УДК 616.132.1/.2-089.86

Oksana ZAYACHKIVSKA[1], Nataliya DOROSH[2], Maryana ZVIR[1], Anna KOZAKOVA[1], Myhajlo PLYATSKO[3], Oleg DOROSH[4,5], Irena YERMAKOVA[4]

DETECTION OF EARLY RISK FACTORS OF STRESS IN STUDENTS USING „SMART LION" M-HEALTH TECHNOLOGY

[1]Physiology Department, [2]Department of Medical Informatics, [3]Department of Internal Medicine No.1, Lviv National Medical University, Lviv, Ukraine, ozayachkivska@gmail.com, nvdorosh5454@gmail.com

[4]International Scientific-Training Center for Information Technologies and Systems, National Academy of Sciences, Ministry of Education and Science, [5]National University „Kyiv-Mohyla Academy", Kyiv, Ukraine

Introduction. *Modern methods and means of health monitoring involving mobile phones (m-Health) can soon become widespread personal health assistants ensuring strong motivation for optimization of the healthy lifestyle. Despite the major advances in understanding the pathogenesis of mental health and internal diseases, the research of the early risk factors that affect the health of young adults has become a priority in medicine.*

This study is aimed at creation of a new «in silico» diagnostic medical technology, which could provide efficient and convenient approach to personal/doctor's control and analysis of health (longevity operative informative technology, acronym: SMART LION) for the purpose of investigating the impact of lifestyle on health of medical students and IT (Information Technology) students.

Methods. *We held a cohort study using a sleep diary, stress reaction, alexithymia and sleep/health-related data of about 100 students (56 females and 44 males aged 18-24) focusing on body weight index (BWI, norm = 18.5-24.9), sleep pattern (timing, duration per day/week), physical activity related to sport exercises and duration of daily sitting time, including work with computer (divided into 3 groups: 1-low, 2-regular, 3-intense), learning performance (divided into A, B, and C classes), incidences of acute respiratory infections (ARI) per year (divided into low – <4 times a year or high - >4 times a year. The study involved m-Health programs «Your nervus» and «Analysis of the HRV» for Android smartphones and tablets.*

Results: *BMI<18.5 was found in 22% (19% of female, 3% of male) of students; normal BMI – in 76% (35% of women and 41%of men), and BMI > 24.9 – in 2% of MS. Forty-three percent of students in group 1 engaged into physical activity, as did 50% of those in group 2, and 7% of students in group three. Sixty-eight percent of students worked on their computers for more than 6 hours a day, and 32% - less than 6 hours. The daily lack of sleep (6 hrs and less) was found in 43% of students; 6-7 hrs of sleep - in 42% of students, and > 7 hrs - in*

15% of students. Academic performance: 26% of medical students who participated in the study belonged to group A, 56% - to group B, and 18% - to group C. The students identified inability to cope, helplessness, increased psychological pressure, mental tension, and excessive workload as main stress factors. Students' own estimation of stress was confirmed by 87% of male and 61% of female students while HRV estimation revealed sympathetic hypertonus in 94% of female and 75% of male students. The incidence of ARI >4 times/year was the highest in the first group (53%). Circadian dysfunction (CD) was recognized by about 65% of persons, students with moderate and intense physical activity fell ill 3-4 times a year. Students who sleep less than 6 hrs a day (16%) had a C academic level, all of them had ARI more than 4 times a year.

Conclusion: *Our pilot study has shown that CD and increased sitting time are the early risk factors in student's lifestyle. The comprehensive specialized multi-function personalized application SMART LION with client-server architecture will help to recognize early changes in human behavior, mindset, and emotional state, which can be induced by CD and increased sitting time as soon as possible, and stimulate the student's interest in and preparedness to lead a healthy lifestyle.*

Key words: *mHealth, risk factors, student health, circadian rhythm, stress, sitting time.*

*Оксана ЗАЯЧКІВСЬКА[1], Наталія ДОРОШ[2], Мар'яна ЗВІР[1],
Анна КОЗАКОВА[1], Михайло ПЛЯЦКО[3], Олег ДОРОШ[4,5], Ірена ЄРМАКОВА[4]*

ВИЯВЛЕННЯ РАННІХ ФАКТОРІВ РИЗИКУ СТРЕСУ СЕРЕД СТУДЕНТІВ ШЛЯХОМ ВИКОРИСТАННЯ ПРОГРАМИ „SMART LION"

