ISSN 2544-1361
ISSN 2544-2406

European Journal of Clinical and Experimental Medicine

Formerly: Medical Review

Quarterly

Vol. 16, No. 3

Publication date: September 2018

Rzeszów, Poland 2018

Technical development, layout and interior design: Wojciech Pączek
Cover design: Wiesław Grzegorczyk

ICV 2016 = 81.14
MNiSW: 7.0

Indexing:
Ministry of Science and Higher Education (Poland)
Index Copernicus
The Central EuropeanJournal of SocialSciences and Humanities (CEJSH)
POL-Index
Central Medical Library (Poland)
SPORT Computer Base
ARIANTA – Science and branch Polish electronic journals
J-Gate

e-ISSN 2544-1361
ISSN 2544-2406

EDITORIAL CORRESPONDENCE
European Journal of Clinical and Experimental Medicine Editorial Office
35-959 Rzeszów, ul. Kopisto 2A,
tel. 17 872 11 53, fax 17 872 19 30
http://www.ejcem.ur.edu.pl
e-mail: ejcemur@gmail.com
https://mc04.manuscriptcentral.com/pmur

PUBLISHER: PUBLISHING OFFICE OF THE UNIVERSITY OF RZESZÓW
35-959 Rzeszów, ul. prof. S. Pigonia 6,
tel./fax 17 872 14 26, e-mail: wydaw@ur.edu.pl

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 176

Contents

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.1

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 177–183

ORIGINAL PAPER

Agnieszka Hubert-Lutecka [1(ABCFG)], Dorota Bartusik-Aebisher [2(BDFG)], Marcin Żal [3], Monika Binkowska-Bury [1(DEFH)]

Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care – validation of the Polish language version of the questionnaire

[1] Institute of Nursing and Health Sciences, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[2] Department of Experimental and Clinical Pharmacology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[3] Provincial Military Staff in Krakow, Kraków, Poland

ABSTRACT

Introduction. According to the World Health Organization, non-infectious chronic diseases will become the leading cause of disability by 2020 and can be the most expensive health problem. Type 2 diabetes, hypertension, smoking, poor eating habits, insufficient physical activity and the resulting overweight and obesity are among the main modifiable factors of non-infectious chronic diseases. The results of epidemiological studies indicate that the prevalence of these factors in the Polish population is constantly growing, which is associated with the dissemination of unfavorable eating habits and sedentary lifestyle. Their combating and preventive and educational activities of patients in the scope of modifiable lifestyle behaviors related to lifestyle should be implemented primarily through primary care physicians.

Aim. To validate the Polish language version of Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care.

Material and methods. A Polish version of the questionnaire "Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care" was created. Validation was carried out on a group of 30 primary care physicians.

Results. Very good results in terms of internal coherence of the questionnaire were obtained - the Alpha-Crombach coefficient was 0.82. The level of reproducibility was established with an ICC factor, which was 0.81.

Conclusions. The tested Polish version of the questionnaire can be used to conduct research among primary care physicians in Poland.

Keywords. diet, physical activity, weight control

Introduction

Prevention of non-infectious diseases including such as diabetes, hypertension or obesity and their complications is a serious challenge for the health care system of developing countries in which 85% of premature deaths are recorded.[1] The main reason for the increase in the incidence of these diseases are lifestyle changes, reduced physical activity and changing habits. Nutrition based

Corresponding author: Agnieszka Hubert-Lutecka, e-mail: hubertagnieszka@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 10.06.2018 | Accepted: 16.08.2018
Publication date: September 2018

Hubert-Lutecka A, Bartusik-Aebisher D, Binkowska-Bury M. *Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care – validation of the Polish language version of the questionnaire*. Eur J Clin Exp Med. 2018;16(3):177–183. doi: 10.15584/ejcem.2018.3.1

on high consumption of high-calorie products and a diet deficient in valuable nutrients. According to the World Health Organization (WHO, report, in 2014 39% of adults worldwide (over 18 years of age) were overweight (38% of men and 40% of women), whereas between 1980 and 2014 the worldwide prevalence of obesity increased almost twice, ie over half a billion adults were classified as obese. In 2013, about 42 million children under the age of 5 (6.3%) were overweight. The upward trend in this phenomenon is worrying as the overweight in the group of children increased from around 5% in 2000 to 6% in 2010 and 6.3% in 2013. Currently, it is estimated that the problem of overweight and obesity affects over 340 million children worldwide.[2,3] It has been shown that excessive consumption of high-calorie products containing high levels of saturated fats, trans fatty acids, simple sugars and the supply of large amounts of salt as an independent factor or in combination with insufficient physical activity can significantly contribute to the development of obesity and diabetes and other non-infectious chronic diseases.[4] Elevated BMI (Body Mass Index) is the main risk factor for non-communicable diseases, such as: cardiovascular diseases (mainly heart disease and stroke), which was the leading cause of death in 2012, diabetes, musculoskeletal disorders (particularly degenerative disease) arthritis); some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney and colon). The risk of non-communicable diseases increases with increasing BMI. Overweight and childhood obesity is associated with a greater chance of premature death, disability and obesity in adulthood. In addition to increased risk in the future, obese children experience difficulty in breathing, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects.[5] The prevalence of overweight and obesity among adults over 50% of the population is not less than 21 countries from 34 OECD countries.[6] The World Health Organization recognized obesity as the most frequent metabolic disease and the global epidemic of the 21st century. Excessive body weight is the fifth most common risk factor for deaths in the world. Nearly 2.8 million adults die each year as a result of overweight or obesity, yet the prevalence of obesity is high and increasing. Obesity is a chronic disease and in the majority of cases resulting from abnormal health behaviors related to lifestyle, positive energy balance, poor diet and sedentary lifestyle.[7,9,8] Results of the Central Statistical Health Surveys of WOBASZ II in Poland in 2013-2014 that every fourth inhabitant of Poland is obese, and over the last decade obesity in the general population has increased, especially among men. Abdominal obesity was observed in every third man and almost every second woman. Obesity was found in 24.4% of men and in 25% of women, overweight in 43.2% of men and 30.5% of women. Also worrying is the fact that since 2005, the weight distribution according to the BMI category has been shifted to higher values and the incidence of obesity in men has increased, while the percentage of adults with normal waist circumference significantly decreased in both sexes.[10,11] Lipid metabolism disorders are the most widespread and least-controlled risk factor of cardiovascular disease in Poland. Type 2 diabetes, hypertension, smoking, poor eating habits, inadequate physical activity and the resulting overweight and obesity are among the main modifiable risk factors for atherosclerosis and its complications such as ischemic heart disease, stroke and peripheral arterial disease. The results of epidemiological studies indicate that the prevalence of these factors in the Polish population is constantly growing, which is associated with the dissemination of unfavorable eating habits and sedentary lifestyle.[12,13] Their control is one of the main challenges in public health, so it is so important to take activities of population prevention. Primary care physicians are especially responsible for patients at high risk, because the patient first reports to the patient indicating a health problem. The fight against overweight and obesity and the factors predisposing to it should be part of a broader strategy aimed at reducing the total cardiovascular risk and, consequently, reducing mortality, morbidity and disability resulting from cardiovascular diseases. Lipid metabolism disorders are the most widespread factor of cardiovascular risk, and the prevalence of dyslipidemia in Poland is estimated at 60-70% of people in the population over 18 years of age.[14] Based on the results of the NATPOL study carried out in 2011, it was found that in Poland hypertriglyceridemia occurs in 30% of patients, more often in men than women (38% vs. 23%).[15] In 2 years, WOBASZ II hypercholesterolemia was diagnosed in 70.3%. men and 64.3% of women over the age of 20, which constituted 67.1% of the total population studied. It was also found that as many as 60.6% of those tested with hypercholesterolemia were not aware of this fact, and only 6% were effectively treated and reached the reference lipid level.[16] Assuming that in the model practice, the primary care physician cares for a population of approx. 2,500 patients, of which adults account for more than 75% and taking into account the prevalence of dyslipidemia in Poland estimated at 60-70% of people in the population over 18 years, it can be assumed that every doctor is under the care of about 1100-1300 people with lipid disorders, including up to 10 patients with familial hypercholesterolemia.[17] The most common cause of deaths of people over 65 are cardiovascular diseases. The main risk factors for cardiovascular disease include abdominal obesity (BMI over 30 and waist circumference over 80 cm in women and 94 cm in men). These values are often underestimated by patients who have no

knowledge about the impact of these factors on their health, hence the role of the general practitioner in raising awareness and educating their patients.[18] The current public health problem is also the sarcopene obesity, characterized by an increase in the amount of adipose tissue while losing muscle mass, which is more and more common in the population of older people around the world, which results from the progressive aging of the population and the prevalence of overweight and obesity, as well as in lifestyle over the last few decades. The pathogenesis of sarcopene obesity is multifactorial. There is a relationship between aging, sedentary lifestyle and unhealthy eating habits, insulin resistance, inflammation and oxidative stress, resulting in a quantitative and qualitative decrease in muscle mass and increased fat mass.[19-23] Sarcopathic obesity in people older people are associated with metabolic complications and inappropriate health behaviors and pose a major public health challenge in people over 65 years of age. 24 Another major health problem faced by primary care physicians are cancers, whose incidence increases with age. It is estimated that approximately 60% of people diagnosed with cancer are over 65 years old and diagnosis is made almost 2.5 times more common in adults over 65 years of age compared to people aged 45-64. In most European countries, the incidence of cancer increased from 1-3% in the 1990s to 4-5% in 2010. This increase is largely due to earlier detection and more effective treatment. The prevalence of people who have won the fight against cancer in Europe is estimated at an average of 2% and only 1% in Poland.[25–27] In 2005, chronic diseases were the cause of 35 million deaths, half of which affected patients under 70 years of age. Currently, 41 million people die every year due to non-communicable chronic diseases, which corresponds to 71% of all deaths in the world. There are 7.2 million deaths each year (including exposure to passive smoking) and a significant increase is expected in the coming years, an estimated 4.1 million deaths per year are affected by excess salt / sodium in food, while 1, 6 million deaths per year are attributed to inadequate physical activity.[28] Cardiovascular diseases are the leading cause of death (17.9 million annually), followed by cancers (9.0 million), respiratory diseases (3.9 million) and diabetes (1.6 million). These four groups of diseases account for over 80% of all premature deaths due to non-infectious chronic diseases. Lack of physical activity, unhealthy diet, high body weight, smoking and risky drinking increase the risk of death from non-communicable chronic diseases.[29] It is estimated that there are chronic diseases in 133 million people worldwide, and this number is expected to increase by 1% annually by 2030, resulting in a population of 177 million chronically ill. According to WHO data, 75% of the general population has at least one chronic disease, and almost half of people with chronic conditions suffer from at least two diseases that require constant contact with healthcare. Visits of patients with chronic diseases constitute 80% of consultations as part of primary care. On average, 15% of these patients have three or more chronic conditions, and 30% of hospitalizations are a consequence of exacerbation of the clinical condition in this group of patients. According to the World Health Organization, non-infectious chronic diseases will become the leading cause of disability by 2020 and can be the most expensive health problem.[30-33]

The incidence of type 2 diabetes is also a growing problem worldwide. Diabetes was directly responsible for 1.5 million deaths in 2012, and its incidence in 2014 in the world population was 9% .3 It is estimated that around 415 million adults have diabetes and, according to recent forecasts, this number will increase to 642 million by 2040.[34] The high costs of treatment and the reduced professional activity associated with diabetes is a serious problem and economic burden for the sick, their families and for the entire health care system. In 2010, about 12% of total health care expenses in the world were the costs of treating diabetes and its complications.[35] There is scientific evidence that people at high risk of diabetes (eg with impaired glucose tolerance) can be prevented from significantly reduce its effects by maintaining a healthy lifestyle, maintaining a healthy weight, using the right diet and physical activity.[36,37] Basic health care is the first place, and often the only contact of the patient with the health care system. The role of the family doctor in the health care system is crucial in the context of the increase in the number of chronically ill people. The family doctor should focus his thinking not only on the sick, but also on healthy members of the population to prevent them from falling ill. His task should also be to systematically carry out promotional and screening activities in order to prevent the development and minimization of the effects of chronic non-communicable diseases. The role of the primary care doctor is to educate the public, based on promoting a healthy lifestyle, that is, encouraging physical activity, maintaining a healthy body weight, following a healthy diet and avoiding stimulants including cigarettes and alcoholic beverages. The doctor should influence his patients in order to maintain and improve their health.[38-40] The most difficult challenge for the current health care system is to prevent preventive and prophylactic activities from being only of a share nature (such as prevention programs or, for example, the WOBASZ project), only to be gradually incorporated into existing social systems. This would allow to provide appropriate conditions for systematic, lasting action to improve the health of the Polish population. Currently, there are no tools in the Polish language that would allow to assess the frequency of advice on diet, physical activity and weight control provided by primary care practitioners

and which would allow the doctor to determine the frequency of the assessment of these factors in adult patients (both those with chronic or at risk patients as well as healthy patients).

Questionnaire Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care

The translation, development and validation of the Polish language version of the questionnaire assessing the frequency of advice provided by the primary care doctor concerning the correct diet, physical activity and weight control as well as the frequency of assessment of these factors in the patients he treated were made. For this purpose, the Physician Survey of Practices on Diet, Physical Activity & Weight Control Questionnaire was used: The National Cancer Institute in collaboration with the Office of Behavioral and Social Sciences Research, the National Institute of Child Health and Human Development, the National Institute of Diabetes and Digestive and Kidney Diseases, and the Centers for Disease Control and Prevention. It is a sample of Family Medicine Physicians, General Internists, Obstetrician / Gynecologists, and Pediatricians. The questionnaire is freely available and can be downloaded from the National Cancer Institute website.

The questionnaire of the questionnaire is intended for doctors treating adults and consists of four sections:

Section A: Characteristics of the population of treated patients.

Section B: Barriers in the process of evaluation, control and patient management.

Section C: Health status / health behaviors.

Section D: General information

Section A includes the characteristics of treated patients, contains questions about the frequency and method of assessment of the patient in terms of diet, level of physical activity and body weight, as well as questions about the frequency of advice to patients on changing eating habits, physical activity or weight loss. The questionnaire includes questions regarding the inclusion of their patients in the professional doctor and outside their physical activity, the nature of the questions with which this assessment is carried out, as well as the range of questions assessing the diet and frequency of the doctor's measurements in their patients, including such as body weight measured on the scales, waist size, height, BMI. Questions also concern the frequency of commissioning diagnostic tests (blood glucose level) in overweight and obese patients. The last question in this section concerns the coexistence of the assessment of diet, physical activity and body weight with the treatment of patients suffering from diseases such as asthma, type II diabetes, cancer, eating disorders, hypercholesterolemia, overweight and obesity, hypertension, coronary heart disease, arthritis, apnea drowsiness and family history of neoplastic diseases, heart disease or diabetes.

In section B of the questionnaire there are questions about barriers in the process of evaluation, control and management of the patient, they concern improvements for doctors, which could help to reduce the health problems of patients dependent on diet, physical activity and body weight. This section also includes questions about the doctor's position regarding the promotion of a healthy lifestyle, being the authority of their patients in this area, possessing the appropriate skills needed to effectively advise their patients about healthy eating, physical activity, maintaining a healthy body weight or her reduction. Section C contains questions about the health behavior and health of the doctor, its height and weight, eating habits, the frequency of consumption of specific groups of food products, the intensity and type of physical activity. The questions also concern smoking, exposure to passive tobacco smoke, propagation of anti-smoking prophylaxis among their patients, ordination of nicotine replacement therapy or pharmacological treatment in patients addicted to nicotine, as well as the role of the doctor in the process of persuading patients to quit smoking. This part of the survey also includes questions about the type, quantity and frequency of consuming alcoholic beverages. Section D contains questions about the year of birth, sex, and the main place of medical practice, the number of patient visits during the standard working week.

Materiał and methods

The English version of the questionnaire was translated into Polish by two independent translators, in accordance with international recommendations. During the translation process, all the lexical difficulties resulting from the cultural differences of the two countries were identified and resolved so that the words and phrases used would adequately reflect their meaning. The two Polish versions of the text created in this way were compared with each other in terms of existing differences. Then a common version was created on their basis. A bilingual medical expert got acquainted with the initial versions of translations and evaluated them. All translation sentences were discussed until the opinion was compliant. As a result of these operations, a version that meets the condition of semantic compatibility with each answer was created. Validation of the questionnaire was done using the guidelines for the translation and validation of questionnaires contained in the document describing the process of translation and adaptation of WHO instruments.[41] In the next stage, the scale was re-translated, ie translated into the original language by a translator whose native language is English, but who lives in Poland and is fluent and speaks Polish fluently. The next step was to meet the criterion

of functional equivalence of the questionnaire. An assessment was carried out to check whether the translated questionnaire can be used to evaluate the same purposes as the original version. The assessment of the scale of sensitivity and its resistance to the same disturbing factors that result from the cultural differences of the countries in which the questionnaire is used was also made. The principle of face questionnaire equivalence has been preserved, which consists in maintaining compliance in terms of graphics, the manner and amount of formulating questions and a cafeteria response to the questions and instructions on how to fill in the questionnaire. A high degree of facade equivalence with the original version of the scale has been achieved. While preparing the Polish version of the questionnaire, the same graphic form of the questionnaire as the one in the original version was used. Fidelity to the reconstruction has been preserved. In order to determine the accuracy and reliability of the scale, statistical methods such as the value of the Alpha-Cronbach coefficient were used. The psychometric equivalence of both questionnaires was also assessed. Research analyzes of elements similar to those in the original version were carried out. As a result of the activities carried out, a Polish version of the questionnaire was created, on the basis of which preliminary research was carried out.[42,43]

Preliminary research was carried out on a group of 10 primary care physicians practicing in public healthcare facilities in the Podkarpackie Voivodeship. The time needed to complete the questionnaire was measured and then questions were asked about the clarity and comprehensibility of the content contained therein. All doubts and suggestions from the respondents were noted. On the basis of the information obtained, a report was prepared. Subsequently, the tool was validated in a group of 30 POZ doctors who were asked to fill in the questionnaires twice, observing a 10-day interval in the study. The obtained results were subjected to statistical analysis to assess the reliability of the questionnaires developed. The internal coherence of the scales was examined using the Alpha-Cronbach coefficient and by determining the correlation coefficients between the response of the individual questions and the total score of the scale. Test-retest reliability was determined based on a comparison of the results obtained during the same questionnaire twice being filled in 10 days with the same questionnaire and by determining the intraclass correlation coefficient (ICC). The obtained results were subjected to statistical analysis using the STATISTICA 10.0 program, statistical analysis was performed at the confidence level $\alpha = 0{,}05$.[44,45]

Results

As a result of statistical analysis, the Alfa-Crombach coefficient was calculated, which was 0.82, which indicates very good internal coherence of the questionnaire. On the basis of properly completed questionnaires, the questionnaire credibility was analyzed. A high correlation was found between the results obtained for each question and the total number of points. The level of repeatability was determined using the ICC factor, which was 0.81. There were no statistically significant differences between the total score and the score for individual questions after completing the questionnaire twice. Correlation coefficients between responses to individual questions obtained during the first and second survey fill were calculated, and a statistically significant and high correlation was found between the results obtained for each question during the two-time completion of the questionnaire.

Discussing the results

This questionnaire will be the first tool of this type in the Polish language that will help assess the frequency and help show the methodology of basic care provided by primary care physicians regarding proper diet, physical activity and weight control, and will show barriers that prevent or significantly hinder doctors for this assessment. In addition, the questionnaire has a part regarding the assessment of the health behavior of the respondent, that is the primary care doctor. Smith and coworkers used the Physician Survey of Practices on Diet, Physical Activity and Weight Control questionnaire with a national representative sample of primary health care (n = 1211) in the US to examine primary care physicians clinical practices regarding overweight and obesity. The response rate for the survey was 64.5%. Less than 50% of respondents reported that the doctor always provides them with detailed guidelines on diet, physical activity or weight control. The results of the conducted study indicated that the primary care doctor was more likely to advise his patients on the subject of physical activity than to observe the proper diet or weight control (ps <0.05). Over 70% of physicians answered that they prescribed pharmacological treatment in the treatment of overweight, and 86% directed the patient to an operation related to obesity. In conclusion, the study concluded that the assessment and management of the patient's therapy by the primary care physician in terms of physical activity, diet and body weight is very low in relation to the size of the problem in the US.[46,47]

Conclusions

Due to the high values of the Alfa-Cronbach coefficient and the intra-group ICC correlation coefficient, the Polish version of the Physician Survey of Practices on Diet, Physical Activity and Weight Control: Questionnaire on Adult Care can be considered reliable and thus it is possible to use it to conduct research among primary physicians healthcare in Poland.

