; 6: 27.
15. Coulthard J, Pot G. The timing of the evening meal: How is this associated with weight status in UK children? Brit J Nutr 2016; 115(9): 1616–1622.
16. Figueroa A, Wong A, Kinsey A, et al. Effects of Milk Proteins and Combined Exercise Training on Aortic Hemodynamics and Arterial Stiffness in Young Obese Women With High Blood Pressure. Am J Hypertension 2014; 27(3): 338–344.
17. Liu X, Zhang Q, Han M, et al. Intrapericardial capsaicin and bradykinin induce different cardiac-somatic and cardiovascular reflexes in rats. Autonom Neurosci 2016; 198: 28–32.
18. Arablou T, Aryaeian N. The effect of Ginger (Zingiber Officinale) as an ancient medicinal plant on improving blood lipids. J Herb Med 2017; 12: 11–15.
19. Munteanu MF, Ardelean A, Borcan F, et al. Mistletoe and Garlic Extracts as Polyurethane Carriers – A Possible Remedy for Choroidal Melanoma. Curr Drug Deliv 2017; 14(8): 1178–1188.
20. Pergola BL, Moonie S, Pharr J, et al. Sleep duration associated with cardiovascular conditions among adult Nevadans. Sleep Med 2017; 34: 209–216.
21. Cole HV, Owusu-Dabo E, Iwelunmor J, et al. Sleep duration is associated with increased risk for cardiovascular outcomes: a pilot study in a sample of community dwelling adults in Ghana. Sleep Med 2017; 34: 118–125.
22. Jakovljevic DJ. Physical activity and cardiovascular aging: Physiological and molecular insights. Experim Gerontol 2017, pii: S0531-5565(17)30100-6.
23. Küster I, Vila N. Healthy lifestyle and eating perceptions: correlations with weight and low-fat and low-sugar food consumption in adolescence. Frontiers Life Sci 2017; 10: 48–62.
24. Avram S, Borcan F, Borcan LC, et al. QSAR Approaches Applied to Antidepressants Induced Neurogenesis - in vivo and in silico Applications. Mini-Rev Med Chem 2016; 16: 230–240.
25. Mernea M, Borcan L-C, Borcan F, et al. Antipsychotics as Psychosis Drugs and Neuroprotective Promoters Evaluated by Chemical QSAR - in silico and in vivo Studies. Lett Drug Design&Discov 2016; 13: 269–275.
26. Avram S, Mernea M, Bagci E, et al. Advanced structure-activity relationships applied to Mentha spicata L. subsp. spicata essential oil compounds as AChE and NMDA ligands, in comparison with donepezil, galantamine and memantine – new approach in brain disorders pharmacology. CNS & Neurological Disorders-Drug Targets 2017; 16: 800–811.
27. Avram S, Alexandrescu I, Puia A, et al. Aneuploidy-Inducing Mutations in Mitotic Checkpoint Protein hMad1-Carboxi Terminal Domain Analyzed by SAR and Computational Mutagenesis. Curr Proteom 2017; 14: 254–260.

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