*[1]Кафедра нормальної фізіології, [2]Кафедра медичної інформатики,
[3]Кафедра внутрішніх хвороб №1, Львівський національний медичний університет імені Данила Галицького, Львів, Україна
ozayachkivska@gmail.com, nvdorosh5454@gmail.com*

*[4]Міжнародний науково-практичний центр інформаційних технологій і систем Національної академії наук, Міністерство освіти і науки,
Національний університет „Києво-Могилянська академія", Київ, Україна*

Вступ. *Незважаючи на значні успіхи в розумінні патогенезу психічного здоров'я та захворювань внутрішніх органів, дослідження ранніх факторів ризику, які впливають на здоров'я молоді, є пріоритетом у медицині. Сучасні методи та засоби спостереження за здоров'ям через мобільні пристрої (смартфони, планшети тощо) – mHealth незабаром можуть стати широкопоширеним помічниками для забезпечення здоров'я індивідума, створюючи сильну мотивацію для дотримання та оптимізації здорового способу життя.*

Дане дослідження спрямоване на створення нової «in silico» діагностичної технології медичного спрямування, яка може забезпечити ефективний та зручний підхід до персонального/лікарського контролю та аналізу стану здоров'я (Longevity Operative Informative Technology, акронім: SMART LION), щоб дослідити роль впливу циркадних порушень (ЦП) на здоров'я студентів-медиків та студентів факультетів інформаційних технологій.

Методи: *Когортне дослідження, що включало в себе використання щоденника сну, оцінку перцепції стресу, алокситемії, збір даних про сон та інших показників, пов'язаних зі станом здоров'я, було проведено на 100 студентах (56 осіб жіночої статі, 44 особи чоловічої статі; віком 18-24 років), приділяючи особливу увагу індексу маси тіла (ІМТ, норма 18.5-24.9), режиму сну (час, тривалість протягом дня, тижня), фізичній активності відповідно до фізичних навантажень та тривалості часу проведеного у сидячому положенні щодня, включно з часом роботи з комп'ютером (розподілення на 3 групи: 1-низька, 2-регулярна, 3-інтенсивна), продуктивності навчання (оцінюються в А, В, С клас), випадкам гострих респіраторних інфекцій (ГРІ) (<4 або >4 разів/рік) з використанням m-Health програм "Ваша нервова система" ("Your nervus") та «Аналіз варіабельності серцевого ритму (ВСР)» ("Analysis of the HRV") для смартфонів і планшетів з оперативною системою Android.*

Результати: *ІМТ <18.5 розрахований у 22% (19% жінок, 3% чоловіків); нормальний ІМТ – у 76% (жінки - 35%, чоловіки - 41%), ІМТ > 24,9 – у 2% обстежених. Фізична активність 1 групи виявлена в 43%, 2-ї – у 50%, і 3-ї – у 7% осіб із загальної групи. Повсякденна тривалість роботи з комп'ютером > 6 год спостерігалася у 68%; < 6 год - у 32%. Щоденна нестача сну (тривалість сну 6 год і менше) наявна в 42,85%; сон протягом 6-7 годин – у 42%, > 7 год – у 15,73%. Продуктивність навчання: клас А у 26%, В - 56%, С - 18% від загальної кількості обстежених студентів. Захворюваність на ГРІ > 4 на рік виявлена у 26%; < 4 рази на рік – у 74% студентів. Рівень високої тривожності ІТ-студентів на момент випробувань складав 30%, середньої-60%, низької -10%. Він оцінювався за допомогою методики (шкали) Спілберга-Ханена, а також програми "Ваша нервова система" ("Your nervus") для визначення рівня стресостійкості. Шкала складалася з 40 питань, спрямованих на визначення реактивної та особистісної тривожності.*

Нездатність впоратися з поставленим завданням, безпорадність, збільшення психологічного тиску, психічне напруження та занадто велике навантаження були головними самостійно оціненими «чинниками стресу». Самооцінку стресу підтвердили 87% і 61%, а оцінка ВСР виявила симпатичний гіпертонус в 94% і 75% студентів жіночої і чоловічої статі, відповідно. Захворюваність на ГРІ > 4 рази / рік була найвищою у 1 групі (53%). ЦД визнаються в близько 65% осіб, студенти з помірною та інтенсивною фізичної активності хворіли 3-4 рази на рік. Академічний рівень класу С виявлений у студентів, які сплять менше 6 год на день (16%), у всіх них частота ГРІ > 4 рази / рік.

