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THE INTERCONNECTION BETWEEN INDIVIDUAL CIRCADIAN RHYTHMS AND EATING BEHAVIOR AS ONE OF MAIN REASONS OF OVERWEIGHT AND OBESITY IN YOUNG PEOPLE

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ABSTRACT

The article features the problem of overweight and obesity and its prevalence among young people. Possible negative outcomes of mentioned states and mechanisms of obesity development are listed. The programs of obesity prevention and their main directions are mentioned. The role of individual circadian rhythms on metabolism of a person is explained. The original research results regarding the interconnection between individual circadian clock, eating habits and body mass index are presented. Conclusions were made about influence of biological rhythms and eating patterns synchronization on body weight and metabolism and their application as simple and efficient way of obesity prevention in young people.

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According to definition of World Health Organization, “overweight and obesity are the result of formation of abnormal or excessive adipose tissue that may harm one’s health” [1]. The world statistics shows that about 39% of adult men and 40% of adult women are suffering from obesity. Moreover, the constant progression of number of obese people is seen during the period from 1975 to 2016; for example, the dangerous dynamics was revealed among children and adolescents, as during the mentioned time the prevalence of boys and girls with obesity rose up from 4% to 18% [1]. Overweight endangers one’s life as it is a huge risk factor of numerous noncommunicable diseases, such as cardiovascular diseases, diabetes, disorders of musculoskeletal system, oncological diseases, including widespread cancers of endometrium, mammary gland, ovaries, prostate gland, liver, large intestine, etc. [1, 2, 3, 4].

Regarding possible outcomes of obesity, the research of factors causing it and development of effective strategies of overweight prevention are carried out all over the world, however, still are very important. As the main reason of body weight increase is always the phenomenon of energetic imbalance, i.e. the misalignment of metabolic needs of the body and energy intake in form of diet peculiarities, the essential factors leading to that imbalance (excessive caloric value of food, hypodynamy, physical inactivity, etc.) are greatly and widely studied [2, 3, 4, 5]. The possible ways and tactics for fighting against obesity are listed in “WHO Global Strategy on Diet, Physical Activity

and Health”, 2004, and “Global Plan on Prevention of Noncommunicable Diseases 2013-2020”. The listed documents contain not only recommendations for population (like decrease of diet caloric value and regular physical activity), but also for organizations related to food industry and marketing (for example, decrease of content of fat, sugar and salt in manufactured dietary products and shortening of advertisement time for products with high content of mentioned substances) [1]. However, the search for new possible risk factors and possible solutions of weight problem continues, and recently the active study of connection between circadian rhythms and obesity due to special influence of those rhythms on metabolic status of living beings is carried out [2, 3, 4, 5, 6].

Nowadays the fact of presence in every living organism of individual internal clock that control all the organism’s functions from cellular to social levels is widely known [7]. The manifestation of circadian rhythms influence in human body is seen in peculiarities of eating behavior, digestion and metabolism determined by variations of levels of hormones regulating mentioned processes [2]. The food intake aligned with individual biorhythms has shown itself as an effective way of weight control, however, the reversed connection is also present, as the fixed intake of food according to precise schedule is one of main factors of setting of circadian rhythms leading to stabilization and normalizations of hormonal status and weight. Circadian rhythms modulate the energy exchange both on central and on local levels with supraoptic nucleus of hypothalamus being the central pacemaker. The influence of circadian clock on metabolic processes occurs through circadian proteins, such as CLOCK, BMAL, PER, CRY, REV-ERB, that regulate the metabolism through influence in cellular energetic processes and change the balance with help of various mechanisms including certain metabolites (NAD, NADH, ATP) and interaction with different genes controlling the homeostasis of lipids and proteins in the body [2]. Inappropriate food intake that doesn’t correspond with individual nervous and humoral circadian regulatory mechanisms may lead to disorders of normal metabolic profile of a person, as it causes the decrease of levels of leptin and melatonin and rises the level of ghrelin in circulating blood leading to increased appetite followed by larger food intake and, correspondingly, the shift of energy balance. Furthermore, the disturbance of circadian rhythms decreases the insulin response to glucose, becoming a risk factor of obesity and diabetes mellitus development [2]. Regarding all mentioned above, during recent time the utmost importance belongs to concept of chrononutrition that takes into account not only food content, but also time of its intake [2, 6, 7]. According to that concept, from one side, the food intake is a modulator of circadian rhythms that can be used for weight control, and from the other side, the mentioned connection may cause the particular “vicious circle” when the absence of coordination between feeding plan and individual biological clock, especially seen for a long time, leads to changes of body mass, obesity and its consequences appearance, and those changes are the bigger the more potent are possible changes [3, 4, 6, 7].