References

1. Global status report on noncommunicable diseases 2014. World Health Organization. http://apps.who.int/iris/bitstream/handle/10665/148114/9789241564854_eng.pdf?sequence=1. Published 2014. Aceessed June 10, 2018.
2. Global action plan for the prevention and control of noncommunicable diseases 2013–2020. World Health Organization. http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf. Published 2013. Accessed June 10, 2018.
3. Obesity and owerweight. World Health Organization site. http://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight. Published February 16, 2018. Accessed June 12, 2018.
4. Fiscal policies for diet and prevention of noncommunicable diseases: technical meeting report 2015. WorldHealthOrganization. http://apps.who.int/iris/bitstream/handle/10665/250131/9789241511247-eng.pdf. Published 2016. Accesssed June 12, 2018.
5. Global Strategy on Diet, Physical Activity and Health. World Health Organization site. http://www.who.int/dietphysicalactivity/en/. Accessed June 15, 2018.
6. OECD "Overweight and obesity", in OECD Factbook 2013: Economic, Environmental and Social Statistics. OECD Publishing. https://www.oecd-ilibrary.org/docserver/factbook-2013-en.pdf. Accessed June 15, 2018.
7. de Munter JS, Tynelius P, Magnusson C, Rasmussen F. Longitudinal analysis of lifestyle habits in relation to body mass index, onset of overweight and obesity: results from a large population-based cohort in Sweden. *Scand J Public Health*. 2015;43: 236-245.
8. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA*. 2013;309:71-82.
9. Seidell JC, Halberstadt J. The global burden of obesity and the challenges of prevention. *Ann Nutr Metab*. 2015;66(2):7-12.
10. Stepaniak U, Micek A, Waśkiewicz A, et al. Prevalence of general and abdominal obesity and overweight among adults in Poland. Results of the WOBASZ II study (2013-2014) and comparison with the WOBASZ study (2003-2005). *Pol Arch Med Wewn*. 2016;18:126(9):662-671. doi: 10.20452/pamw.3499.
11. Overweight and obesity. OECD site. Poland_extended_report_april_2018compressed.pdf. Published April 8, 2016. Accessed June 15, 2018.
12. Zdrojewski T, Solnica B, Cybulska B, et al. Prevalence of lipid abnormalities in Poland. The NATPOL 2011 survey. *Kardiol Pol*. 2016; 74: 213–223.
13. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts): Developed with the special contribution of the European Association for Cardiovascular Prevention and Rehabilitation (EACPR). *Eur Heart J*. 2016; 37: 2315–2381.
14. Jóźwiak J. *Ocena wybranych czynników ryzyka sercowo-naczyniowego w ogólnopolskiej 5-letniej prospektywnej obserwacji kohorty pacjentów POZ*. Częstochowa: Wydawnictwo Politechniki Częstochowskiej; 2013.
15. Banach M, Rizzo M, Toth P, et al. Statin intolerance: an attempt at a unified definition. Position paper from an International Lipid Expert Panel. *Arch Med Sci*. 2015;11:1–23.
16. Pająk A, Szafraniec K, Polak M, et al. Changes in the prevalence, management and treatment of hypercholesterolemia and other dyslipidemias over 10 years in Poland. The WOBASZ study. *Pol Arch Med Wewn*. 2016;19,126(9):642-652. doi: 10.20452/pamw.3464.
17. Pająk A, Szafraniec K, Polak M, et al. Prevalence of familial hypercholesterolemia: a meta-analysis of six large, observational, population-based studies in Poland. *Arch Med Sci*. 2016;12:687–696.
18. Bledowski P, Mossakowska M, Chudek J, et al. Medical, psychological and socioeconomic aspects of aging in Poland: assumptions and objectives of the PolSenior project. *Exp Gerontol*. 2011;46:1003-1009.
19. Tian S, Xu Y. Association of sarcopenic obesity with the risk of all-cause mortality: a meta-analysis of prospective cohort studies. *Geriatr Gerontol Int*. 2016;16:155–166.
20. Molino S, Dossena M, Buonocore D, Verri M. Sarcopenic obesity: an appraisal of the current status of knowledge and management in elderly people. *J Nutr Health Aging*. 2016;20:780–788.
21. Prado CM, Gonzalez MC, Heymsfield SB. Body composition phenotypes and obesity paradox. *Curr Opin Clin Nutr Metab Care*. 2015;18:535–551.
22. Cauley JA. An overview of sarcopenic obesity. *J Clin Densitom*. 2015;18:499–505.
23. Park SH, Park JH, Song PS, et al. Sarcopenic obesity as an independent risk factor of hypertension. *J Am Soc Hypertens*. 2013;7:420–425.
24. Li Z, Heber D. Sarcopenic obesity in the elderly and strategies for weight management. *Nutr Rev*. 2012;70(1):57-64. doi: 10.1111/j.1753-4887.2011.00453.x.
25. Sulicka J, Pac A, Puzianowska-Kuźnicka M, et al. Health status of older cancer survivors—results of the PolSenior study. *J Cancer Surviv*. 2018;12(3):326–333.
26. Vrdoljak E, Wojtukiewicz MZ, Pienkowski T, et al. Cancer epidemiology in central, south and eastern European countries. *Croat Med J*. 2011;52(4):478–487.
27. Derksen JW, Beijer S, Koopman M, et al. Monitoring potentially modifiable lifestyle factors in cancer survivors: A narrative review on currently available methodologies and innovations for large-scale surveillance. *Eur J Cancer*. 2018; pii: S0959-8049(18)30912-2. doi: 10.1016/j.ejca.2018.06.017.

28. GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1659-1724.
29. Noncommunicable diseases. World Health Organization site. http://www.who.int/en/news-room/fact-sheets/detail/noncommunicable-diseases. Published June 1, 2018. Accessed June 18, 2018.
30. Schols J, Crebolder H, Van Weel C. Nursing home and nursing home physician: the dutch experience. *J Am Med. Directors Associat*. 2004;5(3):207–212.
31. Wilson T, Buck D, Ham C. Rising to the challenge: will the NHS support people with long-term conditions? *Br Med J*. 2005; 330:657–661.
32. Griffiths FE, Lindenmeyer A, Borkan J, et al. Case typologies, chronic illness and primary health care. *J Eval Clin Pract*. 2014;20(4):513-21. doi: 10.1111/jep.12070.
33. Kurpas D, Hans-Wytrychowska A, Mroczek B, Chronic illnesses in primary healthcare. *Fam Med. Primary Care Rev*. 2011;13,2:325–327.
34. IDF Diabetes Atlas, 8th edition 2017. International Diabetes Federation. http://www.diabetesatlas.org. Published 2017. Accessed 20 June, 2018.
35. Zhang P, Zhang X, Brown J, et al. Global healthcare expenditure on diabetes for 2010 and 2030. *Diabetes Res Clin Pract*. 2010; 87:293–301.
36. Ali MK, Singh K, Kondal D, et al. Effectiveness of a Multicomponent Quality Improvement Strategy to Improve Achievement of Diabetes Care Goals: A Randomized, Controlled Trial. *Ann Intern Med*. 2016:165:399–408.
37. Ali MK, Narayan KM. Screening for Dysglycemia: Connecting Supply and Demand to Slow Growth in Diabetes Incidence. *PLoS Med*. 2016;13:e1002084. doi.org/10.1371/journal.pmed.1002084.
38. Narayan KM, Rhodes EC. Addressing noncommunicable diseases in primary care: the case of type 2 diabetes. *R Coll Physicians Edinb*. 2016; 46(4):272-277. doi: 10.4997/JRCPE.2016.414.
39. Bornhoeft K. Perceptions, Attitudes, and Behaviors of Primary Care Providers Toward Obesity Management: A Qualitative Study. *J Community Health Nurs*. 2018; 35(3):85-101. doi: 10.1080/07370016.2018.1475792.
40. Aragão EIS, Campos MR, Portugal FB, Gonçalves DA, Mari JJ, Fortes SLCL. Social Support patterns in Primary Health Care: differences between having physical diseases or mental disorders. *Cien Saude Colet*. 2018;23(7):2339-2350. doi:10.1590/1413-81232018237.21012016.
41. Jaracz K. Adaptacja kulturowa narzędzi badawczych do oceny jakości życia. *Jakość życia w naukach medycznych*. 2011;281-290.
42. Brzyski P. Aspekty metodologiczne użycia skal, jako instrumentów pomiarowych w badaniach epidemiologicznych. *Przegl Lek*. 2012;69(12):1287-1292.
43. Beaton DE, Bombardier C, Guillemin F, Bosi Ferraz M. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*. 2000;25(24):3186-3191.
44. Cronbach LJ. Ustalenie trafności testu. Brzeziński J, red. *Trafność i rzetelność testów psychologicznych. Wybór tekstów*. Gdańsk: Gdańskie Wydawnictwo Psychologiczne; 2005.
45. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika*. 1951;16:297–334.
46. Smith A, Borowski L, Liu B, et al. U.S. Primary Care Physicians Diet, Physical Activity, and Weight-Related Care of Adult Patients. *Am J Prev Med*. 2011; 41(1):33–42. doi: 10.1016/j.amepre.2011.03.017.
47. Tucker CM, Shah NR, Ukonu, NA. Views of Primary Care Physicians Regarding the Promotion of Healthy Lifestyles and Weight Management Among Their Patients. *J Clin Out Manag*. 2017;24(6):259-266.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.2

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 184–189

ORIGINAL PAPER

Justyna Wyszyńska (ADEFG), Katarzyna Dereń (DEF), Iwona Hausner (ABCG), Artur Mazur (AEG)

Selected factors influencing the level of physical activity in the elderly

Medical Faculty, University of Rzeszów, Rzeszów, Poland

ABSTRACT

Introduction. It is commonly known that physical activity has great influence on the quality of life and health in the people of all age groups. Physical activity has a beneficial influence on both functional and locomotive abilities, the dynamics of which deteriorates during the process of aging, and this in turn has an impact upon satisfaction of basic biological, social and psychological needs.

Aim. The main purpose of this study was an assessment of selected factors affecting the level of physical activity in the elderly.

Material and methods. The study group consisted of 100 participants (85 women and 15 men), aged from 65 to 69 years old. An International Physical Activity Questionnaire (IPAQ) - Polish long version was used.

Results. A high level of physical activity was reached by 44 participants, moderate level of physical activity was noted in 53 participants, and low in physical activity was found in 3 participants. Older the subjects reached lower MET value in case of job-related physical activity and higher MET value in case of physical activity in free time and total intense effort.

Conclusion. The level of job-related physical activity, the level of physical activity in free time and the total intense level of activity depended on the age of the subjects. There were no association between the level of total physical activity and sex, place of residence and BMI of participants.

Keywords. physical activity, older people, factors

Introduction

The World Health Organization (WHO) recognizes the age of 60 as the beginning of late adulthood (old age). Three basic stages are distinguished: from 60 up to 75 years of age - early period of old age; from 75 up to 90 years of age - late old age; over 90 years of age – longevity.[1] Successful aging consists of numerous factors among which physical activity can be mentioned, which is the sphere of human activity giving the opportunity to express oneself in a very individualized form, taking into account ones potential, preferences, and allowing to shape own interests and activate creative processes.[2] Physical activity has many health benefits, especially for the elderly. The benefits of physical activity for both physical and

Corresponding author: Justyna Wyszyńska, e-mail: jwyszynska@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 5.07.2018 | Accepted: 18.07.2018
Publication date: September 2018

Wyszyńska J, Dereń K, Hausner I, Mazur A. *Selected factors influencing the level of physical activity in the elderly.* Eur J Clin Exp Med. 2018;16(3):184–189. doi: 10.15584/ejcem.2018.3.2

mental health among older adults has been shown in numerous studies.[3] Maintaining activity in the elderly gives the ability to use existing reserves of energy, develops the opportunity to make new contacts and communicate with people. In addition, physical activity makes it possible to play important roles in the field of social life. According to Bień, the deficit of activity among older people evokes feelings of loneliness, social isolation, the progression of disability, and even premature mortality.[4]

Seniors constitute a huge part of our society which has to cope with many problems and concerns about their existence. According to research estimates, in the next twenty years there will be rapid growth in the number of the elderly due to the increase in the average life expectancy. The analysis of test results revealed that by 2035 seniors in Poland will represent a quarter of the entire population. According to calculations, the greatest number of seniors will live in cities.[5]

The level of physical activity in older people is not satisfactory in Poland in comparison to other EU countries. The residents of the Scandinavian countries, particularly Sweden, where the greatest number of centenarians live, are the most active.[6] However, the phenomenon of longevity is more complex. Women are usually more physically inactive than men, regardless of their place of residence. This fact is confirmed by the present study, however, statistically they live longer.[7]

Aim

The aim of the study was to assess the level of physical activity of people over 65, as well as to analyze selected factors affecting the level of physical activity.

Material and methods

Participants

The research involved elderly people attending classes organized by the University of the Third Age in Przemyśl. Out of the 225 seniors attending classes and lectures, 100 agreed to take part in the study. The youngest of the respondents were 65 years old and the oldest were 69 years old. Written consent for participation was obtained from participants prior to the study. All subjects were informed about the possibility of dropping out of the study at any stage.

Outcome measurements

We used the International Physical Activity Questionnaire (IPAQ) - Polish long version. The questionnaire consists of 5 parts containing a total of 27 questions. Each of these parts refers to the following areas of activity: (1) job-related, (2) transportation, (3) housework, (4) recreation, sport, and leisure-time, (5) time spent sitting. The questionnaire contains detailed questions about the activity undertaken during the last week. Individual types of effort were defined in Metabolic Equivalent of Task (MET) units min / week. Based on the obtained calculations, the level of physical activity was determined. Three types of physical activity levels are specified: (1) low - physical effort not taken at all or the total activity value is not higher than 600 MET-min / wk; (2) moderate - total physical activity is in the range above 600 MET-min / wk and does not exceed more than 3000 MET-min / wk; (3) high - determines physical effort above 3000 MET-min / wk.[8]

Data analysis

Results of the study were developed using descriptive statistics: number (n), %, $\overline{x}$ (mean) and standard deviation (SD). To analyze the results obtained in this study, non-parametric tests were used.

The Spearman's rank correlation coefficient was used to determine the relationship between two numerical features and is an indicator that takes values from the range of 1 to 1. The correlation coefficients 0.9 or -0.9 indicate the same (very high power of correlation), although the conclusions drawn on their basis will be opposite - in the first case with the increase in the value of one feature, the value of the other also grows, and in the second case they decrease. In this study, the following adjectival scale was assumed: Correlation force: $|R| < 0.3$ - no correlation; $0.3 \leq |R| < 0.5$ - weak correlation; $0.5 \leq |R| < 0.7$ - average correlation; $0.7 \leq |R| < 0.9$ - strong correlation; $0.9 \leq |R| < 1$ - very strong correlation; $|R| = 1$ - perfect correlation. The Pearson chi-square test was used to analyze variables having the character of qualitative data. The significance level was adopted at $p < 0.05$. Calculations were performed with Statistica 10.0.

Results

The study was attended by 100 participants aged over 65 (85 women and 15 men). The average age of the respondents was 61.3 ± 3.8 years. The youngest of the respondents was 65 years old and the oldest was 69 years old. The body weight of respondents ranged from 52 kg to 102 kg. The BMI of the respondents ranged from 19.7 kg/m^2 to 32.9 kg/m^2. Table 1 presents the general characteristics of the groups.

The average job-related activity in the studied group was 206.8 ± 498.8 MET min / wk. This value, however, seems to be biased looking at the distribution of results obtained by individuals. According to the obtained data, the majority of respondents in this category obtained 0 MET (inactive professionally - retired or on pension). The average value for transportation was about 939.3 ± 675.8 MET min / wk. The smallest recorded activity in this sphere was 132 MET and the largest 2772 MET. The value recorded in the case of physical activity related to housework, general housekeeping and family care was on average 1063.8 ± 511.4 MET min / wk. The smallest

recorded activity in this area was 132 MET, and the largest 2370 MET. The value recorded in the case of physical activity in free time was on average 629.1 ± 418.9 MET min / wk. The smallest recorded activity in this sphere was 66 MET and the largest 1706 MET (Table 2).

Table 1. General characteristics of the studied groups

Variable	Full sample
Sex [a]	
Woman	85
Man	15
Education [a]	
Secondary	46
Higher	54
Place of residence [a]	
City	76
Village	24
Age [year] [b]	61.3 ± 3.8
Body mass [kg] [b]	72.8 ± 11.0
Body mass index [kg/m^2] [b]	26.0 ± 3.6
Body mass index [a]	
Normal	38
Overweight	43
Obesity	19

Data are expressed as: [a] n (%); [b] $\bar{x}$ (SD).

On the basis of the results obtained in the IPAQ questionnaire, data was recalculated according to the appropriate scale and transformed into qualitative data, so that it was possible to determine the total physical activity of individuals. High level of physical activity was reached by 44 subjects, moderate level of physical activity was noted in 53 subjects, and low in physical activity was found in 3 subjects (Table 2).

Table 2. Level of physical activity

Physical activity	Value
Job-related physical activity [a]	206.8 ± 498.8
Transportation related physical activity [a]	939.3 ± 675.8
Housework, house maintenance and caring for family related physical activity [a]	1063.8 ± 511.4
Recreation, sport, and leisure- time related physical activity [a]	629.1 ± 418.9
Walking in total [a]	1246.9 ± 776.9
Moderate physical activity in total [a]	1484.9 ± 694.4
Intensive physical activity in total [a]	90.8 ± 182.0
Physical activity in total [a]	2822.6 ± 1092.0
Time spent sitting in total [a]	1844.7 ± 588.6
Average time spent sitting [a]	263.5 ± 84.1
Level of physical activity [b]	
High	44
Moderate	53
Low	3

Data are expressed as: [a] MET – minutes/week: $\bar{x}$ (SD); [b] n (%)

Statistical analysis by Spearman's rank correlation test confirmed that job-related physical activity, free time physical activity and total intense effort was related to the age of the subjects ($p < 0.05$). The absolute values of the correlation were $|R| = 0.2$ which indicates a very weak correlation power. Correlation orientation in the case of job-related physical activity was negative, which means that the older the subjects were, the lower was the MET value. In the case of physical activity in free time and in the case of total intense effort, the orientation of the correlation was positive, which means that the older the respondents were, the higher the value of MET they obtained (Table 3).

Table 3. Age and BMI vs. the level of physical activity

Level of physical activity	Spearman's R	*p*
Age		
Job-related physical activity	-0.2	0.027*
Transportation related physical activity	0.1	0.320
Housework, house maintenance and caring for family related physical activity	0.0	0.783
Recreation, sport, and leisure- time related physical activity	0.2	0.028*
Walking in total	0.1	0.256
Moderate physical activity in total	-0.1	0.312
Intensive physical activity in total	0.2	0.018*
Physical activity in total	0.1	0.489
Time spent sitting in total	0.0	0.941
Average time spent sitting	0.0	0.942
BMI		
Job-related physical activity	-0.0	0.961
Transportation related physical activity	0.1	0.143
Housework, house maintenance and caring for family related physical activity	0.1	0.437
Recreation, sport, and leisure- time related physical activity	0.2	0.059
Walking in total	0.2	0.033*
Moderate physical activity in total	0.1	0.555
Intensive physical activity in total	0.1	0.487
Physical activity in total	0.2	0.107
Time spent sitting in total	0.2	0.086
Average time spent sitting	0.2	0.087

Based on the results presented in Table 3, it was found that there is a relationship between the level of physical activity associated with total walking and the BMI value of the subjects ($p < 0.05$). The absolute value of the correlation was $|R| = 0.2$ which testifies to its very weak strength (Table 3).

The level of total physical activity in the subjects was not inflenced by their sex. The education of the respon-

dents was not a factor determining the statistically significant level of physical activity. More often, however, a high level of activity was recorded among the respondents with higher education. People with secondary education more often than the others presented moderate and low activity.

The general level of physical activity did not depend on the place of residence of the respondents. The level of high and moderate activity was more frequently demonstrated by rural residents. The low level was more frequently observed among urban residents.

The general level of physical activity of the subjects was not dependent on the BMI value. It can be observed, however, that the highest level was obtained by obese people, while the moderate level was obtained by overweight people. The low activity level was only found in people with normal body weight (Table 4).

Table 4. Sex, place of residence and BMI vs. the level of physical activity

Variable	Level of physical activity			*p*
	High n (%)	Moderate n (%)	Low n (%)	
Sex				
Woman	36 (42.3)	46 (54.1)	3 (3.5)	0.602
Man	8 (53.3)	7 (46.6)	0 (0)	
Education				
Secondary	18 (39.1)	26 (56.5)	2 (4.3)	0.556
Higher	26 (48.1)	27 (50.0)	1 (1.8)	
Place of residence				
City	33 (43.4)	40 (52.6)	3 (3.9)	0.612
Village	11 (45.8)	13 (54.2)	0 (0)	
BMI				
Healthy	16 (42.1)	19 (50.0)	3 (7.9)	
Overweight	18 (41.8)	25 (58.1)	0 (0)	0.224
Obesity	10 (52.6)	9 (47.3)	0 (0)	

Discussion

The results of our research confirm that the study group willingly decided to spend time actively. This is demonstrated by the analysis of the declared activity. Out of 100 subjects, as many as 53% were characterized by moderate levels of physical activity. A high level was noted in 44% of the respondents, while a low level was found by 3% of the respondents. In studies carried out in Warsaw, among the respondents of a similar age, it was found that over 67% of the respondents declared high and moderate levels of physical activity, while 32.4% found themselves among those least involved in active leisure activities 32.4 %.[9] Similar results are presented among the students of the University of the Third Age in Wałcz, who present a high and moderate level of activity amounting to 58.3%.[10] The reverse results were obtained by analyzing the entire Polish population. It turns out that despite the National Health Program campaigns to raise awareness of the benefits of running various forms of activity in the elderly, only 10% of seniors are willing to follow the recommendations.[11]

The results of our research showed that older subjects achieved lower MET index. The results of studies conducted by Szymczak and Skrzek also indicated a negative correlation between the level of physical activity and the age of the subjects. The authors also showed a slight difference in the level of physical activity between women and men.[12]

Based on the analysis of the results of own research, it was shown that physical activity related to job-related physical activity was at a low level. The explanation of these results may be the fact that the majority of the respondents were professionally inactive. In turn, in the studies of Szymczak and Skrzek, the surveyed men were a group of economically active people, which is why they obtained higher results than in our research.[12] In a study conducted in a group of nurses, Bergier et al. noted high MET indicators in the group of health care staff.[13] Topolska et al. noted low values of job-related physical activity among elderly women in Zamość area, as well as in the work related to household duties.[14]

The results of our research have shown that in the field of leisure activity, as well as analyzing the total intense physical effort, older subjects obtained higher values of the MET index. It can be assumed that the students of the University of the Third Age are aware of the benefits of active spending free time for their health. Age is not an obstacle for them to take recreational forms of activity. According to research carried out by Dębicka and Chudecka, the University of the Third Age students are characterized by a high level of physical activity in comparison with other peers.[15] Older nurses in the range above 51 yrs., in comparison with younger collegues, also spent their free time actively by participating in recreational physical activity. This group was most likely to take such activities as cycling or running. To a lesser extent they were interested in swimming or dancing.[13] According to Topolska et al., similarly a lot of free time had women aged 55-65 from Zamość area. They also had high rates of transportation related physical activity.[14] Research by Tuero et al. confirms the relationship between active spending free time and physical fitness.[16] Many researchers have also proven that there is a relationship between spending free time actively and the occurrence of obesity.[17-20]

In the present study, no correlation was found between sex of the subjects and the total level of physical activity. In turn, the results of research conducted by Tablot et al. indicated that women had a lower level of physical activity than men.[21] In the studies of Szymczak and Skrzek, the studied elderly women were also characterized by a lower level of physical activity in relation to men.[12]

In our study, no relationship between the total level of physical activity and the BMI index was found. However, obese or overweight people were more likely to have high or moderate levels of physical activity. The result may also be due to the fact that these people may have tried to reduce excessive body mass by intensifying the level of physical activity. However, in studies carried out in the area of University of the Third Age in Wałcz, 81.3% of obese people have a low level of physical activity.[10] Similarly, according to Szymczak and Skrzek, overweight respondents were characterized by a lower level of physical activity.[12] As it is commonly known, the proper level of physical activity affects the maintenance of normal body mass. The finding of this dependence has contributed to the formulation of many recommendations for people who are overweight or obese. It is believed that it is necessary to perform at least 60-90 min of physical activity daily at moderate level to maintain a healthy body weight.[22]

In our research, the level of education was not a determinant of physical activity at the statistically significant level. However, people with higher education were more likely to have high levels of physical activity. Similarly, Knapik et al. in their research have proved that an important factor influencing the level of activity in older people is education, which subsequently influences the self-assessment of health.[23]

According to analyzes carried out by Piątkowska, age is the most important factor conditioning the attitude of Poles towards physical activity.[24] Literature review confirms the relationship in which the level of activity decreases with age both among men and women.[25] Similar data obtained the researchers from other countries.[26,27]

Conclusion

The level of job-related physical activity, the level of physical activity in free time and the total intense level of activity depended on the age of the subjects. There was a relationship between the level of physical activity associated with total walking and the BMI.