Висновок: *Наші попередні результати показали, що ЦД впливає на здоров'я студента. Комплексна, спеціалізована, мультифункціональна персоналізована програма SMART LION із структурою клієнт-сервер допоможе в найшвидший спосіб виявити ранні зміни в поведінці людини, її мисленні та емоційному стані, які можуть бути викликані ЦД і збільшенням проведеного часу в сидячому положенні, а також розвиватиме зацікавленість і готовність студентів до ведення здорового способу життя.*

Ключові слова: *m-Health, фактори ризику, здоров'я студентів, циркадний ритм, стрес, час в сидячому положенні.*

INTRODUCTION

Modern digital health systems are innovative opportunities for health care and interaction between patient and medical staff, which is often based on informative computer technology (ICT) cloud-, telemedicine-, and mobile phone approaches (mHealth) (Eyesenbach, 2001). Involvement of patients (consumers) into preventive care via modern channels of information delivery (smartphones or tablets) is the global trend aimed at monitoring well-being, health control, and easy connectivity with health professionals via ICT gadgets (Free, 2013; Adibi, 2015). According to the data of the European Research Counsel for 2015, 97,000 of mHealth apps are currently available and 70% of them target costumers and their well-being & fitness while 30% are aimed at health professionals. In the meantime, modern everyday social life is characterized by overload of stress related to circadian dysfunction, caused by "blue light" from multi-screen influence (PC, laptop, desktop PC, tablets, e-readers) or lack of sleep, insomnia (Chang, 2015; Stevens, 2015), and wide common "desk-style" lifestyle inducing additional constant negative impact on health (Proper, 2011; Martins, 2015). Recent data have shown that sitting for a long time is a kind of a "second smoking" habit. It causes endothelial dysfunction (Thosar, 2015), along with chronodisruption (Karatsoreos, 2012). Current changes in population dynamics (migration, social isolation, family disintegration or war-time), as well as barely tolerated population diversity, also belong to the negative factors that impact health (Gouin, 2014; Mikal, 2015), cognitive functions and memory (Garett, 2010). Therefore, they can be interpreted as additional present-day lifestyle risk factors. It is well known that development of Alzheimer's disease spectrum (AD), according to the data of the Karolinska University (2013-2015), Mayo clinic reports (2014-2015), and Harvard and USLA studies (2012-2015) related to vascular dementia and accelerated aging, often started at young age, sometimes even before 30 and was clinically invisible and generally ignored (Shaw, 2013; Knopman, 2014). The ranges of behavioral disturbances and cognitive impairment in AD genesis and their neuropsychological performance scores have been investigated in the last years. Recent studies point out the link between stressful life events and depression, being the prodromal stage of AD, as well as with „frailty", described as the decreased ability of an organism to respond to stressors (Assari, 2015; Robillard, 2015). Besides, changes of cognitive reserve, an individual difference in mind's resistance to brain injury by numerous environmental or inner factors, is generally considered as a measure of regulatory influence induced by chronic stress (Rickenbach, 2015). There are also numerous data proving that melatonin, being released in an age-dependent manner, helps the organism to anticipate periodic changes in the environment, and consequently represents important adaptive mechanisms allowing the organisms to survive under markedly altered conditions (Zayachkivska, 2007-2014; Kepka, 2015; De Berardis, 2015). Melatonin-related biological circadian rhythms play an important role in physiological functions and adaptation to stress (Yamanaka, 2014). Moreover, circadian dysfunction contributes to the incidence of a wide range of clinical pathological conditions including sleep disorders, inflammation and even carcinogenesis (2007-2014). In fact, disorders of melatonin release associated with social stress and circadian dysfunction caused by environmental factors ("blue light" influence, lack of sleep) may be hidden by adaptive reactions of the organism and only integrative approach of mHealth can reveal the abnormalities. If this is correct, integrative evaluation and regulation in real-time mode by mHealth multi-monitoring of personal physiological parameters during the stress, sleep and daily activities, as well as of psychological changes, along with imaging of neural processing, should reflect early asymptomatic (preclinical) or thinking difficulties (mild cognitive impairment) stages of AD, which are a critical "window" for disease-modifying treatment. Currently, there are many medical gadgets and mobile devices that provide a different discrete information about health: pulse, blood pressure, the level of physical activity, the number of burned calories over time, time and phases of sleep, and others. However, there are not enough software tools for effective analysis of the data taking into account the possible impact of some parameters on the other ones, which would allow identifying risk groups and preventing potential diseases, as well as creating programs for corrective feedback.