The aim of current research was to determine the state of synchronization and desynchronization of individual circadian rhythms and patterns of eating behavior among young people and to find out the possible outcomes of that state on body mass as one of indexes of organism’s metabolism.

Materials and methods. The study was carried out in Kharkiv National Medical university. 72 students took part in current study, all aged 18-21, 39 (54%) were young men and 33 (46%) young women. All participants voluntary agreed to take part in research and signed the written consent. As the main index determining the individual biological clock is person’s chronotype, the pattern of circadian rhythms was defined by adapted version of Munich ChronoType Questionnaire (MCTQ). The individual eating behavior was studied based on results of Eating Habits Questionnaire (EHQ), that included such parameters as frequency and time of food intake, its approximate quantity and content, frequency of eating of particular products (fresh fruits and vegetables, fast food, etc.), changes of eating patterns depending on day of the week and others. The categorization according to weight was made by body mass index (BMI) value calculated by standard formula, as BMI is thought to be the most convenient research method of overweight among population, is universal and doesn’t depend on sex and age (WHO, 2018).

Results and discussion. Results achieved with help of MCTQ allowed us to determine among examined people 5 different patterns of circadian rhythms (pic. 1). Among 72 participants 3% were people with moderately early chronotype, 12% with slightly early, 38% with normal, 32% with slightly late, and 15% with moderately late chronotype. Extreme chronotypes (extremely early and extremely late) were absent in examined group. Therefore, the bigger part (47%) of examined young people have late chronotype that can be explained by both genetically determined peculiarities and by

influence of external factors, including eating behavior peculiarities, parameters of external environment (first of all, intensity and duration of different illumination), and also high intellectual and emotional load caused by process of training in medical university.

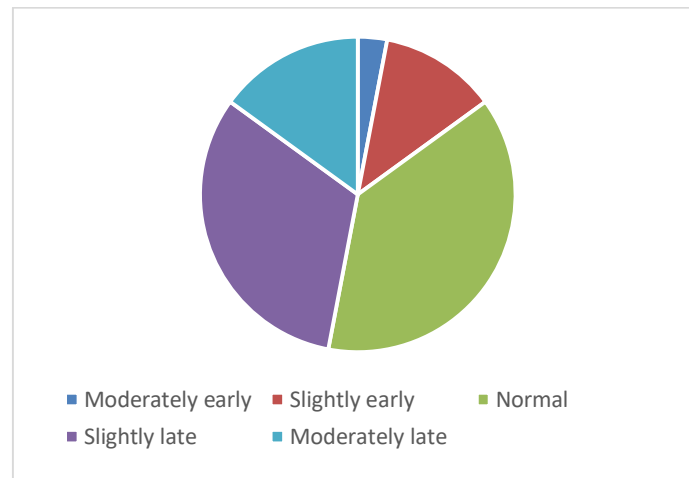


Fig. 1. The distribution of chronotypes among examined young people

The comparison of individual chronotypes with eating patterns, data about which was received with help of EHQ, allowed estimation of state of synchronization of individual biological clock with peculiarities of food intake, according to which all examined people were divided into 2 groups. The 1st group (synchronization group) included 27 people (38% of all examined) with satisfactory level of those processes alignment. The 2nd group (desynchronization group) was made of 45 students (62%) with significant misalignment of circadian rhythms and eating patterns. Such results allow to suspect the possible metabolic changes in people of desynchronization group, caused by disturbances of control of levels of insulin, leptin, glucose and other important metabolic parameters [3, 4]. Furthermore, the smallest misalignment was seen in people with moderately early and moderately late chronotypes, and the biggest among examined with slightly early, slightly late and normal. That can be related to peculiarities of studying process and daily regimen in students, that include early waking up and high mental load until the late evening, and tight schedule often doesn't allow to take meals at specific time or to have a normal full meal during the day at all, thus meal time shifts to late evening leading to desynchronization of eating schedule with one's individual chronotype.