References

1. Definition of an older or elderly person. World Health Organization Website. http://www.who.int/healthinfo/survey/ageingdefnolder/en/. Accessed April 1, 2018.
2. Posłuszna M. Aktywność rodzinna i społeczna osób starszych. *Now Lek*. 2012;81:75–79.
3. Vogel T, Brechat PH, Leprêtre PM, Kaltenbach G, Berthel M, Lonsdorfer J. Health benefits of physical activity in older patients: a review. *Int J Clin Pract.* 2009;63(2):303-320.
4. Franco MR, Tong A, Howard K, et al. Older people's perspectives on participation in physical activity: a systematic review and thematic synthesis of qualitative literature. *Br J Sports Med*. 2015;49:1268-1276.
5. Prognoza ludności na lata 2008 – 2035 [Population projection for Poland 2008–2035]. GUS. http://stat.gov.pl/cps/rde/xbcr/gus/L_prognoza_ludnosci_na_lata2008_2035.pdf Accessed April 2, 2018.
6. Rizzuto D, Orsini N, Qiu C, Wang H-X, Fratiglioni L. Lifestyle, social factors, and survival after age 75: population based study. *The BMJ*. 2012;345:e5568.
7. Wieczorowska-Tobis K. Dlaczego mężczyźni żyją krócej? *Now Lek*. 2012;81:386–389.
8. Biernat E. Międzynarodowy Kwestionariusz Aktywności Fizycznej – Polska długa wersja. *Med Sport*. 2013;1:1-15.
9. Biernat E, Tomaszewski P. Socio-Demographic and Leisure Activity Determinants of Physical Activity of Working Warsaw Residents Aged 60-69 Years. *J Hum Kinet*. 2011;30:173-181.
10. Krzepota J, Biernat E, Florkiewicz B. Poziom aktywności fizycznej słuchaczy Uniwersytetu Trzeciego Wieku o zróżnicowanym indeksie masy ciała. *Med Og Nauki Zd*. 2013;19:200–205.
11. Wojtyniak B, Goryński P. Sytuacja zdrowotna ludności Polski. PZH, Warszawa; 2003.
12. Szymczak M, Skrzek A. Analiza związku codziennej aktywności fizycznej i składu ciała osób starszych. *Gerontol Wsp*. 2014;2: 33-39.
13. Bergier J, Bergier B, Soroka A, Kubińska Z. Aktywność fizyczna pielęgniarek z uwzględnieniem ich wieku. *Med Og Nauki Zd.* 2010;16:595–605.
14. Topolska M, Sapuła R, Topolski A, Maciejewski M, Marczewski K. Aktywność fizyczna a zdrowie u kobiet w wieku od 19 do 65 lat w różnych dziedzinach życia. *Zam St Mat*. 2011;13:27-36.
15. Dębicka J, Chudecka M. Wybrane aspekty aktywności fizycznej oraz charakterystyka morfologiczna słuchaczek Uniwersytetu III Wieku w Szczecinie. *Ann UMCS Sect D*. 2006;94:413–418.
16. Tuero C, De Paz JA, Marquez S. Relationship of measures of leisure time physical activity to physical fitness indicators in Spanish adults. *J Sports Med Phys Fitness*. 2001;41:62-67.
17. Fung TT, Hu FB, Yu J, et al. Leisure-time physical activity, television watching, and plasma biomarkers of obesity and cardiovascular disease risk. *Am J Epidemiol*. 2000;152:1171-1178.
18. Riebe D, Blissmer BJ, Greaney M, et al. The relationship between obesity, physical activity, and physical function in older adults. *J Aging Health*. 2009;21:1159-1178.
19. Koolhaas CM, Dhana K, Schoufour JD, Ikram MA, Kavousi M, Franco OH. Impact of physical activity on the association of overweight and obesity with cardiovascular disease: The Rotterdam Study. *Eur J Prev Cardiol*. 2017;24:934-941.
20. Coombs N, Stamatakis E, Lee I. Physical inactivity among older adults: Implications for life expectancy among non-overweight and overweight or obese individuals. *Obes Res Clin Pract*. 2015;9:175-179.

21. Talbot LA, Metter EJ, Fleg JL. Leisure- time physical activities and their relationship to cardiorespiratory fitness In health men and women 18-95 years old. *Med Sci Sports Exerc*. 2000;32:417-425.
22. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*. 2007;39:1423-1434.
23. Knapik A, Rottermund J, Myśliwiec A, Plinta R, Gruca M. Aktywność fizyczna a samoocena zdrowia osób w starszym wieku. *Prz Med Uniw Rzesz Inst Lek*. 2011;2:195–204.
24. Piątkowska M. Wiek jako czynnik różnicujący poziom aktywności fizycznej polskiej populacji. *Antropomotoryka*. 2012;59:19-20.
25. Denison E, Vist GE, Underland V, Berg RC. Interventions aimed at increasing the level of physical activity by including organised follow-up: a systematic review of effect. *BMC Family Practice*. 2014;15:120.
26. Centers for Disease Control and Prevention (CDC). Prevalence of no leisure-time physical activity--35 States and the District of Columbia, 1988-2002. *MMWR Morb Mortal Wkly Rep*. 2004;53:82-86.
27. Statistics Canada. Health indicators. No. 82–221XIE, 2002. https://www150.statcan.gc.ca/n1/pub/82-221-x/01002/4061971-eng.htm. Accessed April 3, 2018

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.3

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 190–197

ORIGINAL PAPER

Anna Nagórska (A-H)

Attitudes towards depression and symptoms of depression among Polish and British adults

Stockport College, Stockport, United Kingdom

ABSTRACT

Introduction. Depression is a mental illness widespread in the population and is the most common mental disorder. There has been an increase in number of depression diagnoses among the wider population in the past few years.

Aim. The aim of the study was to gain knowledge regarding the attitudes towards depression and to measure the occurrence of depression symptoms among open populations of Polish and British people.

Materials and methods. The study was conducted from March to May 2015 by posting an electronic survey on a social network in Polish and English language. 143 completed questionnaires were obtained. The method of diagnostic survey was used in this study. The research tools was a survey created by the authors and the Beck Depression Inventory (BDI).

Results. Every third respondent acknowledged that they have a sufficient knowledge of depression. Based on BDI results, 75% of Poles and 39% of British did not show any signs of depression.

Conclusions. The British understand the term "depression" correctly more often than Poles. The inhabitants of Poland and Great Britain take a positive attitude towards people with depression. The British have depressive symptoms more frequently than Poles. Nationality and age do not affect the severity of depressive symptoms in both groups.

Keywords. attitudes, depression, Poland, United Kingdom

Introduction

According to the WHO (World Health Organization), depression is a common mental disorder characterized by sadness, loss of interest or pleasure, guilt or reduced self-esteem, sleep and eating disorders; feeling of tiredness and decreased concentration.[1] The following description of depression is provided from a clinical psychology manual: "This disease is dominated by depressed mood, deep sadness, despair, a sense of emptiness and hopelessness and helplessness; the feeling of pleasure and joy disappears, and mood disorders are accompanied by loss of interest, apathy and inhibition of activity. Depression and anxiety may also accompany depressive mood."[2]

The term depression is used to describe general well-being or mood, e.g. as a temporary state of dysphoria (the opposite of euphoria), which can last from a few moments to several days. The words depression is also

Corresponding author: Anna Nagórska, email: annanagorska@hotmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 6.07.2018 | Accepted: 7.08.2018
Publication date: September 2018

Nagórska A. *Attitudes towards depression and symptoms of depression among Polish and British adults*. Eur J Clin Exp Med. 2018;16(3):190–197. doi: 10.15584/ejcem.2018.3.3

used in colloquial language to refer to reactions to difficult life situations. According to Hammen, depression is "a set of experiences, including not only the mood, but also physical, psychological and behavioral experiences that define a more long-lasting, harmful and serious condition that can be clinically diagnosed as a depressive syndrome."[3]

Recently, an increased incidence of depression has been observed in wider populations.[5] According to WHO data from 2013, 27% of the general adult population (18-65 yrs) in Europe (EU + Iceland, Norway, Switzerland) experienced at least one psychological problem (psychosis, anxiety, depression, substance dependence, eating disorders) within last year. The scale of the problem is enormous, as it is estimated to affect approximately 83 million people. The report also confirms greater prevalence of such disorders among women (33.2%) than in men (21.7%). WHO data on depression indicate that currently depression is the fourth most common health issue worldwide, and estimates that in 2020 it will be the second only to cancer.[6,7]

According to the US *Healthline* health website based on various data, it is estimated that around 121 million people in the world are struggling with depression. Most cases are recorded in India (> 36%), followed by the Netherlands, France and the United States (> 30%), followed by European countries (including Poland), Australia and Canada (> 20-30%). In the United States, one in ten people has depression, and the number of patients increases by 20% each year, and 80% of the patients do not receive any treatment. Risk factors include unemployment and divorce, age (45-64 years), and sex as depression affects women more often than men. According to this data, the symptoms of baby blues affect 1 in 10 mothers up to seven days after birth.[8]

Aim

The aim of the study was to gain knowledge regarding attitudes towards depression and measure depression symptoms among a open population of Polish and British people.

Material and method

Anonymous surveys were conducted between March and May 2015 by posting an electronic survey in Polish and English on one of the social networking sites. 143 correctly completed questionnaires were obtained. The research tool was a survey designed by the authors and Beck Depression Inventory (BDI).

The characteristics of the studied group were based on the data contained in the author's part of the questionnaire including: country of residence, sex, age, occupational and housing status, family and material status, perception of the most important values in life and problem solving, and self-assessment of knowledge and attitudes towards people with depression. 76 Poles (53.1%) and 67 Britons (46.9%) participated in the study.

The mean age of the respondents was 34 (19-63), 35 years for respondents from Poland and 29 years from Great Britain. Almost 40% own a flat, 35% rent a flat, and 27% live in a family home. Over half of the respondents are professionally active (56%); an equal percentage of the respondents of both nationalities (21%) study or work and study simultaneously. Most participants (62%) are in relationship, and 38% are single. The general financial situation of the respondents is quite good; 64% earn enough to manage their needs, and 36% earn less than their needs.

Table 1. Socio-demographic characteristics of the studied population

Variables	Poland		Great Britain		p
Country	76	53.1%	67	46.9	
Sex					0.7157
Man	26	34.2%	21	31.3%	
Woman	50	65.8%	46	68.7%	
Housing situation					**0.0250***
Lives with parents	22	28.9%	16	23.9%	
Rents a flat	19	25.0%	31	46.3%	
Owns a flat	35	46.1%	20	29.9%	
Professional status					**0.0017****
Studies	22	28.9%	8	11.9%	
Works	31	40.8%	49	73.1%	
Studies and works	21	27.6%	9	13.4%	
Does not study or work	2	2.6%	1	1.5%	
Family status					0.6530
Single	30	39,5%	24	35,8%	
In relations	46	60,5%	43	64,2%	
Material status					0.3294
Income lower than expenses	31	40.8%	20	29.9%	
Income equal to expenses	35	46.1%	34	50.7%	
Income higher than expenses	10	13.2%	13	19.4%	
The most important value in life					**0.0005*****
Family	49	64.5%	57	85.1%	
Health	24	31.6%	4	6.0%	
Friends	3	3.9%	6	9.0%	
Problem solving					0.6015
Manage independently	46	60.5%	44	65.7%	
Family suport	15	19.7%	14	20.9%	
Parents, siblings support	15	19.7%	9	13.4%	

Family is the greatest value in life, as declared by 74% of the participants, and 20% of people put health first in the hierarchy of values. In the face of difficult life situations, 63% of the respondents manage independently, other respondents need family support (17%) or friends (20%) (Table 1). As in the case of research agency PBS (Partner in Business Strategies) study, the most important value for Poles is their family (51%). In the CBOS (Centre for Public Opinion Research) study "Values and norms in Polish lives" from 2005, respondent indications confirmed that the most important values are family life (84%), and health (69%), and in the 2010 study, health was ranked first (97%) before family life (95%). These two values always rank highest in the hierarchy of Polish values. Interestingly, in our research only 20% of the respondents put health first in the hierarchy of values. [9]

The method of diagnostic survey was used in the study, the research tools were a questionnaire developed by the author and the Beck Depression Inventory (BDI). The author's questionnaire contained 12 questions, of which 5 were related to the socio-demographic characteristics of the surveyed group. Another 7 questions allowed for determining the attitude of the respondents towards depression and the sources of knowledge about this disease.

The Beck Depression Inventory (BDI) by Aaron Temkin Beck (1961) is one of the most popular auxiliary tools to measure the symptom severity of depressive syndrome, and the Polish version of the scale was developed in 1977 by Parnowski and Jernajczyk.[10] The scale consists of 21 questions with 4 variants of the answers. The respondent could score from 0 to 3 points for each answer. The sum of points obtained in the assessment of individual symptoms is the numerical value - the so-called depression level indicator ranging from 0 to 63 points. The following interpretation of the results of BDI was adopted in the study: up to 10 points - no depression, lowered mood, between 11-27 points moderate depression, from 28 points severe depression.[11] The chi-square independence test, the Mann-Whitney test and the Spearman rank correlation coefficient were used in the statistical analysis. The level of significance was assumed at p = 0.05, and the strength of dependence was marked in the text respectively: * weak dependence, ** moderate dependence, *** strong dependence. It should be added that BDI is not a recognized tool in the diagnosis of depression and can only serve as an auxiliary tool in determining the severity of symptoms considered depressive.

Results

Depression is the most widespread mental illness and depressive mood is treated as a predisposition and tendency to depression which may turn into this disease in the future. Taking into account statistical data and scientific reports pointing to the growing scale of the problem of depression in the world population, a study was undertaken to learn about attitudes towards depression and the incidence of depressive symptoms in the open population of Poles and British. 143 people, including 96 women and 47 men, participated in anonymous online questionnaire.

The majority of the respondents stated that they did not have sufficient knowledge about depression (68.5%), only every third respondent recognized that they had such knowledge (31.5%). The British assessed their knowledge better (p = 0.0043 **).

When asked about depression, most respondents said it was a disease (45%), 30% of the respondents think that it was low mood, 19% believe it was a temporary breakdown and 6% claim it was an excuse in difficult situations. The correct answer that depression is a disease was more often provided by the British - 59.7% and by 31.5% of Poles (p = 0.0048 **).

Among the sources of knowledge, the respondents most often indicated the Internet - 65.3%, books 24.5%, and TV and radio 10.2% (p = 0.0030 **).

People with depression or other mental illness are often stigmatized socially. In our study, these tendencies are more optimistic. Most respondents would accept a person with depression in the closest neighborhood (93%), at work (85.3%), among friends (93.7%) or in a family (95.8). Regarding the neighborhood, the highest tolerance was shown by Poles (p = 0.0005 ***) (Table 2).

The tendency to depression based on the results of Beck Depression Inventory occurs at various levels in Poles and Britons. Surveyed British definitely show more depressive symptoms. The mean results in Beck Depression Inventory for Poland was 8.2 points and 15 points for Great Britain. Also the median value is twice as high for the British as for the Poles (p = 0.0000 ***) (Table 3).

A descriptive depression scale based on BDI confirmed that the symptoms described as "severe depression" are reported by 11.9% of Britons. Almost half of the respondents from Great Britain and every fourth Pole showed signs of moderate depression. The majority of investigated Poles (75%) recognize that they do not struggle with symptoms of depression. In the case of the British, this percentage was 39%. According to our analysis, Poles are in a better mental condition. This dependence is statistically significant (p = 0.0000 ***) (Table 4).

In the latter part, an analysis of the impact of sex and age on the symptoms of depression was made. The analysis was conducted independently for the Polish and British communities, the results are presented in summary tables.

Table 2. Depression in the opinion of the respondents

	Poland		Great Britain		*p*
Self-assessment of knowledge about depression					**0.0043****
I have knowledge about depression	16	21.1%	29	43.3%	
I don't have knowledge about depression	60	78.9%	38	56.7%	
What is depression?					**0.0048****
A state of lowered mood	31	40.8%	12	17.9%	
State of temporary breakdown	16	21.1%	11	16.4%	
Disease	24	31.6%	40	59.7%	
An excuse in difficult situations	5	6.6%	4	6.0%	
Sources of knowledge about depression					**0.0030****
Internet	32	53.3%	32	84.2%	
Books	18	30.0%	6	15.8%	
TV, radio	10	16.7%	0	0.0%	
Would you accept a person with depression?					
In neighborhood	76	100%	57	85.1%	**0.0005*****
At work	65	85.5%	57	85.1%	0.9393
Among friends	71	93.4%	63	94.0%	0.8811
In a family	72	94.7%	65	97.0%	0.4978

Table 3. Results for BDI

Country	Beck Depression Inventory (pts.)				
	$\bar{x}$	Me	s	min	max
Poland	8.2	7.5	5.7	0	26
Great Britain	15.0	14	9.3	0	41
p			**0.0000*****		

p – test probability value calculated using the Mann-Whitney test

Table 4. Results for BDI

Level of depression	Country				Total
	Poland		Great Britain		
no	57	75.0%	26	38.8%	83
moderate	19	25.0%	33	49.3%	52
severe	0	0.0%	8	11.9%	8
p	**0.0000*****				

Comparing the results in the group of women and men, it turns out that 80.8% of Polish men and only 23.8% of British men and 72% of Polish women and 45.7% of British women did not show any symptoms of depression. Moderate depression was reported by 19.2% of Polish men and 71.4% of British men and 28.0% of Polish women and 39.1% of British women. The score corresponding to severe depression was obtained by 15.2% of women and 4.8% of men from Great Britain. Both Polish men and Polish women did not receive a score corresponding to severe depression.

As can be seen from the tables below, there is no basis for finding a statistically significant effect of sex on the level of depression determined by Beck's point scale. Both in the Polish and British communities, the mean level of depression for women and men is almost identical. The lack of statistical significance of differences is evidenced by the high probability p values calculated using the Mann-Whitney test (Table 5).

Regarding the Beck Depression Inventory, an adjective evaluation of the level of depression was also used, presenting the results in the form of a contingency table and assessing differences in the percentage structure using the chi-square independence test. After categorizing up to three levels of depression, the differences in their distribution in the group of women and men in the British population are statistically significant ($p = 0.0463$ *). Although the nature of this relationship is quite complicated - among women there are more cases of lack of depression and severe depression, and less of moderate depression. Comparing the results in the group of women and men, it turns out that the features of depression did not occur in 80.8% of Polish men and in only 23.8% of British men and 72% of Polish women and 45.7% of British women. Moderate depression was reported by 19.2% of Polish men and 71.4% of British men and 28.0% of Polish women and 39.1% of British women. The score corresponding to severe depression was obtained by 15.2% of women and 4.8% of men from Great Britain. Both Polish men and Polish women did not obtain a score corresponding to severe depression (Table 6).

Table 5. Results for Beck Depression Inventory

Sex	Beck Depression Inventory (pts.)									
	Poland					Great Britain				
	$\bar{x}$	Me	*s*	min	max	$\bar{x}$	Me	*s*	min	max
man	7.8	5.0	6.7	0	24	15.4	16.0	8.0	2	41
woman	8.4	8.0	5.2	1	26	14.8	13.5	10.0	0	41
	p = 0.3459					p = 0.6340				

p – test probability value calculated using Mann-Whitney test

Table 6. Intensity of depression among the Polish and British

Depression intensity	Poland		Great Britain	
	man	woman	man	woman
lack	21 80.8%	36 72.0%	5 23.8%	21 45.7%
moderate	5 19.2%	14 28.0%	15 71.4%	18 39.1%
severe	0 0.0%	0 0.0%	1 4.8%	7 15.2%
	p = 0.7042		p = 0.0463*	

Table 7. Age of the respondents.

Country	Age				
	$\bar{x}$	Me	*s*	min	max
Poland	34.6	35	11.3	19	52
Great Britain	33.6	29	12.4	19	63
	p = 0.5958				

p – test probability value calculated using Mann-Whitney test

The analysis confirmed that the age does not differentiate the level of depression in the studied groups, the probability value measured by the Mann-Whitney test is: p = 0.5958 (Table 7).

Table 8. Correlation coefficients between age and BDI

	Age	
	Poland	Great Britain
Beck Depression Inventory (pts.)	-0.03 p = 0.7647	-0.04 p = 0.7770

In the case of the study of the influence of age on the level of depression, the Spearman rank correlation coefficient was also used. The table below presents the values of correlation coefficients between age and BDI in the Polish and British communities. Statements of statistical significance of the analyzed dependences are given in brackets. As a result of the analyzes, a model example of the lack of any dependencies was obtained, because the value of the age correlation coefficient is close to zero (statistically insignificant).

The result is illustrated in the scatterplot. Simple regressions, marked on the chart, have almost zero slope, which means that age does not differentiate the level of depression. This is somewhat understandable, because depression is not a disease for which age is a risk factor, as in many other diseases (cardiological diseases, cancer, etc.). It is worth noting that the simple regressions for the Polish and British communities are almost parallel, which means that the difference between the mean values of the BDI scale in both compared countries is similar for different age groups.