Therefore, our aim was to create a new «in silico» diagnostic tool for efficient and convenient personal and medical control and analysis of health, lifestyle and stress-induced living behavior via mHealth approach using software "SMART LION" (Longevity Informatics Operative Navigator) based on "Multi-scale Modular Mathematical" (3M) analysis.

SUBJECTS AND METHODS

One hundred apparently healthy students (56 female and 46 male) of the Lviv National Medical University (LNMU) and the National University «Kyiv-Mohyla Academy» (KMU) aged 19-24 were enrolled in a cohort study. The data collected included anthropometric results (height measured by standardized stadiometer and weight measured according to EP240 (Ukraine), calculation of body mass index (BMI, normal = 18.5-24.9), sleep pattern investigation (timing, duration per day, and week), identification of duration of sitting time and physical activity (divided into 3 groups: 1-low, 2-regular, 3-intensive), academic performance (divided into A, B, and C classes according to academic reports), and incidences of acute respiratory infections (ARI) per year divided into: low <4 or high >4 times/year. In addition, stress perception and alexithymia were tested. All subjects underwent an investigation by m-Health program «Your nervus» and «Analysis of the HRV» for Android smartphones and tablets (Dorosh, 2015). The Ethics Committees of the LNMU and the International Scientific-Training Center for Information Technologies and Systems approved the design and study protocol. Collecting integrative data of human parameters, "SMART LION" allowed conducting a comparative express-analysis (normal, borderline, abnormal) for identification of risk groups, and revealing the integrated indicators (indexes) for complex and professional analysis.

Structural organization of Smart Lion health navigator includes client and server parts (Fig. 1). Structural organization of the client-server part of such system intended for personalized healthcare envisages the following elements at the client level: user identification procedures; transfer of data from medical sensors and devices or data input with the help of keyboard; establishment of a local database, local computing module, and polls; performance of express analysis, and display of results. A global database is formed on the server, and a comprehensive analysis (e.g. of heart rate variability) is carried out. Its results are further used for the production of corrective recommendations. Android Studio integrated development environment (http://developer.android.com/tools/

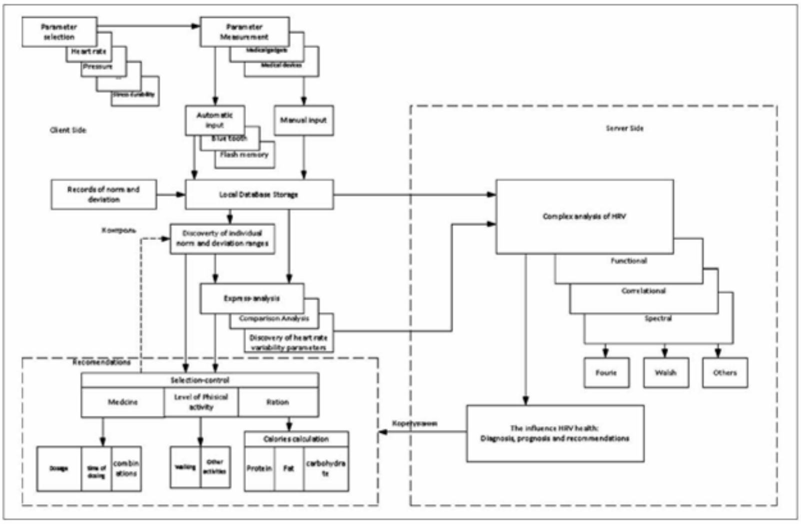

Fig. 1. Structural organization of the Smart Lion health navigator (Dorosh O., et al 2015).