Research of body mass index (BMI) showed significant differences between two examined groups based on different alignment index of circadian rhythms and eating patterns (pic. 2 and 3). In group of synchronization the average BMI was 20,32 and varied within the group from 17,36 to 23,73. 18% of people from that group (all young women) had BMI below normal, other 82% had normal BMI value. In desynchronization group the average BMI was 23,88 that is considered as normal, but is at the higher border of normal value, so average BMI of 2nd group is higher than in 1st one. The variations of BMI inside the 2nd group were determined in range from 17,9 to 30,95, from them 9% were underweight people, 56% with normal BMI, and 35% with overweight.

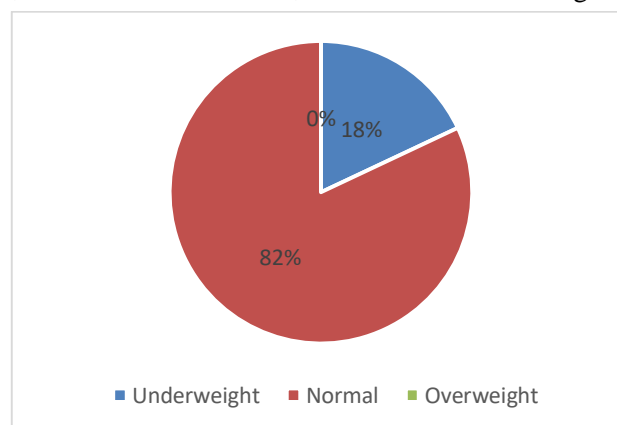


Fig. 2. BMI in group of synchronization

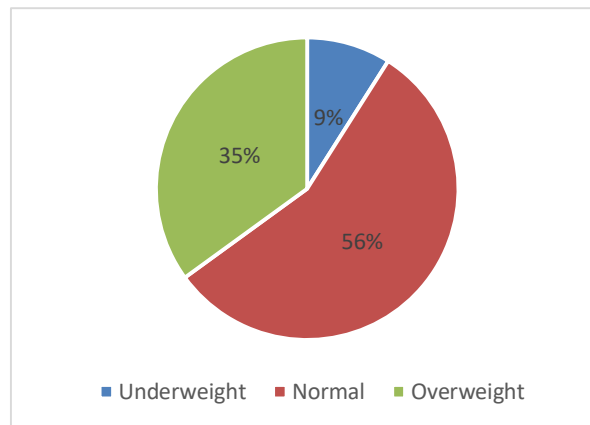


Fig. 3. BMI in group of desynchronization

Such results signalize about existence of interconnection between the pattern of eating behavior, individual circadian rhythms and peculiarities of metabolic status in young people. The particular tendency was determined – the more significant is misalignment between eating habits and biological clock, the more is the shift of body weight from normal values. Such results can be explained by few mechanisms, including, firstly, the decrease of leptin level and related to it increase of appetite that leads to increase of number of meals per day in group with desynchronization; secondly, such state of misalignment of circadian rhythms and eating behavior cause the changes of energy balance of the body as it leads to decreased glucose tolerance and increase of lipogenesis resulting in development of overweight and obesity [4, 5, 8, 9].

Conclusions. The desynchronization of individual biological clock with patterns of eating behavior in young people may cause the increase of body mass and changes of metabolic status of the body, that may lead to such negative outcomes in the future as metabolic syndrome, diabetes mellitus type 2, various cardiovascular diseases, etc. At the same time as food intake is one of the main factors in setting and stabilizing the circadian rhythms of the human body, the adjustment of individual eating pattern to one's biological clock may be used as a simple and effective method of body mass control and mentioned diseases prevention.

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