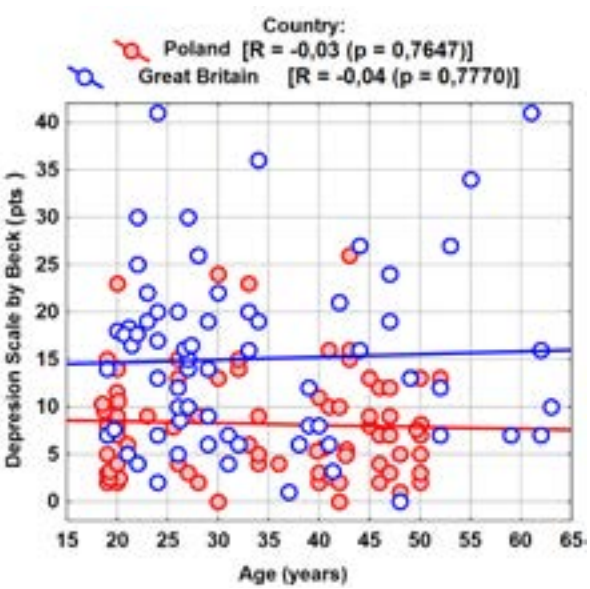

Fig. 1. Age in years (18-63) and BDI points (0-40)

In summary, it can be stated that age does not condition the intensity of depression in the studied groups,

and the features that affect this in a significant way is nationality and sex. In the case of sex, it does not differ from the observed trends described in the introduction.

Discussion

According to the research of the British Mental Health Foundation, between 8 and 12% of the population suffers from depression every year, and 2% experience a depressive episode without accompanying anxiety symptoms. It is estimated that more than half of people experiencing a depressive episode will experience another in the future, while those experiencing a second depressive episode will have 70% chance of relapse. After the third episode, the risk increases to 90%. Depression is chronic in 1 in 5 people. Worldwide, 5.8% of men and 9.5% of women will experience depression within 12 months, which gives about 121 million people. The World Health Organization believes that in 2020 depression will be the second most frequently occurring disease, coexisting with other disorders.[12]

According to NIFCE data in the United Kingdom, depression is more common in women than in men, where every fourth woman requires treatment for depression at some point in life, for men it is about one in ten. The reasons for this are unclear, this is due to both social and biological factors. It was also found that depression in men may be unrecognized because they present symptoms of the disease differently than women (National Institute For Clinical Excellence, 2003).[13] Further data confirm these trends. According to the official data of the ONS (Office for National Statistics) based on a study conducted in 2010-2011 in 40,000 British households, 1/5 adults in the UK experience anxiety or depression. Anxiety and depression were most common in people aged 50-54, and more often in women (21%) than men (16%). This study also confirms a greater tendency for depression among single persons (27%) than those living in formal and informal relationships (16%). A higher level of depression was also observed among the unemployed (23%) than in those with permanent employment (15%). The results also confirmed the relationship between overall satisfaction with health and the symptoms of depression. Symptoms of depression occur in 38% of those dissatisfied with their health and 11% of those who showed such satisfaction.[14]

Epidemiological research on mental disorders (EZOP) on a sample of 10,000 Poles aged 18-64 have estimated that symptoms such as anxiety, irritability and mood depression occur in 20-30% of the population. A dozen or so percent indicate such symptoms as: fits of anger, social anxiety or attacks of panic. Mood disorders (depression, dysthymia, mania) were confirmed in 3.5% of the respondents. Depression alone with varying intensity was reported by 3% of the respondents. Sex was confirmed as the socio-demographic factor predisposing to this type of symptoms, - women were more vulnerable than men to the symptoms of this type of disorder, occupational situation, where the most vulnerable groups are the unemployed, pensioners, the retired and housewives, low social support, loneliness - people without a life partner, residents of big cities. All these symptoms may in the future manifest themselves with mental disorders (EZOP, 2007).[15] Another study on 445 inhabitants of the Wielkopolska rural areas with the use of BDI showed that symptoms of depression were observed in 30% of the respondents. The severity of symptoms was dependent on age, sex and quality of life.[16]

High social awareness, knowledge of mental diseases and knowledge of depression may contribute to better acceptance and tolerance of people affected by this disease. Polish CBOS research from 2007 entitled "Public opinion on mental disorders" shows that the best-known mental disorder is schizophrenia, as declared by 40% of the respondents. The second one in the list is depression, which was confirmed by every fifth respondent (22%). Nearly two-fifths of the respondents (40%) admitted that they could not point to any mental illness. The self-assessment of Polish society regarding knowledge about mental illness is not satisfactory. More than half of the respondents (52.7%) said they knew little about mental illness, and more than one third (36.5%) estimated that they knew practically nothing about them. This report also shows that mental illness in the opinion of Poles most often arouses sympathy (58%), and mentally ill are treated worse than others in many areas of social life.[17]

The level of knowledge on depression declared by the respondents in our research is also not satisfactory, because the majority of the respondents claimed not to have sufficient knowledge on this issue 68.5% and only every third respondent recognized having such knowledge (31.5%). In the study by Kużel, 73% rated their level of knowledge about depression as average.[18] In Podbrożna's research, only 5% of the respondents assessed their own knowledge about the mentally ill at a high level, 39% – at a moderate level, 38.5% - negligible, and 7.5% admitted that they did not have knowledge on this subject.[19]

When asked about what depression was, most respondents answered that it was a disease (45%), 30% of the respondents thought that it was a low mood, 19% of people believe it to be a temporary breakdown, and 6% - an excuse in difficult situations. The correct answer that depression is a disease was more often given by the British 59.7% than Poles (31.5%). To compare, in the study of Iwanicka-Maciura, over 89% of the surveyed students were able to correctly define depression as a disease, and in the study by Kużel et al. 77% of the respondents con-

sidered depression to be a serious disease impeding normal functioning.[18, 20]

In the study we also asked to indicate the most important source of knowledge about depression. The respondents most often mentioned the Internet - 65.3%, books 24.5%, and TV and radio 10.2%. In other authors the Internet is also one of the most important sources of information, for example, in Iwanickia-Maciura study the Internet was indicated by 70.6 % of the respondents, similarly in Kużel's, the respondents acquired the knowledge about depression mainly from the media (66.5%) and the Internet (60.5%).[20,18]

People with depression or other mental illness are often stigmatized socially. The conducted research confirms great acceptance for people with depression in the nearest environment, over 85% of the respondents declare acceptance of an ill person at work, in the neighborhood, in the family and among friends. In the Iwanicka-Maciura's study, over 90% of the respondents are able to accept the disease in the closest people, and about 40% declare friendship and create a relationship with a person after depressive episodes. In the studies of Kużel et al. conducted in the group of nurses and teachers, 77% of the respondents accept people with depression.[20,18]

In 2015, social studies were conducted in Great Britain, which showed a higher level of social acceptance for people with depression than with schizophrenia. Over 70% of the respondents are willing to accept a friend or neighbor with depression. A relationship with a person suffering from depression is much less acceptable – 36%.[21] In research by Podbrożna, 60% of the respondents would agree to build a center dealing with mentally ill people in their neighborhood.[19]

In the CBOS report from 2012, almost two-thirds of the respondents (65%) declare that they have a sympathetic attitude towards the mentally ill, in which slightly more than half (52%) define their attitude as "rather benevolent." Few respondents admit to dislike (5%), and every fourth (26%) - to indifference.[22]

Conclusions

1. The British understand the term „depression" correctly more often than Poles.
2. The inhabitants of Poland and Great Britain take a positive attitude towards people with depression and declare high acceptance of people with depression in the closest environment.
3. Based on the results of Beck Depression Inventory, it can be concluded that the British have depressive symptoms more frequently than Poles.
4. Nationality and age do not affect the severity of depressive symptoms in both groups, while sex is a feature significantly influencing the level of depression only in the British population.

References

1. Depression. World Health Organization Site. www.who.int/topics/depression/en. Accessed April 04, 2018.
2. Sęk H. *Psychologia Kliniczna*. Warszawa: PWN; 2010;2:47.
3. Hammen C. *Depresja. Modele kliniczne i techniki terapeutyczne*. Gdańsk: Gdańskie Wydawnictwo Psychologiczne; 2014:46.
4. Depresja a depresyjność u dorastających. Medforum 2009. http://static.medforum.pl/edukacjamedcyzna_pl_janas_kozik_depresyjnosc.pdf Accessed April 25, 2018.
5. Rosenthal MS. *Depresja.* Warszawa: KDC; 2002:72.
6. Mental health, Data and statistics. World Health Organization Website. *http://www.euro.who.int/en/health-topics/noncommunicable-diseases/mental-health/data-and-statistics.* Accessed April 20, 2018.
7. WHO: The World Health Report. World Health Organization, Genewa. 2001:1-177.
8. Depression and Mental Health by the Numbers: Facts, Statistics, and You. Newsletter Healthline. 2015. http://www.healthline.com/health/depression/statistics-infographic. Accessed April 18, 2018
9. Wartości i normy w życiu Polaków. Komunikat z badań CBOS. Warszawa; 2015: 65.
10. Lewicka M, Makara-Studzińska M, Wdowiak A, Sulima M, Kanadys K, Wiktor H. Poziom lęku i depresji w okresie okołooperacyjnym a kategoria zabiegu operacyjnego w grupie kobiet leczonych z powodów ginekologicznych. *Med Og Nauk Zdr.* 2012;18(2):107-111.
11. Kurowska K, Celmer-Ozdowska I. Depresyjność a jakość życia u osób z rozpoznaną zaćmą. *Hygeia Public Health*. 2014;49(3):554-559.
12. Depression. Mental Health Foundation. http://www.mentalhealth.org.uk/content/assets/PDF/publications/fundamental_facts_2007.pdf?view=Standard. Accessed April 25, 2018.
13. National Institute for Clinical Excellence: Clinical guidelines. United Kingdom: 2003.
14. Office of national statistics. www.ons.gov.uk. Accessed April 26, 2018.
15. Kiejna A, Adamowski T, Piotrowski P, et al. Epidemiologia zaburzeń psychiatrycznych i dostępność psychiatrycznej opieki zdrowotnej. EZOP – Polska – metodologia badania. *Psych Pol*. 2015;49(1):5-13.
16. Łojko D, Czajkowska A, Suwalska A, et al. Symptoms of depression among adults in rural areas of western Poland. *Ann Agric Environ Med.* 2015;22(1):152–155. Doi: doi.org/10.5604/12321966.1141386
17. Opinia publiczna o chorobach psychicznych. Raport z badania typu Omnibus. CBOS. http://lekarze.slask.pl/dok/opinia.pdf. Accessed April 25, 2018.
18. Kużel A, Krajewska-Kułak E, Śmigielska-Kuzia J. Percepcja depresji w wybranych grupach społecznych. *Med Og Nauk Zdr.* 2015;21(3):295–302. doi: 10.5604/20834543.1165356
19. Podbrożna S. Postawy społeczne wobec chorych psychicznie. *Puls Uczelni. 2012;*4: 10-15.

20. Iwanicka-Maciura A, Szewerniak P. *Wiedza i postawy studentów wobec chorych z depresją*. Binkowska-Bury M, Marć M ed. Badania w pielęgniarstwie XXI wieku. Rzeszów: Wydawnictwo Uniwersytetu Rzeszowskiego; 2012:97-108.
21. British Social Attitudes. Attitudes to mental health problems and mental wellbeing. Findings from the 2015 British Social Attitudes survey. Nat Cen Social Research. http://www.bsa.natcen.ac.uk/latest-report/british-social-attitudes-33/mental-health.aspx. Accessed April 25, 2018.
22. Omyła-Rudzka M. *Stosunek do osób chorych psychicznie*. Komunikat z badań CBOS. Warszawa; 2012:34.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.4

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 198–203

ORIGINAL PAPER

Joanna Sobczyk [1(ACDEF)], Aleksandra Pusz-Sapa [1,2(CDEFG)], Aneta Wojtasik [1,2(ABCFG)], Greta Gaweł [1,4(DEF)], Adrian Truszkiewicz [1,3(EF)], Wiesław Guz [1,2,3(EF)]

The influence of ODM technique on the radiation dose received by patients during head CT scan

[1] Department of Electroradiology, Faculty of Medicine, University of Rzeszow, Rzeszow, Poland
[2] Clinical Radiology and Diagnostic Imaging Department, Regional Hospital No.2 in Rzeszow, Rzeszow, Poland
[3] Center for Innovative Research in Medical and Natural Sciences, Faculty of Medicine, University of Rzeszow, Rzeszow, Poland
[4] Clinical Radiology and Diagnostic Imaging Department, Podkarpackie Oncology Centre Regional Hospital No.1 in Rzeszow, Rzeszow, Poland

ABSTRACT

Introduction. Computed tomography (CT) is inexpensive radiological examination of high diagnostic effectiveness. However, common use of CT tests has led to increased exposure to ionizing radiation in the population.

Aim. To assess the effect of organ dose modulation (ODM) technique on the radiation dose received by patients during head CT scan.

Material and methods. A retrospective analysis of 120 tests in two groups of patients who had CT scans without and with ODM. Every group consisted of 60 people (30 women and 30 men in each). The ability to perform tests in two algorithms (without and with ODM) resulted from the fact that after installing the apparatus, tests were carried out using standard technique, and only then the ODM function was launched.

Results. We found that during examinations with ODM, patients received a reduced dose of ionizing radiation. The mean DLP value with ODM is 9.4% lower than the mean DLP value without ODM by comparing the tests with and without contrasting agent. The mean DLP value obtained in men using ODM was 11.9% lower than the mean dose without ODM, and in women this difference was 6.6%.

Conclusion. The mean DLP value received by men with ODM was by 11.9% lower than the mean dose without ODM, and in women this difference was 6.6%. Patients receive a lower dose both in tests with and without a contrasting agent compared to the tests where ODM was not used. A statistical significance of the obtained results was found.

Keywords. organ dose modulation, computed tomography, protection against ionizing radiation

Corresponding author: Joanna Sobczyk, e-mail: joanna331@op.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 1.05.2018 | Accepted: 9.07.2018
Publication date: September 2018

Sobczyk J, Pusz-Sapa A, Wojtasik A, Gaweł G, Truszkiewicz A, Guz W. *The influence of ODM technique on the radiation dose received by patients during head CT scan.* Eur J Clin Exp Med. 2018;16(3):198–203. doi: 10.15584/ejcem.2018.3.4

Introduction

Computed tomography (CT) is available and relatively inexpensive radiological examination of high diagnostic effectiveness. Multi-detector row CT scanners and shortened acquisition time have led to more frequent clinical use of CT. The result was a significant increase in the number of tests - it is estimated that it amounts to as much as 40% of all diagnostic examinations. In the past 25 years, worldwide, the number of nuclear medicine examinations has almost tripled, while the number of CT examinations has increased more than twenty times.[1]

However, common use of CT tests has led to increased exposure to ionizing radiation in the population. United States citizens are exposed to ionizing radiation from medical devices almost six times higher than in 1980, and CT constitutes 45% of the total exposure to medical radiation in the USA, although it has only a 12% share in medical procedures.[2] Head CT is one of the most common CT examinations. Exposure to X-rays in this area has a twofold aspect. First of all, there are eye lenses which are an anatomical element particularly sensitive to X-rays. Secondly, it is the anatomical area with a high content of bone elements, hence the need to use X radiation of greater hardness which results in the emission of higher doses.[3] In addition, in many clinical situations it is necessary to repeatedly examine the same patient. All these issues require the head CT scan to be performed in such a way that the patient is exposed to the lowest possible dose.

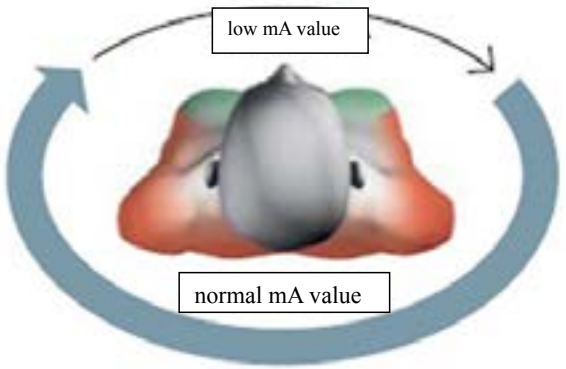

Fig. 1. Graphical principle of the ODM function.[5]
Reference: Siemens Healthcare, Guide to Right Dose

One of the ways of dose reduction, also in the case of CT scan of the head, is the use of the organ dose modulation (ODM) technique. This technique is based on automatic adjustment of the lamp current in real time, in order to obtain the optimum quality of the diagnostic image at the lowest possible dose, depending on the size and construction of the patient. Thus, the radiation dose is modulated to adapt to the image of the organ and the patient's body characteristics (Fig. 1) in order to better manage the dose in relation to the anatomy of the examined patient.[4]

Aim

The aim of the study is to compare X-rays doses obtained during CT examinations performed in standard technique and ODM technique.

Material and methods

A retrospective analysis was performed in two groups of patients who had CT scans due to different clinical indications. Each group consisted of 60 people (30 women and 30 men in each). Patients had the examination performed using a 256-slice Revolution CT scanner by GE. The ability to perform tests in two algorithms (without and with ODM) resulted from the fact that after installing the apparatus, tests were carried out in the standard technique, and only then the ODM function was launched.

Group A - patients who had head CT scans without ODM; mean age was 66.7 (26 to 90 yrs).

Group B - patients who had head CT scans with the ODM; mean age was 62.5 (19 to 92 yrs).

The same protocol was used in all examinations. First, two preliminary images (Scout views) were taken with 250 mm coverage - the first in the anterio-posterior projection (a-p), the other in the lateral projection. The transverse plane of slices was set through the nasal bridge and external auditory openings. A constant voltage of 120 kV and the examination time - 9 s (with the rotation time of the lamp-panel system - 1 s), pitch 1.0 were used. mA values were automatically selected - SmartmA 100-300 mA. The test was performed using 2.5 mm slices, the test range was 16 cm to cover the entire head. Noise Index in all examinations was at 2.5. All patients had the examination initially without and later with a contrasting agent. Dose Length Product (DLP) was recorded for each patient. DLP is the product of CTDIvol (in mGy) and scan length (in cm). CTDIvol is CT volume dose index expressed in the form of CTDIw divided by pitch factor (quotient of the displacement of the table during a complete revolution of the X-ray lamp and the thickness of a single slice. CTDIw is a weighted CT dose index that allows the assessment of the average dose in a single slice.

The variable distribution has been checked. It deviates from the normal distribution. Normalization by logarithm did not bring enough change. Therefore, non-parametric tests were performed. The Mann-Whitney U test was used to compare the mean DLP doses in the examinations without and with ODM, without contrasting agent and after its administration, as well as a

comparison of mean DLP doses with and without ODM between the sexes.

The Wilcoxon signed-ranks test was used to compare mean doses of DLP in the examinations without and with ODM in the groups of women and men. Statistical significance was defined at $p < 0.05$.

Results

After performing the test without and with the contrasting medium, the mean DLP values for groups A and B were calculated. The differences in mean DLP values between group A (the standard technique, without ODM) and B (with ODM) were analyzed. The results are shown in Figure 2.

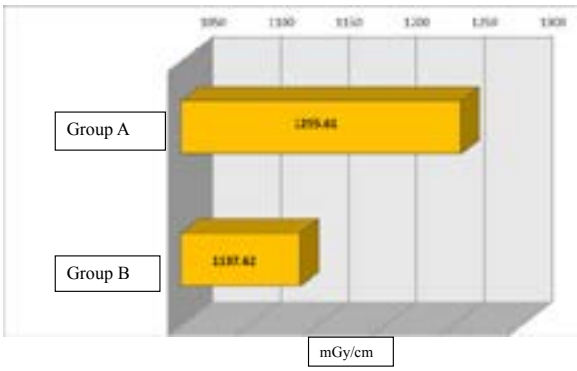

Fig. 2. Comparison of mean DLP values between groups A and B during CT scan without and with the contrasting agent

The mean DLP value for all patients during the head examination with ODM was 9.4% lower than the mean dose without ODM. The difference is 117.99 mGy/cm and is statistically significant ($p = 0.000007$).

Then the differences in mean DLP values for men in group A and B were analyzed. The results are shown in Figure 3.

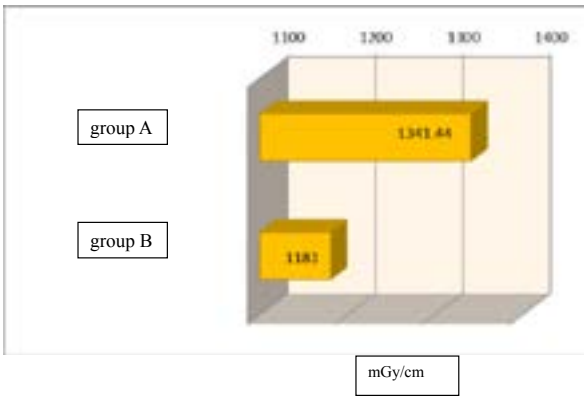

Fig. 3. Comparison of mean DLP values between groups A and B in men during CT scan without and with ODM

The mean DLP value in men during the head examination with ODM was 11.9% lower than the mean dose without ODM. The difference amounted to 160.44 mGy / cm and was statistically significant ($p = 0.0007$).

In the same way, the difference in doses of DLP received by women in group A and B was analyzed. The results are presented in Figure 4.

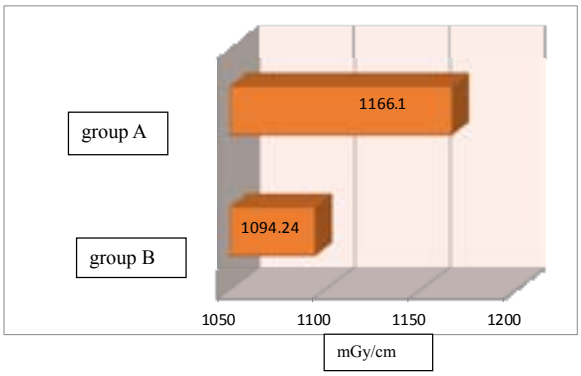

Fig. 4. Comparison of mean DLP values between groups A and B in women during CT scan without and with ODM

As in the group of men, women received by 6.6% lower dose of DLP when using ODM. The mean DLP dose with ODM was by 71.86 mGy / cm lower and the difference was statistically significant ($p = 0.006$).

Due to differences in mean values in the group of men and women, a comparison was made between both sexes.

Mean doses were compared in men and women during CT scan without and with a contrasting agent, without ODM and the results are summarized in Figure 5.