studio/index.html) was used for health navigator software development. Examples of the developed software systems include «Your nervus» and «Analysis of the HRV» m-health programs for Android smartphones and tablets. «Your nervus» has a set of test questions to determine the stress level of a person (perception of stress, alexithymia and anxiety). The software allows analyzing the answers to the questions given by key schemes of different difficulty levels and displaying the analysis results on the screen of personal mobile devices. Medical gadgets with built-in pulse sensors, like MioFuse fitness bracelet (fig.2), were used to test the «Analysis of the HRV». The heart rate was being monitored for 10 hours. A comprehensive professional analysis of HRV via the server was done using the methods of spectral analysis of functions in different bases, including the maximum and average values of heart rate (HRV), the analysis of time intervals (RR), and calculation of the following parameters: MHR - mean heart rate, mRR - mean RR-intervals, pNN50 - the number of pairs of successive NN-intervals that exceed 50 milliseconds. In determining the distribution of cardio intervals we defined: Mo - fashion, meaning the level of functioning of the cardiovascular system; the most frequently observed Amo - amplitude modes; power value influences of sympathetic part in autonomic nervous system (ANS), which are most frequently observed; and VAR - variational scale, a measure of power influences of neurohumoral regulation. SI is the regulatory systems tension index showing the degree of regulatory systems tension (a measure of the activity of the central benefits of autonomous regulatory mechanisms). In the process of Fourier spectral analysis we evaluated: ULF – the power over extremely low-frequency components for measuring very low power influence of neurohumoral control, it is associated with thermoregulation or other long-term control systems, such as renin-angiotensin system and the sympathetic part of ANS; VLF, LF - extremely low-power and low-frequency components for measuring low power influence of neurohumoral control, they are associated mainly with the sympathetic and parasympathetic parts of ANS. In the course of research, we also recorded HF - high-power components for measuring the power of high impact neurohumoral control (it is predominantly associated with parasympathetic part of ANS); TP - total power spectrum of HRV for measuring power influence of neurohumoral control; LFnorm - normalized low-power components; the relative level of low-level of neurohumoral control associated with impact of sympathetic part of ANS; HFnorm - normalized power high-frequency components for measuring the relative level of the high-level of neurohumoral control, associated with the relative level of the parasympathetic part of ANS; LF / HF - ratio of low capacity and high-frequency components determined by measuring the balance of low- and high-frequency parts of control to detect a disbalance in ANS control.

Statistical analysis of all data was done using the Statistica 10.0 (Statsoft, USA) statistical package.

RESULTS AND DISCUSSION

Main anthropometric data and normal range of BMI were found in 76% (35% - women and 41% - men) of students while the incidence in BMI changes reached 24%. The tendency of BWI being less than 18.5 was found in 22% (19% of women, 3% of men) of students and BMI > 24.9 in 2% of the subjects, which indicated the first grade of obesity. Forty-three percent of students of the 1 group, 50% of students of the 2 group, and 7% of students of the 3 group were physically active. The parameters of daily duration of computer work have shown that all students spend about 4 or more hours at their computers. In 68% of subjects out of the total study group, this indicator exceeded 6 hours, and in 32% it was less than 6 hours or about 4 hours, which confirmed a prolonged daily sitting time and the excessive influence of the "blue light". The data from student sleeping diary records have shown that daily lack of sleep (6 hours and less) was present in 43% subjects; 6-7 hours of sleep - in 42%, and > 7 hours – in 16% of subjects. CD was recognized in about 65% of persons. The students' academic performance, according to their grades was as follows: 26% of students had "A" grades, 56% - "B" grades, and 18% - "C" grades. The incidence of ARI that exceeded 4 times/year was found in 26% of subjects, and less that 4 times/year – in 74% of subjects. The incidence of ARI >4 times/ year was highest in the 1st group (53%), i.e. the students with moderate and intensive physical activity fell ill 3-4 times a year. Students, who sleep less than 6 hours/day (16 %), had "C" grades, and all of them had ARI >4 times/year.

Inability to cope, helplessness, increased psychological pressure, mental tension ant too much workload were main self-estimated "stress factors" determined by "Your nervus" app. Self-estimation of stress in the study group was confirmed by 87% of female and 61% of male students. Analysis of HRV on the basis of the heart rate data and R-R intervals, which was done using the «Analysis of the HRV» by medical gadgets with built-in pulse sensors (on fitness bracelet MioFuse (Fig.2)) together with spectral analysis, has shown normal functioning of ANS or parasympathetic influence (vagotonic impact) in 25% of women and 48% of men that were included into the cohort study.

Fig. 2. The study of heart rate using MioFuse Fitness bracelet.