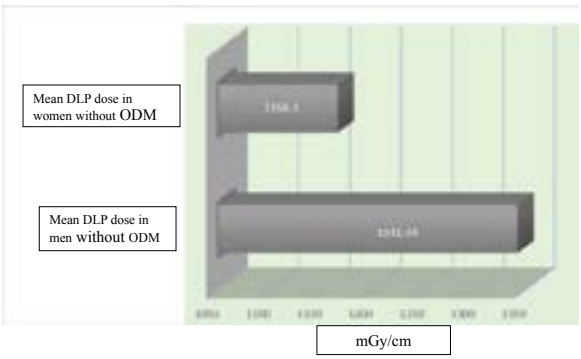

Fig. 5. Comparison of the mean DLP values between men and women in the CT examination without and with the administration of a contrasting agent, without ODM

The mean DLP dose without ODM in men was 1341.44 mGy/cm, whereas in women 1166.1 mGy /cm. The difference was 13% - 175.3 mGy / cm and was statistically significant ($p = 0.000001$).

An analogous comparison was made in case of ODM use. The results are shown in Figure 6.

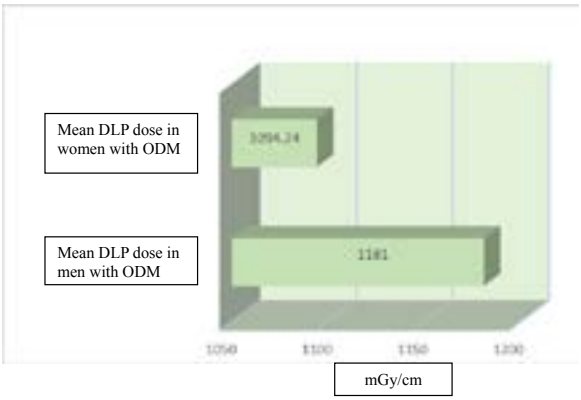

Fig. 6. Comparison of the mean DLP values between women and men in the CT examination without and with the administration of a contrasting agent, with ODM

The mean DLP dose with ODM in men was 1181 mGy /cm, whereas in women 1094.24 mGy /cm. The difference was 7.3% - 86.76 mGy / cm and was statistically significant (p = 0.0072).

Concluding, the difference in the values of received doses (DLP) during the CT examination between women and men in case ODM was not used amounted to 13% and in the case of ODM use, 7.3%.

Since a significant percentage of CT scans are performed without the use of a contrasting agent (most tests in case of injuries), an analogous analysis was made as for the first part of the study, except no contrasting agent was administered.

The mean DLP values for groups A and B were calculated. The differences in mean DLP values between group A (the standard technique, without ODM) and B (with ODM) were analyzed. The results are shown in Figure 7.

Fig. 7. Comparison of mean DLP values between groups A and B during CT scan without contrasting agent

The mean DLP value for all patients during head examination without ODM was 10.9% higher - 76.38 mGy / cm - than the value when ODM was used. The difference was statistically significant (p = 0.000001).

Discussion

A significant increase in the number of CT examinations worldwide allows better detection of pathological lesions. However, the widespread use of this method results in an increase in the level of X-ray doses in the patient population.

The number of CT apparatuses in the world are constantly increasing - although the number of apparatuses per 1 million inhabitants in individual countries is very diverse. The highest number of tomographs are in Japan (almost 103.1 per 1 million inhabitants). To compare, there are 17.2 CT apparatuses per 1 million inhabitants in Poland.[6] In this way, the risk of cancer due to CT examinations also increases.[7-9] However, dose levels in CT examinations (typical effective dose expressed in mSv in the case of head scan is 1.6 mSv) are significantly lower than the threshold dose for inducing deterministic effects, nevertheless they may affect the stimulation of gene mutations and carcinogenesis.[10] Hence, doses generated in CT examinations may particularly pose a risk to pediatric patients, youth and adult women.[11,12] Both doctors referring to examination as well as the patients and their benefactors are generally unaware of the doses of radiation received in the CT examination, its risk of carcinogenesis and the importance of reducing exposure in younger patients.[13,14] Radiologists, who generally have a higher education in radiation biology and radiation risk, often have no direct relationship with patients who are imaged.[15] It has been calculated that in the US, 700 people (including 170 children) die due to radiation-induced malignancies by CT scan of the head and abdominal region a year.[16] The risk of breast cancer is doubled in women with two or more CT examinations before the age of 23.[17]

The latest epidemiological results and studies on animals suggest that dose thresholds causing deterministic effects (e.g. lens opacities that may eventually lead to cataracts) are or may be lower, than has been assumed. [18.19] The radiation dose for the eye lens may vary between 10.6 and 25.5 mGy with an average value of 18.8 mGy.[20.21]

Therefore, despite obvious benefits, limitations on the diagnostic CT tests (especially in children) are introduced because of their potentially dangerous oncogenic effects.[22] The presented issue requires common analysis of radiologists, medical physicists, government legislative bodies and producers of CT equipment. CT staff began more accurately select protocols for individual types of examinations, individualizing them in relation to

specific patients. Two important principles have also been formulated:

1. Referral to CT examination must be well-grounded.
2. All technical aspects of the test must be optimized to achieve the required level of image quality while maintaining the lowest possible doses for every CT scan.[23]

Manufacturers, in subsequent generations of CT devices, began to implement techniques to minimize radiation doses. Among various methods, one of more effective techniques is organ-dose modulation (ODM).[24]

There are few publications describing the use of ODM and they mainly concern phantom research. The first results were presented in 2011 in the American Journal of Roentgenology. It was assessed that the use of ODM reduced the dose on the phantom surface by 27 - 50%, depending on the anatomical region (head or chest) without deterioration in image quality.[25]

In 2012, studies were performed in which the influence of dose reduction on the eye lens using bismuth shielding and ODM protection was compared. Dose reduction with ODM was found to be higher. The dose in the standard CT scan for the eye lens was 32.16 mGy, with bismuth shielding 23.66 mGy, and in case of ODM 22.39 mGy.[26]

In 2015, the results of experimental research on anthropomorphic thoracic and head phantoms were presented. Dose reduction was found in all dosimeter locations with reference to SmartmA (angular modulation and Z axis) 31.3% (nipple), 20.7% (lungs), 24.4% (heart), 5.9% (spine), 18.9% (eye) and 10.1% (brain). On the other hand, simulation studies with voxelized phantoms have shown average reduction of doses: 33.4% (nipple), 20.2% (lungs), 18.6% (spine), 20.0% (eyeball) and 7.2% (brain).[27]

In 2016, another assessment of ODM effectiveness was published - it was found that CTDIvol decreased by about 20%, increasing the noise index by about 14%.[28]

Whereas the producer (General Electric) declares in the manual of the CT apparatus used to perform the tests analyzed in the presented paper, that in the case of head examination - dose reduction up to 30% is expected with the reservation that the accuracy of ODM will be affected by the exact positioning of the patient. Therefore, incorrect positioning of the patient in the a-p direction will affect the effectiveness of dose reduction for radiosensitive organs.[29]

Our calculations have also shown that the use of ODM reduces the dose of DLP both in women and men. The mean DLP value for all patients during the head examination (without and with contrasting agent) with ODM was 9.4% lower than the mean dose without ODM. The mean DLP value in men during the head examination with ODM was 11.9% lower than the mean dose without ODM and in women, the difference was 6.6%. Mean DLP doses without using ODM before and after administration of the contrasting agent were higher than the doses obtained using ODM and were higher by 10.9% and 6.2% respectively. In addition, significant differences were observed when comparing mean doses received by women and men during tests without and with ODM. The difference in tests without ODM was 13% in favor of women, with ODM it was 7.3% also for women. The results of the quoted studies concerned tests performed on phantoms. In the results of our study, when patients were examined, no such significant values of DLP dose reduction were found. Nevertheless, it was found that it is reasonable to use ODM protocols at each head CT scan. This seems particularly important in view of the very large number of patients referred for CT scanning of the head which are not always well justified.[30]

Conclusion

1. Results of the paper confirmed that the use of ODM technique reduces the dose of X-radiation received by the patient during the CT scan of the head.
2. We found that the reduction of DLP in patients is lower than in phantom studies.
3. The mean DLP value using ODM was reduced in the study group by 9.4% and the difference is statistically significant.
4. The mean DLP value obtained by men using ODM was by 11.9% lower than the mean dose without ODM, and in women this difference was 6.6%. Both results are statistically significant.
5. The mean DLP dose without the use of ODM during the examination without contrast was higher by 67.38 mGy / cm (10.9%) than the doses obtained by the subjects when ODM was used.
6. A difference was found in the values of received doses (DLP) during the CT examination between women and men. In case ODM was not used, DLP values in the group of women were 13% lower and in the case of ODM use by 7.3%. The difference was statistically significant.
7. The use of ODM technique should be necessary in all CT scans of the head.

References

1. Amis ES Jr, Butler PF, Applegate KE, et al. American College of Radiology white paper on radiation dose in medicine. *Radiol.*2007;4:273.
2. Mettler FA Jr. Magnitude of radiation uses and doses in the United States: NCRP scientific committee 6-2 analysis of medical exposures. Forty-third NCRP annual meeting program, 2007: 9–10.
3. Opielak G, Dworzański W, Piotrkowicz J, Szeszko Ł, Tsyganok M. Tomografia komputerowa głowy w codziennej diagnostyce. *Medycyna rodzinna.* 2012; 4: 62-64.
4. Revolution CT. Podręcznik użytkownika. *Wyd. GE.* 2014.

5. Akata D, Karaosmanoglu AD, Özman MN, Brkljacic B, Onur MR. Time is Ripe! How to keep up with new technologies for radiation dose optimisation and find ways to incorporate these new developments in radiology equipment renewal. EuroSafe Imaging.2016. site. http://dx.doi.org/10.1594/esi2016/ESI-0021
6. Polska na 36. miejscu pod względem wydatków na ochronę zdrowia – najnowszy raport OECD 05 listopada 2015;site. http://www.politykazdrowotna.com/tag/oecd
7. Berrington de González A, Darby S. Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries. *Lancet.*2004;363:345–351.
8. Brenner DJ, Hall EJ. Computed tomography: an increasing source of radiation exposure. *N Engl J Med*.2007;357:2277–2284.
9. Mettler FA, Thomadsen BR, Bhargavan M, et al. Medical radiation exposure in the U.S. in 2006: preliminary results. *Health Phys*.2008;95:502–507.
10. Deak DD, Smal Y, Kalender WA. Multisection CT Protocols: Sex- and Age-specific Conversion Factors Used to Determine Effective Dose from Dose-Length Product Radiology.2010; Oct:257(1):163.
11. Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. *AJR Am J Roentgenol.*2001;176:289–296.
12. Khursheed A, Hillier MC, Shrimpton PC, Wall BF.Influence of patient age on normalized effective doses calculated for CT examinations. *Br J Radiol*.2002;75:819–830.
13. Griffey RT, Sodickson A. Cumulative radiation exposure and cancer risk estimates in emergency department patients undergoing repeat or multiple CT. *AJR Am J Roentgenol*.2009;192:887-892.
14. Caolili EM, Cohan R, Ellis JH. Decyzje medyczne dotyczące obliczonej dawki promieniowania tomograficznego i związanego ryzyka: perspektywa pacjenta.*Archives of Internal Medicine*.2009;169(11):1069-1071.
15. Shyu JY, Sodickson AD.Communicating radiation risk to patients and referring physicians in the emergency department setting. Br J Radiol.2016;89.
16. Goldberg J, McClaine RJ, Cook B, Garcia VF, Brown RL, Crone K. et al. Use of a mild traumatic brain injury gideline to reduce inpatient hospital imaging and charges. *J Pediatr Surg*.2011;46(9):1777–1783.
17. Merry G. Breast cancer risks from medical imaging computed tomography and nuclear medicine among females enrolled in a large integrated health care system. Radiological Society of North America.2012;site. http://archive.rsna.org/2012/12035878.html
18. Ainsbury EA, Bouffler S., Dorr W, Graw J, Muirhead CR, Edwards AA et al. Radiation cataractogenesis: a review of recent studies. *Radiat. Res*.2009;172(1):1–9.
19. Shore RE, Neriishi K, Nakashima E. Epidemiological Studies of Cataract Risk at Low to Moderate Radiation Doses: (Not) Seeing is Believing. *Radiat. Res*.2010;174(6):889–894.
20. Domienik J, Zmyślony M. Ocena dawek otrzymywanych przez pacjentów poddanych badaniom tomografii komputerowej.*Medycyna Pracy.*2012;63(6):629–635.
21. Nikupaavo U, Kaasalainen T, Reijonen V, Ahenen SM, Kortesniemi M. Lens Dose in Routine Head CT: Comparison of Different Optimization Methods With Anthropomorphic Phantoms, *Medical Physics and Informatics.* 2015;204:117–123.
22. Tian X, Li X, W. Segars P, Paulson EK, Frush DP, Samei E. Pediatric Chest and Abdominopelvic CT: Organ Dose Estimation Based on 42 Patient Models. *Radiology*.2014;270(2):535–547.
23. Smith-Bindman R, Lipson J, Marcus R, et al. Radiation Dose Associated With Common Computed Tomography Examinations and the Associated Lifetime Attributable Risk of Cancer. *Arch Intern Med*.2009;169(22):2078-2086.
24. McCollough CH, Primak AN, Braun N, Kofler J, Yu L, Christner J. Strategies for reducing radiation dose in CT. *Radiol. Clin. North Am*.2009;47:27–40.
25. Xinhui D, WangJ, Christner JA, Leng S, Grant KL, McCollough CH. Dose Reduction to Anterior Surfaces With Organ-Based Tube-Current Modulation: Evaluation of Performance in a Phantom Study. *American Journal of Roentgenology.*2011;197:689-695.
26. Wang J, Duan X, Christner JA, Leng S, Grant KL, McCollough CM.Bismuth Shielding, Organ-based Tube Current Modulation, and Global Reduction of Tube Current for Dose Reduction to the Eye at Head CT. *Radiology*.2012;262(1):191-198.
27. Gandhi D, Crotty DJ, Stevens GM, Schmidt TG. Technical Note: Phantom study to evaluate the dose and image quality effects of a computed tomography organ-based tube current modulation technique.*Med. Phys*.2015;42(11):6572-8.
28. Dixon MT, Loader RJ, Stevens GC, Rowles NP. An evaluation of organ dose modulation on a GE optima CT660-computed tomography scanner. *Journal of Applied Clinical Medical Physics.*2016; 3:380.
29. Revolution CT Podręcznik użytkownika. *Wyd.GE*.2014;259-260.
30. Zdrojewicz Z, Szlagor A, Wielogórska M, Nowakowska D, Nowakowski J. Wpływ promieniowania jonizującego na organizm człowieka. *Family Medicine & Primary Care Review.*2016;2(18):174–179.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.5

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 204–208

ORIGINAL PAPER

Elżbieta Kraśnianin (BCDE), Grzegorz Raba (ACFG), Anna Kremska (BCDE), Romana Wróbel (BCDE), Barbara Zych (BCDE)

Professional experience of midwives is not sufficient to accurately assess the amount of blood loss during labor

Institute of Midwifery and Emergency Medicine. Faculty of Medicine, University of Rzeszów, Rzeszow, Poland

ABSTRACT

Introduction. Postpartum hemorrhage is still one of the causes of maternal mortality and morbidity. The purpose of investigation was an examination of practical skills in blood loss assessment during labor by midwives.

Aim. To examine the practical skills of midwives that have different professional experience in blood loss assessment during labor.

Materials and methods. A case-control prospective study of labour blood loss volume assessment with the use of a birthing simulator was conducted among midwives from 1 September 2016 to 30 May 2017. Midwives were divided in to 2 groups: Group I consisted of midwives who were recent university graduates without professional experience. Group II consisted of midwives with a minimum of two years of professional practice and assistance at more than 1000 births. This was a multicenter study. Outcome measures included visual evaluation of blood loss during simulation scenario.

Results. Average evaluation of blood loss: Group I – 737 ml, Group II – 610 ml ($p = 0.0002$). There were no statistically significant differences between the groups in terms of diagnosing the cause of hemorrhage in the third stage of labor ($p = 0.1503$) neither in terms of identification of hemorrhage after perineal injury ($p = 0.1503$) . The examined midwives underestimated blood loss, however the midwives in Group I assessed blood loss statistically better.

Conclusions. Subjective assessment of the amount of blood loss during labor is underestimated. Professional experience does not improve the accuracy of assessment of blood loss volume during labor.

Keywords. delivery, education, postpartum hemorrhage

Introduction

Postpartum hemorrhage is still one of the main causes of maternal mortality and morbidity. It is often the cause of loss of the ovarian reserve and preterm menopause. Development of an action plan and strategy based on rapid assessment of obstetric situation is crucial for the improvement of obstetric outcomes.[1-5] The practical skill of identification of changes occurring during labor is the basis for early risk identification. Accurate evaluation of blood loss during labor constitutes the basis for perinatal care model. This type of care is recommended by Word Health Organisation (WHO).[6-15] The problem of validating the practical skills of midwives makes simulation training a tool that is increasingly used for teaching and

Corresponding author: Raba Grzegorz, e-mail: rabagrzegorz@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 19.04.2018 | Accepted: 13.07.2018
Publication date: September 2018

Kraśnianin E, Raba G, Kremska A, Wróbel R, Zych B. *Professional experience of midwives is not sufficient to accurately assess the amount of blood loss during labor*. Eur J Clin Exp Med. 2018;16(3):204–208. doi: 10.15584/ejcem.2018.3.5

analysing the operations of an obstetric team. Trainings with simulators allow for gaining practical skills and improve the results of perinatal care.[1-5] Currently, obstetric staff are required to participate in projects aimed at ensuring a normal and safe pregnancy and childbirth. It is only possible when the education and training process is based on the latest medical standards adopted in the world.[1,3-5,16,17] Nowadays, training with simulators is an important part of medical education, thus it is essential to carry out research and organize thematic workshops in this field. Birthing scenarios including elements of labor pathology are often used in simulation team trainings. Simulation training that mirrors real situations allows for gaining the practical skills required to make quick decisions and undertake specific actions.[1,3,11,15,18,19]

Aim of the study

The aim of this study was to examine the practical skills of midwives having different professional experience in blood loss assessment during labor.

Materials and methods

This is a case- control prospective study. The study was carried out from 1 September 2016 to 30 May 2017. The study was carried out with the use of the SimMom birthing simulator (ADM 377-02050). It was attended by midwives divided into two groups (Group I and Group II). This was a multicenter study. Participants were recruited from all 4 provincial hospitals in the Podkarpackie province. The number of births in each of these 4 hospitals exceeds 2000 every year.

Inclusion criteria for the groups:

- Group I: Midwives with recent university graduates without professional experience.
- Group II: Midwives with a minimum of two years of professional practice and assistance at more than 1000 births.

We included midwives who were first to respond to an invitation letter. The invitation letter was sent to all 126 midwives in the Podkarpackie province who just graduated with a university diploma without professional practice and to all 187 midwives employed for a minimum of 2 years as a full time employees in those 4 provincial hospitals. The number of births in each of those hospitals exceeds 2000 every year. After years of employment in these hospitals each of the recruited midwives assisted at more than 1000 births.

Exclusion criteria for the groups:

- Previous experience in workshops or training with birthing simulators.

Participation in the research was voluntary. The consent of the Local Bioethics Committee was obtained. The brand validated labor simulation scenario which summarized the case of natural delivery complicated with hemorrhage was used in the study. The participants were familiarized neither with the scenario nor the clinical diagnosis. The scenario included 3 stages of labor. It contained the following risk factors and disorders:

1. First stage of labor: PROM, secondary uterine adynamia.
2. Second stage of labor: haemorrhage after perineal injury.
3. Third stage of labor: incomplete afterbirth.

In both groups the midwives were supposed to:

1. actively participate in patient care according to the prepared scenario,
2. identify and specify the risk factors of bleeding in the presented case,
3. identify the clinical situation and assess intranatal blood loss.

The assessment of risk factors consisted in the analysis of the presented case study as well as observation and participation in the labor according to the simulation scenario. 800 ml of artificial blood was used to carry out the assessment of blood loss during each simulation. The tool for data collection was SimMom birthing simulator computer system and the procedure was arranged by a brand original birth simulation scenario.

Statistical analysis was performed based on STATISTICA 10.0. The following tests were applied: T-Student test for independent variables or an alternative Mann-Whitney test, which were used to evaluate the differences in the average level of measurable characteristics in two populations, and the Pearson's chi-squared test when variables having qualitative characteristics were used in the analysis. The value of $p < 0.05$ was assumed as the statistical limit level of significance.

Results

The number of recruited subjects to the groups was equal: Group I - 30 midwives and Group II – 30 midwives. The age of the examined midwives in Group I and Group II was statistically significantly different. The midwives with active professional practice over 2 years (Group II) were older (p=0.0000).

Table 1. Sociodemographic characteristics of the Groups

Criteria	Group I n. 30	Group II n. 30	P
Average age (years)	23.5	44.5	0.000
Minimum age	21	30	0.001
Maximum age	38	56	0.001
Age standard deviation	3.38	6.9	0.043
Race	white	white	n/a
Sex	female	female	n/a
Education status	University Diploma	University Diploma	n/a

Hemorrhage after perineal injury as a disorder of second stage of labor was well diagnosed by the exam-

ined midwives. The differences between the groups were statistically insignificant (p = 0.1503).

Table 2. Identification of second stage of labor disorders

Second stage of labor disorders	Group I	Group II	P
Hemorrhage after perineal injury	30 (100%)	29 (93.3%)	= 0.1503

Table 3. Identification of third stage of labor disorders

Third stage of labor disorders	Group I	Group II	P
Incomplete afterbirth	30 (100%)	30 (100%)	= 0.1503

There were no statistically significant differences (p = 0.1503) between the groups in terms of diagnosing the cause of hemorrhage in the third stage of labor. All of the examined midwives stated that the most likely cause of the hemorrhage in the third stage of labor was an incomplete afterbirth.

Table 4. Evaluation of intranatal blood loss

Criteria	Average blood loss (ml)	Minimum blood loss (ml)	Maximum blood loss (ml)	S standard deviation
Group I	737	550	1100	1104
Group I	610	300	850	1138
p = 0.0002				

Both in Group I and in Group II, the midwives underestimated intranatal blood loss, however, midwives in group I assessed blood loss statistically significantly better (p = 0.0002).

Discussion

The presented study shows that assessment of the amount of blood loss during labor is underestimated by midwives. Equally important is the fact that the professional experience of midwives does not improve the accuracy of that assessment. This is a novel finding. Similar works like Dunlop et al. demonstrate low accuracy of visual estimation of intrapartum blood loss.[20] The authors conclude that methods that accurately and objectively quantify intrapartum blood loss are needed for clinical and research purposes, but they do not realize that professional experience of medical staff is not one of these methods. It may be surprising that the midwives who had only academic knowledge assess blood loss during labor better then midwives with professional experience (Table 4). Midwives with many years of professional experience underestimated blood loss significantly. It may result from job "routine" that occurs from time to time, and thus from a dangerous underestimation of frequently observed clinical symptoms. This shows a real problem of lack of validated methods of practical skills training of midwives in blood loss estimation. According to Mbachu et al. periodic education by simulation using clinical scenarios could improve the accuracy of visual blood loss estimation.[21] The examination presented in this study on the practical skills of midwives with the use of a birthing simulator revealed a significant problem, that is a general underestimation of perinatal blood loss by obstetric staff. This phenomenon seems to increase with years of working in the profession. This is consistent with the studies of Hancock et al. [21] The authors noted that common underestimation of blood loss during childbirth results in the fact that medical actions are undertaken not as a reaction to blood loss but as a reaction to clinical symptoms caused by blood loss, and thus with a delay. Moreover, the authors emphasize that there is no possibility to teach how to properly evaluate blood loss during labor because it is a function of not only bleeding intensity but also the function of time. It makes this skill one of the most difficult to master by midwives. In an integrative review of literature Hancock et al. conclued that there is little evidence that improvement of maternal outcomes can be achieved through improving the accuracy of blood loss volume measurements.[22] The authors request a need for change in the direction of future research to explore these in more detail. Our study is a small part of such research and reveals that professional experience, like years of employment and number of assistance at birthing procedures is not the means to improve the accuracy of blood loss volume measurements during labor. Delayed reaction to excessive blood loss is associated with a higher ratio of complications, including maternal deaths as well as higher treatment costs. According to Lertbunnaphong et al. visual estimation is not optimal for measurement of blood loss during labor and should be withdrawn from standard obstetric practice.[23] Nowadays, training with medical simulators seems to be the best method of learning how to evaluate intranatal blood loss because it is the only way to verify and correct our own errors and mistakes retrospectively. In the long run, the cost of training with birthing simulators can be compensated by lowering the expenses related to the treatment of women who suffered from perinatal bleeding, and what is most important, the safety of those in labor can be increased. Criteria for the diagnosis of hemorrhage are very well known.[6-12,14-16] Regardless of the definition, we should remember that the actual blood loss assessed visually and subjectively is very difficult and not precise. Frequently, it depends on one's experience and according to other authors, it accounts for only 30 - 50% of the actual blood loss, which in confrontation with an objective assessment carried out in this study with the use of a birthing simulator allows to conclude that the assessment of the amount of blood lost by women giv-

ing birth with excessive bleeding and perinatal hemorrhage is underestimated.[10,15,16,24,25] The use of a birthing simulator in the subject study for the assessment of practical professional skills has highlighted the parts of the training that can be mastered during academic education, and those that require many years of practical training. The main limitation of presented study was a small number of participants in the groups, however, their homogeneity allows to present the obtained results. The strength of the study was multicenter recrutation of participants from four different hospitals with different training programs. The advantages of training with the use of simulators are emphasized in the available literature.[17-19] It is noteworthy that all participants were interested in team training with a birthing simulator, both the graduates without professional experience and midwives with many years of work experience. According to Joint Commission on Accreditation of Healthcare Organizations (JCAHO) report, it is recommended to carry out team trainings in cases involving high risk to mothers and foetuses. These actions and activities are aimed at teaching professionals more effective cooperation under stress and time pressure. During the workshops with a simulator, it is possible to analyse the strengths and weaknesses of participants, deepen the knowledge, develop skills and communication in the team. Due to the increasing number of evidence proving that simulation improves teamwork, optimizes care and improves treatment results, American College of Obstetricians and Gynaecologists (ACOG) recommends simulation team trainings. In the opinion of the participants, simulation allows to verify knowledge and skills, and it is undoubtedly the future of medical education. It is consistent with the conclusions of other authors.[2,3,17-19] Support of superiors, management and academics or favourable conditions for learning are just some of the factors that encourage to implement new educational methods and tools, such as simulation trainings, in the workplace and training centers.

Conclusions

1. Subjective assessment by midwives of the amount of blood loss during labor is underestimated.
2. Professional experience of midwives does not improve the accuracy of assessment of the amount of blood loss during labor.

References

1. Ersdal HL, Singhal N, Msemo G, et al. Successful implementation of Helping Babies Survive and Helping Mothers Survive programs-An Utstein formula for newborn and maternal survival. *PLoS One.* 2017;12(6):e0178073.
2. Andreatta PB, Bullough AS, Marzano D. Simulation and team training. *Clin Obstet Gynecol.* 2010;53(3):532-544.
3. Moran NF, Naidoo M, Moodley J. Reducing maternal mortality on a countrywide scale: The role of emergency obstetric training. *Best Pract Res Clin Obstet Gynaecol.* 2015;29(2):1102-1118.
4. Ennen CS, Satin AJ. Training and assessment in obstetrics: the role of simulation. *Best Pract Res Clin Obstet Gynaecol.* 2010;24(2):747-58.
5. Raba G. Unilateral recanalisation of hypogastric artery after ligation for postpartum haemorrhage treatment. *Videosurgery Miniinv*. 2014;9(8):289–291.
6. Heller HM, Ravelli ACJ, Bruning AHL, et al. Increased postpartum haemorrhage, the possible relation with serotonergic and other psychopharmacological drugs: a matched cohort study. *BMC Pregnancy Childbirth*. 2017;17(6):166.
7. Macharey G, Ulander VM, Kostev K, Väisänen-Tommiska M, Ziller V. Emergency peripartum hysterectomy and risk factors by mode of delivery and obstetric history: a 10-year review from Helsinki University Central Hospital. *J Perinat Med.* 2015;43(3):721-728.
8. Schorn MN, Dietrich MS, Donaghey B, Minnick AF. US Physician and Midwife Adherence to Active Management of the Third Stage of Labor International Recommendations. *J Midwifery Womens Health.* 2017;62(7):58-67.
9. Liabsuetrakul T, Palanukunwong K, Chindeureh A, Oumudee N. Evaluation of a multifaceted postpartum hemorrhage-management intervention in community hospitals in Southern Thailand. *Int J Gynaecol Obstet*. 2017;139(6):39-44.
10. Evensen A, Anderson JM, Fontaine P. Postpartum haemorrhage: prevention and treatment. *Am Fam Physician.* 2017;95(8):442-449.
11. Blaser SA, Greif R, Hähnlein KA, Cignacco E. Competent Management of Postpartum Haemorrhage: A Review on Effective Training Methods. *Z Geburtshilfe Neonatol.* 2016;220(2):106-115.
12. Kranke P, Annecke T, Bremerich DH, et al. Anesthesia in obstetrics: Tried and trusted methods, current standards and new challenges. *Anaesthesist*. 2016;65:3-16
13. HansonJ, McAllister M. Preparation for workplace adversity: Student narratives as a stimulus for learning. *Nurse Educ Pract.* 2017;25(7):89-95.
14. Clark SL. Obstetric hemorrhage. *Semin Perinatol.* 2016;40:109-111.
15. Lockhart E. Postpartum hemorrhage: a continuing challenge. *Hematology Am Soc Hematol Educ Program.* 2015;20(5):132-137.
16. Woiski MD, Scheepers HC, Liefers, et al. Guideline-based development of quality indicators for prevention and management of postpartum hemorrhage. *Acta Obstet Gynecol Scand.* 2015;94(3):1118-1127.
17. Dayal AK, Fisher N, Magrane D, Goffman D, Bernstein PS, Katz NT. Simulation training improves medical students' learning experiences when performing real vaginal deliveries. *Simul Healthc. 2009;*4(4):155-159.

18. Birdane A, Yazici HU, Aydar Y, et al. Effectiveness of Cardiac Simulator on the Acquirement of Cardiac Auscultatory Skills of Medical Students Advances in Clinical and Experimental Medicine. *Adv Clin Exp Med.* 2012;21(8):791–798.
19. Matsuzaki S, Yoshino K, Mimura K, Kanagawa T, Kimura T. Cesarean delivery via a transverse uterine fundal incision for the successful management of a low-lying placenta and aplastic anemia. *Clin Exp Obstet Gynecol.* 2016;43(6):262-264.
20. Dunlop K, Eckler R, Rosen A. Reliability of Visual Estimation of Intrapartum Blood Loss. *Obstetrics & Gynecology.* 2017. doi: 10.1097/01.AOG.0000514120.11806.a5
21. Mbachu II, Udigwe GO, Ezeama CO, Eleje GU, Eke AC. Effect of on-site training on the accuracy of blood loss estimation in a simulated obstetrics environment. *Int J Gynaecol Obstet.* 2017;137(7):345-349.
22. Hancock A, Weeks AD, Lavender DT. Is accurate and reliable blood loss estimation the 'crucial step' in early detection of postpartum haemorrhage: an integrative review of the literature. *BMC Pregnancy Childbirth*. 2015;15(4):230.
23. Lertbunnaphong T, Lapthanapat N, Leetheeragul J, Hakularb P, Ownon A. Postpartum blood loss: visual estimation versus objective quantification with a novel birthing drape. *Singapore Med J.* 2016;57(6):325-328.
24. Hamadeh S, Addas B, Hamadeh N, Rahman J. Spontaneous intraperitoneal hemorrhage in the third trimester of pregnancy: Clinical suspicion made the difference. *J Obstet Gynaecol Res.* 2018;44(3):161-164.
25. Raba G, Baran P. Hemodynamic parameters following bilateral internal iliac arteries ligation as a treatment of intrapartum hemorrhage. *Ginekol Pol.* 2009;80(7):179-183.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.6

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 209–216

ORIGINAL PAPER

Agnieszka Momora [1(BCFG)], Artur Mazur [2(A)], Katarzyna Dereń [2(D)]

Evaluation of food offered in schools and bought by students in Rzeszów

[1] University of Information Technology and Management in Rzeszów, Rzeszow, Poland
[2] Institute of Nursing and Health Sciences, Faculty of Medicine, University of Rzeszów, Rzeszow, Poland

ABSTRACT

Introduction. According to epidemiologic research, the number of obese and overweight children is increasing. A common way of dealing with this problem is enacting legislation regarding food served in educational institutions. In Poland, the regulations regarding the assortment of school shops are contained in the Ordinance of the Minister of Health of 26th June 2015 (and its subsequent amendments).

Aim. The main aim of this study is to evaluate the product range of school shops and vending machines in Rzeszów.

Methods and materials. The study covered 52 primary and secondary schools in Rzeszów. The schools included in the study had 15568 students altogether. Products bought by students in school shops and vending machines were recorded over the period of 3 days.

Results. The study has shown a statistically significant relationship ($p < 0.001$) between the amount and types of products bought in primary and secondary schools. Healthy snacks only made up a small percentage of products sold. Secondary schools sold 20% more snacks with high sugar content compared to primary schools. A majority of products sold were compliant with regulations ($p=0.12$).

Conclusions. The assortment of school shops has changed after the implementation of the Ordinance of the Minister of Health of 26 June 2015 (and its subsequent amendments). The newly introduced restrictions significantly narrowed down the range of products offered in schools, reducing the number of products containing more than 15g of sugar (13.5g per 100g/ml in case of dairy products) or 10g of fat per portion.

Keywords. nutritional habits, childhood and adolescent obesity, public health

Introduction

Childhood is a vital phase in human development. The processes taking place in a person's body during preschool and school years determine the quality of their life in later stages. Correct development of the organism requires a balanced diet, which stimulates somatic and motoric development in early years of life and is the fundamental element of "diseases of affluence" prevention.

According to epidemiologic research, the amount of obese and overweight children has increased over the last

Corresponding author: Agnieszka Momora, email: agnieszkamomora@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 15.05.2018 | Accepted: 19.07.2018
Publication date: September 2018

Momora A, Mazur A, Dereń K. *Evaluation of food offered in schools and bought by students in Rzeszów.* Eur J Clin Exp Med. 2018;16(3):209–216. doi: 10.15584/ejcem.2018.3.6

years. In the 1st quarter of 2017 the number of obese people in the world stood at around 670 million. Worldwide, 2.6 million people per year die due to obesity or excess weight.[1-3] The problem involves all social groups, affecting the appearance of disorders with a metabolic background, such as: high blood pressure, type 2 diabetes, atherosclerosis on a great scale.[4-9] These medical conditions are currently being called the "diseases of affluence." Research involving 12,491 people show that an average of 70% of children with excess weight become obese adults.[10]

Guardians and the environment during childhood have an enormous impact on the nutritional habits of children and teenagers.[11-12] Another factor is the propagation of different diets though widely accessible media, such as the internet (1 in 4 Poles uses these media).[13-17]

Countries all around the world undertake initiatives aiming to decrease the number of overweight students. Many educational programs are created to help prevent the above mentioned diseases and propagate a correct way of eating. A common way of dealing with excess weight and obesity is passing laws regarding the food that may be sold in educational institutions. Both European and worldwide organizations (such as WHO - World Health Organization) publish solutions which could decrease the number of obese children.[18-23]

In Poland, the law regarding the range of products in shops and vending machines located in educational institutions is regulated by the Ordinance of the Minister of Health of 26th June 2015 (with later changes). It concerns the types of food and snacks that may be sold in schools and the requirements that have to be met by the products used to feed the children and teenagers in schools.[24]

In previous years, the assortment of school shops was characterized by lack of legal restrictions. The alteration of regulations in 2015 resulted in a big change. The majority of highly processed food had to disappear from school shop shelves.[25] The situation caused public objection and a media outburst. 390 press publications mentioned the subject.[26]

After a year, the regulations were made less stringent through the novelization of the Ordinance of the Minister of Health of 26th August 2015 which occurred on 26th June 2016.

Aim

The main aim of this study is to evaluate the product range of shops and vending machines in the schools of Rzeszów.

The study also aims to show whether the assortment of those shops and vending machines has been adjusted to the criteria contained in the new regulations.

Materials and methods

The study included 52 schools (primary and secondary) in Rzeszów that teach a total of 15568 students (10317 in primary schools and 5251 in secondary schools). Some of the institutions were school complexes. According to the collected data, 4 shops included in the study have gone bankrupt after the change in regulations in 2015. Ultimately, 16 shops were subjected to the study. In 5 schools, next to the shop, there was a canteen serving hot meals.

Each vendor was asked to take notes of the amount of sold products of different kinds. During each break, the vendors took record of products bought by students. The notes were taken in a table designed for this purpose which contained a list of products based on information from literature published before the imposition of the Ordinance of the Minister of Health of 26th August 2015.[27] The data was recorded over a period of 3 days.

Products were then classified into 8 groups:

- Products with high sugar content - snacks containing more than 15g added sugar per portion; candy, cookies, lollipops, gum, jellybeans, fruit bars, sweetened drinks, sodas, flavored milk and water, mousses, juices, coca, muesli.
- Products with high fat content; open sandwiches (baguettes), savory pastries, braided bread.
- Products with high sugar and fats content; bars, sesame crackers, sweet buns and other sweet pastries, compound chocolate products and waffles.
- Products with high salt content; salted peanuts.
- Products with high fats and salt content; pretzels, crackers, chips, breadsticks, popcorn, corn puffs with added spice mixes.
- Products with low nutritional value (containing a trifling amount of nutrients) - waffles, rice waffles, puffed rice.
- Appropriate snacks (higher nutritional value compared to products from other categories, lack of substances that could negatively affect the organism); kefir, natural yoghurt, fresh salads (without dressings), wholegrain buns, fresh (quality) sandwiches, fresh and dried fruit.
- Bottled water.

The analysis also included products found in vending machines located in schools. The data was verified with the help of the owners of vending machines.

Analysis of the empirical data was conducted with the chi-squared test which was used to determine whether there is a statistically significant relation between the variables ($p \leq 0.05$).

Results

The amounts of sold products of different groups in primary and secondary schools with reference to the number of students are shown in Table 1.

The research shows a significant correlation between primary schools and secondary schools, in the

amount of sold products of different types ($p < 0.001$).

The products most frequently bought by secondary school students were sweet buns (with or without filling). Sweet buns, sold by 80% of secondary schools, made up 45.47% of sold products. Secondary school students bought almost 50% more sweet buns compared to other, healthier snacks.

The second most popular product was bottled still water, which attributed to over 30% of the assortment. Sparkly water was 60% less frequently bought compared to still water. The percentage of sold juices was 26.11%, which is almost 19% less in comparison to sold sparkly water. Fruit mousses and pulp juices made up 20% of all sold products. Sodas such as Coca-Cola were only available in one of the schools (a sport-profiled secondary school).

The third group of most-sold products were lollipops, making up 30% of products bought by secondary school students. The school shops did not offer dragée, jellybeans or ice cream.

The results of the study show that students preferred highly processed products with high sugar, fats or salt content.

Products containing excess sugar were frequently bought. Lollipops were in the assortment of 60% of primary schools subjected to the observation. They were bought in the amount of 20.33% per student. More lollipops were sold in secondary schools (33.82%). Chocolate bars were more popular than fruit bars. "7 Days" croissants were only available in one of the schools included in the study.

Among sweetened drinks, the most frequently bought group of products were "100%" juices, the second most-popular group of products were fruity drinks and the third group - pulp juices ("Kubuś"). Students did not buy flavored water, flavored milk or fruit mousses very often. Sodas were not sold in any school shop in the schools subjected to observation.

Students also preferred to buy sweet buns. Primary school students bought sweet buns over 50% more often than braided bread.

The study showed that students often bought products with high salt content, such as chips, breadsticks and popcorn.

Fresh sandwiches and fruit were the most popular healthy snacks. Students bought nuts and dried fruit less often. Salads were rarely offered in school shops ($n = 2$) and only made up 2.36% of sold products.

No shops sold pretzels, waffles, crackers or puffed rice.

In primary schools, the amount of sold products with high sugar content almost equaled the number of students (close to 1 product per student). In secondary schools, products of that type were sold 20% more often (with reference to the number of students).

Table 1. Amounts of products sold in schools with reference to the number of students

Product	Products sold per 1 student (%)	
	Primary schools	Secondary schools
Products with high sugar content		
flavored milk	7.32	0.10
100% juices	13.96	26.11
fruity drinks	12.10	11.84
fruity mousses	6.64	8.13
pulp juices (Kubuś)	8.63	7.49
chewing gums	19.67	22.17
lollipops	20.33	33.82
cookies	10.14	1.65
candy	1.40	1.48
sweetened muesli	2.65	3.14
sodas	0.00	1.32
flavored water	7.38	2.71
Products with high sugar and fats content		
compound chocolate products	0.55	0.39
sweet buns	8.11	45.47
chocolate bars	5.05	6.52
7-Days	2.40	2.61
fruity bars	6.04	4.45
sweet wafer-cakes	1.07	0.00
ladyfingers	1.89	0.00
biscuits	1.04	0.00
sesame crackers	0.00	0.48
filled doughnuts	0.00	2.10
Products with high fats and salt content		
corn puffs	10.55	17.88
chips	2.19	10.20
breadsticks	10.82	6.16
popcorn	10.68	9.04
crackers	0.19	0.00
pretzels	0.41	0.00
Products with high fats content		
savoury pastries	2.84	0.61
braided bread	4.13	2.84
open sandwiches (baguettes)	0.96	0.00
Products with high salt content		
peanuts (salted)	0.25	0.00
Snacks with low nutritional value		
rice waffles	5.90	6.00
waffles	7.95	6.68
puffed rice	0.05	0.00
Appropriate snacks		
high-quality fresh sandwiches	14.94	24.91
fruit	6.07	7.03
dried fruit	3.01	4.94
nuts and dried fruit mixes	4.37	4.74
natural yoghurts	1.91	0.39
kefirs	0.03	0.03
fresh salads with no dressing	0.00	2.36
Bottled water		
still water	24.59	32.11
sparkling water	15.14	17.36

Source: own elaboration.

Table 2. Amounts of products from different groups sold in schools with reference to the number of students

Group of products	Primary schools - 3660 students		Secondary schools - 3099 students	
	Amount of sold products	Products sold per student (%)	Amount of sold products	Products sold per student (%)
high sugar content	3616	98.80	3665	118.26
high fats content	186	5.08	88	2.84
high fats and sugar content	1332	36.39	1973	63.67
high salt content	9	0.25	0	0.00
high salt and fats content	1423	38.88	1360	43.89
low nutritional value	507	13.85	393	12.68
appropriate snack	1110	30.33	1376	44.40
bottled water	1454	39.73	1533	49.47
Sum	9637		10388	

Source: own elaboration.

Table 3. Percentages of products from different groups sold in primary and secondary schools

Group of products	Primary schools		Secondary schools	
	Amount of products	Percentage out of all sold products (%)	Amount of products	Percentage out of all sold products (%)
high sugar content	3616	37.52	3665	35.28
high fats content	186	1.93	88	0.85
high fats and sugar content	1332	13.82	1973	18.99
high salt content	9	0.09	0	0.00
high salt and fats content	1423	14.77	1360	13.09
low nutritional value	507	5.26	393	3.78
appropriate snacks	1110	11.52	1376	13.25
bottled water	1454	15.09	1533	14.76
Sum	9637	100	10388	100

Source: own elaboration.

Table 4. Percentages of sold products compliant and non-compliant with the law

	Primary schools		Secondary schools	
	Amount of sold products	Percentage out of all sold products (%)	Amount of sold products	Percentage out of all sold products (%)
Products compliant with regulations	8704	90.32	9448	90.95
Products non-compliant with regulations	933	9.68	940	9.05
Sum	9637	100	10388	100

Source: own elaboration.

Appropriate (healthy) snacks were sold 15% more often in secondary schools than in primary schools.

Bottled water was sold more often in secondary schools (48.47%) than in primary schools (39.73%). Table 2. shows the amount of sold products from different groups in primary and secondary schools with reference to the number of students.

Most distinct correlations were observed in the amount of sold products with high sugar and fats content. Secondary school students bought around 5% more of this type of product compared to primary school students (sold products per student). Table 3. shows a comparison between primary and secondary schools with regard to the amount of sold products of different types and the frequency of purchases (with regard to the number of students).

A majority (90.32%) of sold products were compliant with the law. Analysis with the use of chi-squared test did not show a statistically significant correlation between primary and secondary schools, concerning the amount of sold products compliant and non-compliant with the law. Table 4. shows the amounts of sold

products that were compliant and non-compliant with the regulations and what percentage of all products they made up.

Students of 4 primary schools and 5 secondary schools were able to buy food both from shops and vending machines.

Vending machines were located in 16 schools out of 52 included in the research. The number of machines varied between 1-3. Usually there were 2 machines per school.

Interpretation of gathered data was difficult due to the method used while placing products in the machines.