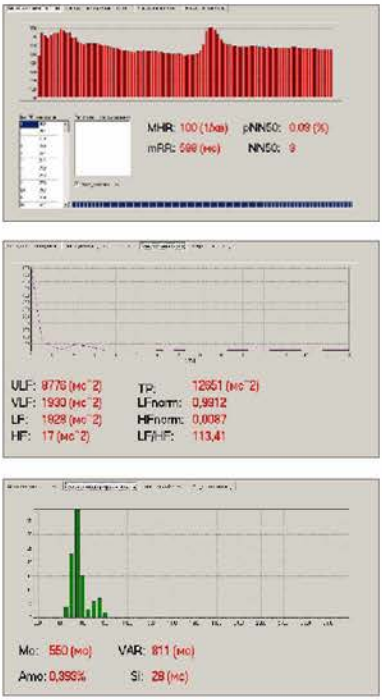

Fig. 3. HRV research by time intervals and spectral analysis.

Fig. 3 shows a case study of HRV in a 21-year-old male student with no stress according to his self-estimation and data of "Your nervus" app. In the course of testing, the program received the following indicators: MHR = 95 (1 / min); mRR = 628 ms; pNN50 = 0.036%; NN50 = 75; Mo = 650 ms; Amo = 0.124%; VAR = 2,967 ms; SI = 100,019 ms; ULF = 8,776 ms2; VLF = 1,930 ms2; LF = 1,928 ms2; HF = 17 ms2; TP = 12,651 ms2; LFnorm = 0.9912; HFnorm = 0.0087; LF / HF = 113.41. A formal diagnosis of moderate strength of HRV; the advantage of the high-level regulation; low risk of a fatal condition.

The results obtained by the "Analysis of the HRV" app reflected the disbalance in ANS with a shift to sympathicotonic hypertonus in 75% of female and 52% of male students.

There are several important limitations of this pilot study. Sharply increased degrees of stress perception and the rise of sympathetic influence in the female group can be explained by the impact of their hormonal sensitivity on HRV tracking during different phases of the menstrual cycle (menses, follicular phase, and luteal phase). Additionally, the current hostilities have a specific and novel kind of influence on human population, when human relationships and interpersonal communication in Ukraine have changed. These emotional changes in civilian population result from their unwillingness to accept different interpretations of political events or views, loss or creation of a new "common ground", which causes the polarization in society. Moreover, the Ukrainian social life is characterized by the shift in everyday activity, departure from the relaxing family pastimes towards the anxious search for the latest news, often late at night, using very interactive technologies (the internet, social networks). The limitless and live-streamed information caused changes in circadian rhythm patterns, one of the main regulators of human physiology and homeostasis. Therefore, economic (decreased incomes, fear of insecure financial future of the Ukrainians) and civil instability, as well as wartime create chronic stress which promotes the development of health problems.

CONCLUSIONS

1. Early risk factors of student lifestyle seem to include circadian dysfunction and increased total daily sitting time combined with increased stress perception.

2. An integrative approach to biomedical sciences and IT sciences can help create a comprehensive specific time-bound multi-personalized mobile system with client-server architecture and adaptability to individual user requirements, which would help monitor the students' health and extend their involvement into prevention of diseases.

3. The specialized software SMART LION enables the increase of the mHealth systems efficiency in identification of early risk factors of stress among students and promotion of their interest in and preparedness to lead a healthy lifestyle.