Observation showed that 75% of vending machines offered sweet drinks, sweets snacks and savory snacks. Sweet snacks included "7 Days" croissants, bars, waffles, cakes. Some machines offered dragée or sesame crackers. Savory snacks included breadsticks, crackers, pretzels, crisps and flavored peanuts. As opposed to school shops, the vending machines offered sweetened drinks.

The above mentioned products are non-compliant with the Ordinance of the Minister of Health of 26 June 2015 (and its subsequent amendments) and were not approved for sale in schools. Majority of products had high caloric value and contained high amounts of sugar, fats and salt. Such snacks took up 50% of the machine.

Some machines offered products not mentioned in the Ordinance of the Minister of Health of 26 June 2015 (and its subsequent amendments). 25% of machines sold snacks of lower sugar, fats and salt content and lower food energy. These machines offered mostly fruit juices, breadsticks, muesli bars and flavored water. Moreover, owners of the vending machines claimed to be selling chips made of dried fruit and vegetables, fruit and nut mixes, sunflower seeds, peanuts, rice/corn/spelt waffles, flavored soy milk. All of these products were compliant with the regulations. They contained less than 15g of sugar, 10g of fats and 1g of salt per a 100 g/ml portion.

Discussion

According to literature, during their time in school, majority of students consumes food acquired from the school shop. Research conducted by Gajda et al. indicates that over 80% of children shop in school shops. Wawrzyniak's analysis shows that this percentage equals 97.9%.[28-29]

The students choice of a snack may be influenced by how much pocket money they get. According to own observations, prices of most products varied between 0.3-2.5 zł. Urbańska's analysis shows that majority of students received enough money to buy different products in school shops. Low retail prices of products sold in school shops encourages the students.

The most popular products sold in portions in school shops in Rzeszów were candy and cookies. According to research published by Wawrzyniak et al., students attending school in the suburbs consumed food from school shops which averagely providing 912 calories out of their daily caloric intake needs. In schools in the city this amount was even higher, standing at 1000 calories, which makes up almost 40% of an average daily caloric intake of a student.

The amount of juices bought by students in Rzeszów recorded in this study is higher than the amounts from previous years (20% higher in primary schools and 40% higher in secondary schools). Szymandera-Buszka's studies showed a similar result. The juices sold in school shops contain sugars added by the producer. Juices promoted as "100% juices" are the primary source of simple sugars.[30-31]

According to APP (American Academy of Pediatrics) recommendations, the children need to be educated about the superiority of fresh juices over sweetened juices.[32] The HBSC report from 2016 shows that 25% of interviewed respondent drinks artificially sweetened sparkly drinks. Meta-analysis shows that the consumption of sweetened drinks affects the body mass.[33-36]

After the introduction of The Ordinance of the Minister of Health of 26th June 2015, there has been a positive change in the amount of consumed sodas. Beverages of that type were in previous years often bought by children.[37-40] Urbańska's and Zynarska's studies (before the regulation was introduced) showed that children drink sweetened drinks almost daily. According to Wakmańska, this type of beverage was consumed by 60% of children.[41]

After the regulations were introduced, this amount decreased. This year, only one of schools subjected to this study sold sodas.

The literature from previous years shows the presence of energy drinks in school shops. This year there were no energy drinks in the school shops subjected to the study.

Students of primary and secondary schools in Rzeszów frequently (7.32%) bought flavored milk drinks, which contains added sugar.

Flavored water was sold in over 33% of school shops in Rzeszów. From a nutritionist's point of view, water should not provide energy or be a source of simple sugars.

Despite the introduction of The Ordinance of the Minister of Health of 26th June 2015 (and its subsequent amendments), students are still able to buy sweets. Snacks from this group (sweet buns, bars, lollipops) were frequently bought. Sweet buns were the most popular snacks (in secondary schools), available in every school shop. In secondary schools, sweet buns were chosen twice as often as regular sandwiches, which is an unsettling fact.

In some shops, which did not comply with the regulations (10%), the students could still buy "7 Days"

croissants, chocolate bars or muesli containing more than 15g of sugar per 100g.

During the production of snacks such as sweet buns, candy, chocolates, pretzels and cakes, producers often use palm oil. Hardening of this oil may involve creation of substances claimed as potentially cancerogenic.[42-43]

The amount of high-calorie snacks in school shops has decreased in previous years. The newly introduced restrictions significantly narrowed down the range of products in school shops, decreasing the number of products containing over 15g of sugar per 100g/ml, 10g of fats per 100g/ml or 13,5g of sugar in case of milk products. The shops stopped selling jellybeans, fruity chewing gum and dragée, which have previously been bought very often. The shops also decreased the range of chocolate bars.

Children and teenagers spend most of their day at school. The daily time spent in educational institutions is averagely between 4-8 hours. During breaks between lessons the students feel hungry, which can cause difficulties with focusing.

Typical short breaks take 5-10 minutes and there is one longer break that lasts 20 minutes.

A country that has successfully resolved the issue of students having little time to eat is Macedonia. The teachers are legally obliged to provide students with at least 15 minutes for snacks and 30 minutes for a bigger meal.[44] In Poland, school principals decide how much time students have to have a meal at school.

Not enough time for students to buy and eat a meal means they would rather buy snacks in vending machines. Convenience of use, wide range of products and relatively low prices encourage students to buy from vending machines rather than eat other meals. An evaluation made by NIK (Najwyższa Izba Kontroli) has shown that 87% vending machines in schools in Wrocław offers products with low nutritional value such as sweet drinks, chips, candy bars. A high percentage of schools reports a need for stricter control of food offered in shops and vending machines.[45]

Mass media, occurring mostly in a form enabling communication, are used by around 1 in 4 Poles. Among people aged 12-15, the most popular are Internet media such as chats, forums, messengers and blogs. A possible influence are also: television, films or video games.

According to a research done by GUS in 2016, children (aged 2-14) averagely spend 2 hours and 20 minutes daily using media. Boys usually spend more time on media than girls. According to the study, 25% of children spent 1 hour a day using media, 20% of children spent close to 2 hours daily using media and 12.5% of children used media for almost 4 hours a day. An average child watches close to 40,000 advertisements per year, which takes up around 333 hours. Around 95% of advertisements in Great Britain promote sweets or other food products containing a lot of sugar. Currently in Poland it is forbidden to place such advertisements on school grounds.[46-47]

Propagating healthy nutrition in schools can be possible with the use of different marketing techniques. According to research from 2016, the use of such techniques greatly increased the consumption of vegetables among primary school students. The aim of the above mentioned research was to investigate whether there is a correlation between the daily exposure to materials promoting vegetable consumption and the nutritional choices of students. Banners depicting vegetables were placed in 10 British schools over the period of 6 weeks. Also, some teachers played short videos with a "vegetable hero" as the lead. As a result of hanging the vegetable posters, 90.05% more children chose vegetables as a snack. In groups that additionally watched vegetable videos, 239.2% more children chose vegetables.[48]

Numerous research indicate that an unhealthy was of eating in childhood increases the risk of metabolic disorders in later years of life.[49-50]

Children develop different eating habits as a result of spending time out of their home and becoming independent. The quality of children's diets depends on the nutritional policy - a correct health-promoting policy can cause a decrease in the number of overweight and obese people. Lack of nutritional education means poor awareness of correct nutrition. Propagating proper diet can involve different forms. It is vital to create ways to change the unhealthy habits of young people.

Conclusions

1. The newly introduced restrictions significantly narrowed down the product range in school shops, eliminating products containing over 15g of sugar, 10g of fats per a 100g portion (or over 13.5g of sugar per 100ml in drinks). Shops stopped selling jellybeans, fruity gum, dragée and reduced the amount of sold sodas, chocolate bars and chips.
2. Despite the enactment of the Ordinance of the Minister of Health of 26th June 2015 (and its subsequent amendments), students continued to buy highly processed snacks. Most popular were sweet snacks, making up 33% of the assortment of shops in primary and secondary schools.
3. Around 20% more products with high sugar content were sold in secondary schools compared to primary schools.
4. Snacks characterized by a high nutritional value and lack of potentially harmful substances made up a small percentage of all products sold in schools in Rzeszów.
5. A statistically significant relation ($p < 0.001$) was shown between products of different types sold in primary and secondary schools.

6. No statistically significant relation (p = 0.12) was shown between the amount of sold products compliant and non-compliant with the regulations.
7. A high percentage of vending machines (75%) offered sweet drinks, sweets and savoury snacks. Highly processed food usually took up 50% of the machine.

References

1. Overweight and obesity, Global Health Observatory (GHO). WHO Web site. http://www.who.int/gho/ncd/risk_factors/overweight/en/. Published October 1, 2016. Updated May, 2017. Accessed Jun 1, 2018.
2. Mazur A. Epidemiologia nadwagi i otyłości u dzieci na świecie, w Europie i w Polsce. *Prz Med Uniw Rzes Inst Leków*. 2011;2:158–163.
3. Obesity update. OECD 2017. http://www.oecd.org/health/obesity-update.htm. Published Jun 1, 2018. Accessed Jun 1, 2018.
4. Reinehr T. Type 2 diabetes mellitus in children and adolescents. *World J Diabetes.* 2013;4(6):270–281.
5. The *Health Behaviour* in *School-aged Children* (*HBSC*) 2016 study (2013/2014 survey). Healthy policy for children and adolescence. 2016:7.
6. Kułaga Z, Różdżyńska-Świątkowska A, Grajda A. Siatki centylowe wysokości, masy ciała i wskaźnika masy ciała dzieci i młodzieży w Polsce - wyniki badania Olaf. *Stand Med*. 2010;7:690-700.
7. Dinsa G , Goryakin Y, Fumagalli E, Suhrcke M. Obesity and socioeconomic status in developing countries: a systematic review. *Obes Rev*. 2012;3(1):1067–1079.
8. NCD Risk Factor Collaboration (NCD-RisC). Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 192 million participants. *Lancet*. 2016;2,387(10026):1377-1396.
9. Lobstein M, Frelut L. Prevalence of overweight among children in Europe. *Obes Rev*. 2003;4:195-200.
10. Mazur A, Rogozińska E, Mróz K, et al. Występowanie nadwagi i otyłości u dzieci przedszkolnych z regionu rzeszowskiego. *Endokrynol Otyłość*. 2008;4(4):159-163.
11. Babicz-Zielińska E, Jeżewska-Zychowicz M. Wpływ czynników środowiskowych na wybór i spożycie żywności. *Handel Wew*. 2015;2(3):5-18.
12. S MO, Yee W, Wardoyo RJ. A Parental Health Education Model of Children's Food Consumption: Influence on Children's Attitudes, Intention, and Consumption of Healthy and Unhealthy Foods. *J Health Commun*. 2017;22(5):403-412.
13. Strasburger C, Mazur A, Szymanik I, Matusik, Małecka-Tendera E. Rola reklam i mediów w powstawaniu otyłości u dzieci i młodzieży. *Endokrynol Otyłość*. 2006;2(1):18–21.
14. Sanecka E. Manipulacja w reklamie telewizyjnej skierowanej do dzieci i młodzieży. *Kultura, Media, Teologia.* 2013;13:19-36.
15. French S. Food Advertising and Marketing Directed at Children and Adolescents in the US. *Int J Behav Nutr Phys Act*. 2004;1:1-17.
16. Policy Statement Children, Adolescents, Obesity and the Media American Academy of Pediatrics. *Policy Statement Pediatrics*. 2011;128(1):201-208.
17. Główny Urząd Statystyczny. *Społeczeństwo informacyjne w Polsce w 2014 r.* Warszawa: Społeczeństwo informacyjne w Polsce; 2014.
18. Jarosz M. *Normy żywienia dla populacji polskiej -nowelizacja.* Warszawa: Instytut Żywienia i Żywności; 2017.
19. World Health Organization. *Draft intemplentation plan for the recommendations of the Commission on Ending Childhood Obesity*. 2016;5-29.
20. Weichselbaum E, J Buttriss. Diet, nutrition and schoolchildren: An update. *British Nutrition Foundation Nutrition Bulletin*, 2014;39:9-73.
21. Talati Z, Norman R, Pettigrew S, Shilton T, Bruce N, Dixon H. The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. *Int J Behav Nutr Phys*. 2017;14:171.
22. Storcksdieck genannt Bonsmann S, Kardakis T, Wollgast J, Nelson M, Caldeira S. Mapping of National School Food Policies across the EU28 plus Norway and Switzerland. JRC *Science and policy report*. 2014;10-25.
23. World Health Organization. *School politic framework Implementation of the Global Strategy on Diet, Physical Activity and Health*. Geneva: WHO Library Cataloguing-in-Publication Data; 2008:16.
24. Rozporządzenie Ministra Zdrowia w sprawie grup środków spożywczych do sprzedaży dzieciom i młodzieży w jednostkach systemu oświaty oraz wymagań, jakie muszą spełniać środki spożywcze stosowane w ramach żywienia zbiorowego dzieci i młodzieży w tych jednostkach. (Dz. U. rok 2016,.poz. 1154).
25. Rozporządzenie Ministra Zdrowia w sprawie grup środków spożywczych do sprzedaży dzieciom i młodzieży w jednostkach systemu oświaty oraz wymagań, jakie muszą spełniać środki spożywcze stosowane w ramach żywienia zbiorowego dzieci i młodzieży w tych jednostkach. (Dz. U. rok 2015,.poz. 1256).
26. Kaliszewska M. Dyskurs medialny o odżywaniu się uczniów w szkole i skutkach rozporządzenia Ministra Zdrowia. Wprowadzenie do badań, cz. 1. *Journalism Research Review Quarterly*. 2016;1:19-35.
27. Kujawska-Pac U, Kwilosz E, Mazur A. Ocena żywności oferowanej w sklepikach szkolnych i kupowanej przez dzieci z krakowskich szkół podstawowych. *Pediatr Pol.* 2014;8(9):347-351.
28. Gajda R, Jeżewska-Zychowicz M. Zachowania żywieniowe młodzieży mieszkającej w województwie świętokrzyskim – wybrane aspekty. *Probl Hig Epidemiol*. 2010; 9(14):611-615.
29. Wawrzyniak A, Sadurska J, Hamułka J. Ocena spożycia śniadań oraz spożycia energii z produktami kupowanymi

w sklepikach szkolnych przez uczniów. *Probl Hig Epidemiol.* 2015;96(1):254-258.
30. Urbańska I, Czarniecka-Skubina E. Częstotliwość spożycia przez młodzież produktów spożywczych oferowanych w sklepikach szkolnych. Żywn *Nauk Technol Jakość*. 2007; 193-204.
31. Szymandera-Buszka K, Waszkowiak K, Jędrusek-Golińska A, Sulima M, Skowrońska. E. Ocena asortymentu sklepików w szkołach miasta Poznania. *Probl Hig Epidemiol*. 2010;91(4):628-631.
32. Heyman M, Abrams A. Fruit Juice in Infants, Children, and Adolescents: Current Recommendations. *Pediatrics*. 2017;1-21.
33. Bacardí-Gascón M, Pérez-Morales E, Jiménez-Cruz A. Sugar-sweetened beverage intake before 6 years of age and weight or BMI status among older children; systematic review of prospective studies. *Nutr Hosp*. 2013;28(1):47-51.
34. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *Am J Clin Nutr*. 2013; 98(4):102-108.
35. Morenga S. Mallard I. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies J. *Mann BMJ*. 2012;345.
36. Vartanian R, Marlene B, Schwartz, Brownell D. Effects of Soft Drink Consumption on Nutrition and Health: A Systematic Review and Meta-Analysis. *Am J Public Health*. 2007;97(4):667-675.
37. Bibiloni M, Fernández-Blanco J, Pujol-Plana N, et al. Improving diet quality in children through a new nutritional education programme. Gac Sanit. 2017; 31(6):472-477.
38. Bieniak M, Chałdaś-Majdańska J, Rząca M, Kocka K. The influence of the Regulation of the Minister of Health on food product groups designated for sale in educational establishments on the health behaviours of students. *Journal of Education, Health and Sport*. 2017;7(6):419-430.
39. Kucharska A, Wiski M, Sińska B, Panczyk M. Zwyczaje związane z zakupami w sklepikach szkolnych oraz opinie uczniów na temat ich zmian w asortymencie po wprowadzeniu Rozporządzenia Ministra Zdrowia z dnia 26 lipca 2015 r. *Kwartalnik Naukowy Uczelni Vistula*. 2017;2(52):275-287.
40. Zysnarska Z, Pertkiewicz J, Kalupa W. Uwarunkowania otyłości wśród dzieci szkół podstawowych. *Now Lek.* 2008;77(6):430-435.
41. Waksmańska W, Małgorzata F, Grzywna T. Badanie częstości występowania nadwagi i otyłości w grupie 16–17-letnich chłopców a rodzaj żywności oferowanej w szkolnych sklepikach. *Piel Zdr Publ.* 2015;5(4):333–339.
42. Risks for human health related to the presence of 3- and 2-monochloropropanediol (MCPD), and their fatty acid esters, and glycidyl fatty acid esters in food. *EFSA Journal*. 2016;14(5):156.
43. Brandt EJ, Myerson R, Perraillon M, Polonsky T. Hospital Admissions for Myocardial Infarction and Stroke Before and After the Trans-Fatty Acid Restrictions in New York. *JAMA Cardiol.* 2017;2(6):627-634.
44. Ekspertyza w sprawie produktów sprzedawanych w sklepikach szkolnych w kontekście propozycji zmian w projekcie ustawy o bezpieczeństwie żywności i żywienia IŻŻ. Warszawa; 2013:2.
45. Maksymowicz-Jaroszuk J, Karczewski J. Ocena zachowań i zwyczajów żywieniowych gimnazjalistów z terenu Białegostoku. *Hygeia Public Health*. 2010;45(2):167-172.
46. Gumiński M, Huet M, Kamińska M. *Wyniki badań statystycznych z lat 2012-2016. Społeczeństwo informacyjne w Polsce.* Warszawa:2016;10.
47. Piekarzewska M, Zajenkowska-Kozłowska A. *Zachowanie zdrowotne mieszkańców Polski w świetle Europejskiego Ankietowego Badania Zdrowia (EHIS) 2014*. Warszawa: Główny Urząd Statystyczny; 2015:7-8.
48. Hanks AS, Just DR, Brumberg A. Marketing Vegetables in Elementary School Cafeterias to Increase Uptake. *Pediatrics.* 2016;138-139.
49. Sørensen L. The effects of Nordic school meals on concentration and school performance in 8- to 11-year-old children in the OPUS School Meal Study: a cluster-randomised, controlled, cross-over trial. *J Nutr.* 2015;113(8):91-128.
50. Zalewska M, Maciorkowska E. Rola edukacji żywieniowej w populacji dzieci i młodzieży. *Med Og Nauk Zdr*. 2013;19(3):375-378.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.7

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 217–223

ORIGINAL PAPER

Joanna Michalik Wolska [1(ABDEF)], Dariusz Wolski [2(CDEF)], Marek Bieńko [3(CDE)], Radosław P. Radzki [3(CDE)]

Life quality of patients with the carpal tunnel syndrome

[1] Department of Oncology and Enviromental Health, Faculty of Nursing and Health Sciences, Medical University, Lublin, Poland
[2] Department of Animal Anatomy and Histology, Faculty of Veterinary Medicine, University of Life Sciences, Lublin, Poland
[3] Department of Animal Physiology, Faculty of Veterinary Medicine, University of Life Sciences, Lublin, Poland

ABSTRACT

Introduction. Carpal tunnel syndrome (CTS) is a neuropathy caused by pressure on the median nerve taking a course in the carpal tunnel. The characteristic symptoms of CTS are: pain, numbness, and a prickling sensation in the hand usually at night or after the physical effort. Symptoms of the disease affect patient quality of life which is desribed as a subjective estimation of life situation.

Aim. The aim of this study was to assess the quality of patient life in those who suffer from carpal tunel syndrome. The studies were aimed to descripe the general quality of patient life and the effect of symptoms on individual aspects in the life of the afflicted.

Materials and methods. The study sample was composed of 60 patients from rehabilitation and physiotherapy institutions located in the Lublin Voivodship (Poland). The studies were based on the questionnaries of life quality estimation dependent on health WHOQOL- BREF and EQ-5D-5L as well as on our own poll questionnaire.

Conclusions. Symptoms of carpal tunel syndrome deteriorate the quality of patient life. Such patients have difficulties with daily activities. Among those examined, as many as 94.12% reported problems performing everyday actions (EQ – 5D – 5L). Difficulties with chores were reported by 86.70% of those examined. The patients with carpal tunel syndrome are less effective at work. Reduced achievements at work were reported by 73.30% of those examined, and a need for a shorter work day was reported by 60%. For 53.30%, difficulties in doing their jobs were significant; 20% of the examined had to change their profession or work station. The examined patients often experienced pain which deteriorated quality of sleep and disturbed everyday functioning. The patients were presented with serious difficulties in doing professional work.