БІБЛІОГРАФІЧНІ ПОСИЛАННЯ

1. Adibi, S. (Ed.), 2015. Mobile Health: A Technology Road Map (Vol. 5). Springer.
2. Assari, S., Lankarani, M. M., 2015. Association Between Stressful Life Events and Depression; Intersection of Race and Gender. Journal of Racial and Ethnic Health Disparities. 1-8.
3. Chang, A.M., Aeschbach, D., Duffy, J.F., Czeisler, C.A., 2015. Evening use of light--emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness // Proc Natl Acad Sci USA. Vol. 27;112(4), 1232-1237.
4. De Berardis, D., Orsolini, L., Serroni, N., Girinelli, G., Iasevoli, F., Tomasetti, C., Mazza, M., Valchera, A., Fornaro, M., Perna, G., Piersanti, M., Di Nicola, M., Cavuto, M., Martinotti G., Di Giannantonio, M., 2015. The role of melatonin in mood disorders. ChronoPhysiology and Therapy. 5, 65-75.
5. Dorosh O., 2015. Medychnyi mobilnyi prystriy na bazi OS ANDROID [ANDROID mobile healthcare device]. Visnyk Natsionalnoho tekhnichnoho universytetu "Kharkivskyy politekhnichnyy instytut". Zbirnyk naukovyh prats. Seriya: Informatyka ta modeliuvannya. 32 (1141), 60-68 (In Ukrainian).
6. Dorosh O.I., 2015. Metody stvorennia indyvidualnykh interaktyvno-analitychnykh system dlia tryvaloho kontroliu ta analizu biomedychnykh pokaznykiv [Methods of creating individual interactive and analytical systems for long-term analysis of biomedical indicators]. Visnyk NTU „Kharkivskyi politekhnichnyi instytut". Zbirnyk naukovykh prats. Seria: Informatyka ta modeliuvannia. No. 32 (1141), 60-68 (In Ukrainian).
7. Eysenbach, G., 2001. What is e-health? Journal of medical Internet research. 3(2).
8. Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P. & Haines, A., 2013. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS Med, 10(1), e1001362.

9. Garrett, D.D., Grady, C.L., Hasher, L., 2010. Everyday Memory Compensation: The Impact of Cognitive Reserve, Subjective Memory, and Stress / Psychology and Aging. 25(1), 74–83.
10. Gouin, J.P., • Zhou, B., Fitzpatrick, S., 2015. Social Integration Prospectively Predicts Changes in Heart Rate Variability Among Individuals Undergoing Migration Stress. Annals of Behavioral Medicine. 49(2).
11. Karatsoreos, I.N., 2012. Effects of circadian disruption on mental and physical health. / Curr Neurol Neurosci Rep. 12(2), 218-225.
12. Kepka, M., Szwejser, E., Pijanowski, L., Verburg-van Kemenade, BM, Chadzinska, M., 2015. A role for melatonin in maintaining the pro- and anti-inflammatory balance by influencing leukocyte migration and apoptosis in carp. Developmental and comparative immunology. 53(1).
13. Knopman, D. S., Petersen, R. C., 2014. Mild cognitive impairment and mild dementia: a clinical perspective. In Mayo Clinic Proceedings. 89(10), 1452-1459.
14. Mikal, J.P., Woodfield, B., 2015. Refugees, Post-Migration Stress, and Internet Use: A Qualitative Analysis of Intercultural Adjustment and Internet Use Among Iraqi and Sudanese Refugees to the United States. Qualitative Health Research. 25(10).
15. Proper, K.I., Singh, A.S., van Mechelen W., Chinapaw MJM, 2011. Sedentary behaviors and health outcomes among adults: A systematic review of prospective studies. Am J Prev Med. 40, 174-182.
16. Rickenbach, E.H., Condeelis, K.L., Haley, W.E., 2015. Daily stressors and emotional reactivity in individuals with mild cognitive impairment and cognitively healthy controls. Psychol Aging. 30(2), 420-431.
17. Robillard, J. M., Illes, J., Arcand, M., Beattie, B. L., Hayden, S., Lawrence, P., ... & Jacova, C., 2015. Scientific and ethical features of English-language online tests for Alzheimer's disease. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 1(3), 281-288.
18. Shaw, G., 2013. An 'F' for online dementia tests. Neurology Now. 9(6), 30-32.
19. Stevens, R.G., Zhu, Y., 2015. Electric light, particularly at night, disrupts human circadian rhythmicity: is that a problem? Philos Trans R Soc Lond B Biol Sci. 5;370 (1667)
20. Thosar, S.S., Bielko, S.L., Mather, K.J., Johnston, J.D., Wallace, J.P.., 2015. Effect of prolonged sitting and breaks in sitting time on endothelial function. Med Sci Sports Exerc. 47(4), 843-849.
21. Yamanaka, Y., Hashimoto, S., Masubuchi, S., Natsubori, A., Nishide, S-Y., Honma, S., Honma, Ken-I., 2014. Differential regulation of circadian melatonin rhythm and sleep-wake cycle by bright lights and nonphotic time cues in humans. AJP Regulatory Integrative and Comparative Physiology. 307(5).

Стаття надійшла 20. 10. 2015
Після доопрацювання 28. 11. 2015
Прийнята до друку 15. 12. 2015