Keywords. carpal tunel syndrome, quality of life, neuropathiers

Corresponding author: Joanna Michalik Wolska, email: michalik_joanna@wp.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 12.06.2018 | Accepted: 11.08.2018
Publication date: September 2018

Michalik Wolska J, Wolski D, Bieńko M, Radzki RP. *Life quality of patients with the carpal tunnel syndrome.* Eur J Clin Exp Med. 2018;16(3):217–223. doi: 10.15584/ejcem.2018.3.7

Introduction

According to the conception of World Health Organization (WHO), life quality is related to all aspects of human functioning. Its essential element is the health condition. Accordingly, the conception health related quality of life (HRQOL) was formulated.[1,2] It defines the effect of disease and accompanying symptoms on functioning of persons in differents spheres. Occurrence of pain and disturbances of organ functions are often connected with life style and limitations in performing some actions. In order to determine the effects of disease on a person's functioning, studies on life quality of patients there are carried out in those suffering from some illnesses or disfunction.[1,2] The most popular questionnaires for life quality evaluation are WHOQOL-BREF and EQ-5D.[2]

Carpal tunnel syndrome is the most frequentyly occurring pressure mononeuropathy of the peripheral nerve innevating the man's upper limb.[3,4] This relates to the median nerve which is the main nerve supplying the man's upper limb. Comming to the palm surface of the hand, it is divided into terminal branches i.e. the muscle branch to the wave of muscles and sensorial branches to the skin of palm surface three and half fingers on the radius side.[5] The carpal tunnel is one of neuralgic sites where the median nerve can undergo excessive compression and lose its function. The capral tunnel syndrome is caused by narrowing of the carpal tunel or swelling of tendons or their capsules. Narrowing in the tunnel strike the median nerve causing symptoms of paraesthesia. Such syndrome is affected also by diseases of the entire system, inflammatory state as well as overwork e.g. in the computer operator, hairdresser, mechanic.[6,7,8] This illness is arduous due to the night and post endeavour pain. Parasthesia, feeling distrubance and arm motorial disfunction render carrying on work and everyday activities render difficult. The carpal tunel syndrome is one of the most frequent reasons for the sick – leave. According to the epidemological data, in well developed countries this syndrom is found in about 10% of women and 5% of men professionally active. About 50 year old women are the most frequent group suffering from it. Due to profession, however, it is more frequent in men. Another reason for this diseases in female are hormonall changes during menopausal period.[7]

One of the symptoms of this illness is lower sleep quality with results in regulary life disturbance. Pain and disfunction of hand result in limited men's activity in many areas. This is connected with functioning in somatic, psychological and social spheres.[9-11]

Etiology of carpal tunnel syndrome

Injury of the median nerve is caused by the increased of pressure in the carpal tunnel to above the critical level and the decrease of blood flow below that providing sufficient nerve nourishment. Even the increased of pressure to above 30 mmHg can lead to mild ailments due to the symptoms. However, if the pressure in the tunel reaches 40 – 50 mmHg severe injury of the median nerve occurs. The histological studies of injured nerves showed demyelination and/or axonal degeneracy. CTS can have primary character when the nerve is injured because of the mechanical conflict (limited space in the carpal tunnel) and processes associated with it, as well as the secondary one, caused by injury or disease.[12,13]

Its general causes can be, among others, endocrinology diseases (diabets, thyroid gland hypofunction), connective tissue diseases (rheumatological arthritis) degenerations and arthritis, hemophilia, acromegaly, obesity, amyloidase, boreliosis, sarcoidose, dialyse therapy, pregnacy swelling innate tendency to compression neuropathy.[14] This is connected mainly with the situation of compression of the nerve inside the deformed carpal tunnel caused by the body position during work.[15] This results from repeated flexion and extension and extension of the carpal, particularly connected with necessity of getting hold of something with fingers or closing the hand. In the case of people whose symptoms are connected with doing physical work CTS occurs mostly on one side and refers to the dominant hand.[16] However, the studies by Brhel et al. Proved that despite subjective or clinical occurrence of symptoms in one limb, bilateral injury was found in 81,4% of the patients by electromyography (EMG) examination.[10,17]

Symptoms of carpal tunnel syndrome

Due to the fact that the sensory fibre of the median nerve are injured first, the initial symptoms of the carpal tunnel syndrome are parasteses in the hand. Firts they occur in the finger bulbs and then the palm surface of the hand. The characteristic subjective symptoms are pain and prickling sensation after the effort and at night resulting in awakening.[18] The second – sided manifestation of symptoms is more common than the one – sided (60%). However, it is more frequent or stronger in the dominant hand.[19] Pain and feeling disturbances inflict first of all the thumb, the index finger, finger III and half of finger IV. These symptoms are often accompanied by the feeling of hand swelling and stiffness. In the furher phase muscles in this area are weakenes. Pains and numbness appear not only at night but also during the day. The carpal pains can be accompanied by ailments in the forearm being so called distant or tranfer pain. The advance stage of the carpal tunel syndrome is associated with loss symptoms: muscle obliteration, weakening sense of touch, sweating disturbance in the area provided by the median nerve. Muscle weakening leads to motorial precision handicap. Moreover, there occur some difficulties in grasping small objects (disturbance of thumb opposition function). In the objective studies loss of thumb muscles wave is evident. This results in

the position of the first finger in the palm plance which gives the picture of so calles „monkey hand".[12]

Aim of the paper

The aim of the paper was to determine life quality of patients with the carpal tunnel syndrome. The paper includes the information about the declared and real quality of life studied by means of questionnaires. Moreover, the investigations are oumed at revealing the data about intensification of symptoms of carpel tunnel syndrome and their effect on quality of sleep, doing work, and every activities. They also estimated the effect of pain on emotions and social relations.

Material and methods

60 patients from local rehabilitation and physiotherapy insituations in the Lublin Voivodship were subjected to the study. They were not operated on the carpal tunnel syndrome. The main group were 50 – 65 years old patients. The investigations were carried out at the beginning of 2016 and participation was anonymous. The research tools were three questionnaires: the own questionnaire, the World Health Organization (WHOQOL – BREF) and the questionnaire EQ-5D-5L.

Characteristics of the studied group

The study group was 60 patients, 44 women (73.30%) and 16 men (26.70%). The patients were divided into three group : ‹ 35, 35 - 49, 50 - 65 years old. The largest number was at the age 50 – 65 (34 people : 24 women and 10 men). The average age was 47 years old. Most of them lived in the village (42 people – 70%), the others lived in towns up to 100 thousand inhabitants (18 people – 30%). In most of them the ailments connected with the carpel tunel syndrome lasted for 4 – 12 months. In the examined group there were 8 pensioners (13.33%) and 52 profesionally active people (86.67%). Most of them were manual workers (40 people – 66.67%).

Results

General quality of life of the people suffering from the carpal tunnel syndrome estimated by means of the questionnaire WHOQOL – BREF was on the average 3.23 ≠0.77. No significant statistical differences were found regarding quality of life between men and women as well as place of living. Considering the age, the estimation of life quality was the lowest in the case of 50 – 65 years old (53.85% in this group described it as bad). The best estimation of life quality came from 35 – 49 year old

Table 1. Classification of replies about life quality depending on pain intensification and time of disease symptoms duration (n – the numer of the people beig examined)

		Bad n % of the given feature % of the total	Neither bad nor good n% of the given feature % of the total	Good n % of the given feature % of the total	Statistical analysis
Intensification of pain in the scale VAS	1-3	0	2	8	df=23, p=0,002750
		-	20 %	80%	
		-	3.33%	13.33%	
	4-6	0	6	10	
		-	37.5%	62.5%	
		-	10%	16.67%	
	7-10	14	12	8	
		41.18%	35.29%	23.53%	
		23.33%	20%	13.33%	
How long have the symptoms lased	< 3 months	0	0	6	df=23, p=0,000367
		-	-	100%	
		-	-	10%	
	4-12 months	2	8	14	
		8.33%	33.33%	58.33%	
		3.33%	13.33%	23.33%	
	2-3 years	2	4	6	
		16.67%	33.33%	50%	
		3.33%	6.67%	10%	
	4-5 years	4	6	0	
		40%	60%	-	
		6.67%	10%	-	
	> 5 years	4	4	0	
		50%	50%	-	
		6.67%	6.67%	-	
Age	< 35	0	4	8	df=23, p≤ 0,01
		-	33.33%	66.67%	
		-	6.67%	13.33%	
	35-49	2	2	18	
		9.1%	9.1%	81.82%	
		3.33%	3.33%	30%	
	50-65	14	4	8	
		53.85%	15.38%	30.77%	
		23.33%	6.67%	13.33%	

people (81.82% estimated it as good). These dependences were statistically significant ($p \leq 0.01$).

Statistically significant dependences between the estimation of life quality and degree of pain intensification as well as time of illness symptoms ($p \leq 0.05$). The higher the pain intensification measured using the scale VAS, the worse estimation of life quality. Taking into consideration the time of ailment, the estimation of life quality decreased with the inereasing time of symptoms occurrence. All patients with the symptoms lasting over 4 years did not estimate their life quality positively.

Despite relatively good estimation of life quality, most of those being examined were dissatisfied with their health condition (22 persons – 36.7%). The average estimation in the scale 1-5 of questionnaire WHOQOL-BREF was 2.80 +/- 0.96. The statistically significant dependence was found between the satisfaction with the health state and pain intensification as well as the time of duration of the carpal tunnel syndrome symptoms ($p \leq 0.05$ and $p \leq 0.01$ respectively). The patients' dissatisfaction with their own health condition grew with the length of disease occurrence.

The questionaire WHOQOL – BREF included the questions referring to four areas of human life: somatic, psychological cosial and environmental. The social area was estimated the most highly.

The reply to the question in the own questionnaire: „Do you thinh that health condition affects negatively you and your life?" - most of the examined person replied – „Yes" (34 women – 77,30% of the group and 10 men – 62.50% of the group). The dependence of the reply about the negative effect of health condition on life on age was statistically significant ($p \leq 0.01$). There was significant statistical correlation between the reply to the question about the negative effect of health condition on life and the question about satisfaction with the health condition ($p \leq 0.05$). With the inerease of dissatisfaction with the own health condition, the increasing number of replies confirming the negative effec of health condition on life was obtained.

In the questionnaire EQ- 5D – 5L the patients made the five – scale evaluation in the following categories: locomotive faculty, self – service, common activities (e.g. work, education, housework, family activities leisure ac-

Table 2. Classifiction of replies to the questions about satisfaction with the own health state depending on pain intensification and duration of disease symptoms (n – the numer of subjects)

		Very satisfied	Unsatisfied	Neither satisfied nor unsatisfied	Satisfied	Statistical analysis
		n % of the given feature % of the total	N % of the given feature % of the total	N % of the given feature % of the total	N % of the given feature % of the total	
Pain intensification in the scale VAS	1-3	0	2	0	8	df=23, p=0,005560
		-	20%	-	80%	
		-	3.33%	-	13.33%	
	4-6	0	4	6	6	
		-	25%	37.5%	37.5%	
		-	6.67%	10%	10%	
	7-10	4	16	10	4	
		11.76%	47.06%	29.41%	11.76%	
		6,67%	26,67%	16.67%	6.67%	
How long have the symptoms lased	<3 months	0	0	2	4	df=23, p=0,001555
		-	-	23.67%	66.67%	
		-	-	3.33%	6.67%	
	4-12 months	0	6	8	10	
		-	25%	33.33%	41.67%	
		-	10%	13.33%	16.67%	
	2-3 years	2	4	2	4	
		16.67%	33.33%	16.67%	33.33%	
		3.33%	6.67%	3.33%	6.67%	
	4-5 years	2	4	4	0	
		20%	40%	40%	-	
		3.33%	6.67%	6.67%	-	
	>5 years	0	8	0	0	
		-	100%	-	-	
		-	13.33%	-	-	

Table 3. Classification of the replies to the question: „Do you think that the health condition affects your life negatively? Depending on the age and answers to the question about satisfaction with the own health condition (n – the numer of examined people)

		Yes N % of the given feature % of the total	It is hard to say N% of the givenfeature % of the total	No N % of the given feature % of the total	Statistical analysis
Age	<35	8	4	4	
		50%	25%	25%	df=23,
		13.33%	6.67%	6.67%	p≤0,01
	35-49	6	0	4	
		60%	-	40%	
		10%	-	6.67%	
	50-65	30	4	0	
		88.24%	11.76%	-	
		50%	6.67%	-	
Are you satisfied with your health condition?	Very dissatisfied	4	0	0	df=17,
		100%	-	-	p=0,040437
		6.67%	-	-	
	Dissatisfied	22	0	0	
		100%	-	-	
		36.67%	-	-	
	Neither satisfied nor dissatisfied	10	4	2	
		62.5%	25%	12.5%	
		16.67%	6.67%	3.33%	
	Satisfied	8	4	6	
		44.44%	22.22%	33.33%	
		13.33%	6.67%	10%	

tivities), pain/discomfort, anxiety and low spirits. Problems with the locomotive faculty were reported in the age group 50 – 65.

The dependences between the consciousness of health condition, age and gender were not statistically significant. However, the relations between the estimation of health condition in the scale EQ VAS and the estimation of the own health one by means of the own questionnaire proved to be statistically important.

The subjects had difficulties in doing professional work due to the carpal tunnel syndrome. However, among office workers such difficulties were insignificant or great. These dependences were not statistically significant (p≤0.01).

The ailments resulting from the carpal disease set bounds to the activities requiring precision e.g. writing, cutting or lacing. They affected not only work but also ways of spending leisure time. As many as 44 people (73.30%) had to give up some jobs and necessity of shorteninig of work time was reported by 60 % of those examined. 86.70% had difficulties doing chores. Statistically significant dependence was found between the feeling of pain or discomfort (measured by the questionnaire EQ-5D, -5L) and necessity of giving up some leisure activities (p≤ 0.05). All people experiencing acute pain nor discomfort had to rule out some forms of spending free time. A similar statistically significant estimates (p≤0.01) was found between the symptoms of CTS and pain intensification meansured by the VAS scale.

Discussion

Treatment of patients should not be confined only to improvement of clinical indices. Of significant importance is paying attention to subjective symptoms accompanying diseases which affect greatly patients' life and its quality.[20] Getting to know the problems particulary arduous for the patient and the illness oriented treatment improve communication with the patient and results in greater engagement of the sick in the treatment proces. This leads to more effective therapy and reduction of its costs.[5]

Life quality is particularly affected by chronic and recurring diseases resulting in pain and restriction of function of some organs. The carpal tunnel syndrome is such a disease. It most frequently occurs in 30-60 year old people. Moreover, the numer of women suffering from it is 2-3 times greater than that of men.[14] In

the own investigations most of the 60 – people research group were 50 – 65 year old patients (34 persons – 56.7%). Mostly they were women (44 persons – 73.3%) which is consistent with the literature data.[21]

As follows from the investigations the greater injury of the median nerve and degree of disease development, the larger emotional disorder of the patients is. The sick with chronic pain ailments have tendency toward depression and symptoms exaggeration. This affects the feeling of pain and extent of disability. The studies by Pogorzelski showed the correlation between the pain in the hand, feel deteronation, smaller strength in hand disappearance of muscles wave as well as appearance of anxiety and depression. The results obtained by the questionnaire EQ-5D, -5L showed anxiety and depression in 83.33% of the patients. The questionnaire WHOQOL - Bref showed worse results in somatic and psychological areas compared to the other two areas (social and environmental).[22,23]

Atroshi et.al. carried out investigations on life quality of patients suffering from the carpal tunnel syndrome before and after the capral operation. They estimated, among others, physical functioning, its effect on playing roles, social functioning as well as influence of emotional state on everyday life.[22] Similar to the own studies the social functioning category showed the best results.

Despite the fact that self – estimation of life quality and health condition was quite good, a great number of those studied were dissatisfied with their health condition. In the studies by Sanni et al. the value of patients' health with the CTS symptoms estimated using EQ VAS was lower (60 – 80. the average 70) but higher than in the own examination.[24]

According to the examined patients, the health condition affects negatively their life. Such opinion was most frequently expressed by those in the oldest group. The estimation of health condition effect on life correlated with their own estimation of health condition – the worse health estimation, the more negative its effect on life of the examined. According to the hitherto reports the frequency of CTS occurrence in computer users and in general population is similar.[24] The investigactions by Lewańska et al. proved that despite patients' expectations and common belief the symptoms connected with the carpal tunnel syndromes have another cause than work with the computer.[25]

Of five categories estimated by means of the questionnaire EQ-5Dm -5L the largest problems involved pain or discomfort. All examined patients felt pain or discomfort and estimated it as mild. There were fraquent statements that pain nor discomfort was strong (30%) – mainly among 35 - 49 year old patients (40% of the group). Of the patients examined by Sauni et al. pain or discomfort was experienced by 85.1 %. Also the studies by Atroshi et al. proved low estimation of pain which reached the averge value 36.9.[24]

Due to common character and frequent occurrence in the production age people, the carpal tunnel syndrome is a the production age people, the carpal tunel syndrome is a cause of sick leave. [26] All examined patients had difficulties in doing their jobs due to it. For most of them they were serious (32 people – 53.3%). Twelve of them were not able to perform their professional duties (20%) and they were forced to change their jobs or posts. A large part of the examined declared the need to shorten the work time (36 persons – 60%) and smaller achievements at work (44 persons – 73.3%) due to the symptoms of carpal tunnel syndrome. Żyluk and Puchalski reported in their studies that 39% of professionally active patients experienced arduous pain because of carpal tunnel syndrome which resulted in the three – month sick leave.[7,8]

References

1. Schünke M, Schulte E, Schumacher U, Voll M, Wesker K. *Atlas anatomii człowieka tom I.* Wrocław: Wyd. Medpharm; 2013:373.
2. Wnuk M, Marcinkowski J. Przegląd koncepcji jakości życia w naukach społecznych. *Hygeia Public Health.* 2013;48(1):10-16.
3. Kunikowska B, Lewandowska M, Glińska J, Puzder A, Szrajber B, Kujawa J. Analiza porównawcza jakości życia chorych z różnymi dysfunkcjami narządu ruchu. *Kwart Ortop.* 2011;4,329-340.
4. Zwolińska J, Kwolek A, Skrzypiec J. Skuteczność wybranych metod fizjoterapii w leczeniu zachowawczym zespołu cieśni nadgarstka (zcn). *Prz Med Uniw Rzesz.* 2007;3:239-244.
5. Turska W, Skowron A. Metodyka oceny jakości życia. *Farm Pol.* 2009;65(8):572-580.
6. Marquardt TL, Evans PJ, Seitz WH Jr, Li ZM. Carpal arch and median nerve changes during radioulnar wrist compression in carpal tunnel syndrome patients. *J Orthop Res.* 2016;34(7):1234-40.
7. Żyluk A, Puchalski P. Historia naturalna zespołu kanału nadgarstka – przegląd piśmiennictwa. *Chir Narz Ruchu.* 2010;74(4):261-266.
8. Żyluk A, Puchalski P. Niezdolność do pracy przed i po operacji zespołu kanału nadgarstka. *Chir Narz Ruchu.* 2008;73(5):303-308.
9. Biernawska J, Niemczyk A, Pierzchała K. Udział czynników zawodowych i pozazawodowych w etiopatogenezie zespołu cieśni nadgarstka. *Med Pr.* 2005;56(2): 131-137.
10. Brhel P, Dufek J, Říhová A, Bartnická M. Rozwój zespołu cieśni nadgarstka (ZCN) po stwierdzeniu choroby zawodowej. *Med Pr.* 2003;54(1):17-21.
11. Pilecka-Rybka K, Bułatowicz I, Hagner W, Biesek D, Janowiak-Maciejewska K. Wyniki operacyjno-usprawniającego postępowania w zespole cieśni nadgarstka. Valetudinaria – Post. *Med Kli. Wojsk.* 2011;16(1):38-41.

12. Bilewicz T, Durmała J, Dzierżęga J, Flak M, Keller A. Metoda mięśniowo-powięziowego rozluźniania (myofascial release) w terapii zespołu cieśni nadgarstka – doniesienie wstępne. *Ann Acad Med Siles.* 2007;61(4):289-293.
13. Mazurczak-Pluta T, Pomianowski S, Szopiński K. Zespół kanału nadgarstka w praktyce lekarza rodzinnego. Znaczenie badania ultrasonograficznego w odniesieniu do elektromiografii. *Ultrasonografia.* 2007;31:73-84.
14. Nawrot P, Nowakowski A, Bartochowski Ł. Współczesne poglądy dotyczące diagnostyki i leczenia zespołu kanału nadgarstka. *Chir Narz Ruchu Ortop Pol.* 2008; 73(2):112-115.
15. Mediouni Z, de Roquemaurel A, Dumontier C. Is carpal tunnel syndrome related to computer exposure at work? A review and meta-analysis. *J Occup Environ Med.* 2014; 56:204–208.
16. Palmer KT, Harris EC, Coggon D. Carpal tunnel syndrome and its relation to occupation: a systematic literature review. *Occup Med.* 2007;57:57–66.
17. Biesek D, Magdzik J, Pilecka K. Elektrofizjologiczna ocena skuteczności kompleksowego leczenia zespołu cieśni nadgarstka u osób zwiększonego ryzyka wystąpienia mononeuropatii z ucisku nerwu pośrodkowego. *Prz Lek.* 2011;68(3):175-178.
18. Georgiew F, Maciejczak A, Otfinowska E. Ocena stopnia nasilenia dolegliwości subiektywnych towarzyszących zespołowi kanału nadgarstka w zależności od nasilenia zmian stwierdzanych badaniem elektroneurograficznym. *Rehabil Med.* 2010;14(2):17-22.
19. Harris-Adamson C, Eisen A, Dale AM, Evanoff B. Personal and workplace psychosocial risk factors for carpal tunnel syndrome: a pooled study cohort. *Occup Environ Med.* 2013;70(8):529–537.
20. Bożek M, Gaździk T.S. Wartość badania klinicznego w diagnostyce zespołu kanału nadgarstka. *Ortop Traumatol Rehabil.* 2001;3(3):357-360.
21. Kroc A, Kroc Ł, Kuliński W. The effects of selected physical procedures on the treatment of unadvanced stage of idiopathic carpal tunnel syndrome and the patient quality of life. *Acta Balneol.* 2013;55(4):249-256.
22. Atroshi I, Gummesson C, Johnsson R, Sprinchorn A. Symptoms, disability, and quality of life in patients with carpal tunnel syndrome. *J Hand Surg.* 1999;24(2):398-404.
23. Pogorzelski R, Kułakowska A, HalickaD, Drozdowski W. Profil neurologiczny i emocjonalny pacjentów z zespołem cieśni nadgarstka. *Prz Lek.* 2011;68(5):269-273.
24. Sauni R, Virtema P, Pääkkönen R, Toppila E, Pyykkö I, Uitti J. Quality of life (EQ-5D) and hand-arm vibration syndrome. *Int Arch Occup Environ Health.* 2010;83:209–216.
25. Lewańska M, Wągrowska-Koski E, Walusiak-Skorupa J. Analiza czynników etiologicznych zespołu cieśni nadgarstka w populacji osób pracujących zawodowo z użyciem komputera. *Med Pr.* 2013;64(1):37-45.
26. Parot-Schinkel E, Roquelaure Y. Factors Affecting Return to Work After Carpal Tunnel Syndrome Surgery in a Large French Cohort. *Arch Phys Med Rehabil.* 2011;92:1863–1869.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.8

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 224–227

ORIGINAL PAPER

Zuzanna Bober [1(ABG)], David Aebisher [2(ABDGF)], Adrian Truszkiewicz [1(ABG)], Łukasz Ożóg [3(ABG)], Dorota Bartusik-Aebisher [4(ABDGF)]

The usefulness of relaxation time using MRI measurements

[1] Department of Electroradiology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[2] Department of Human Immunology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[3] Center for Innovative Research in Medical and Natural Sciences, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[4] Department of Experimental and Clinical Pharmacology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland

ABSTRACT

Introduction. Magnetic Resonance Imaging methods are now frequently used for the analysis of the diseased tissue. These methods are based on the fact that the spin-lattice, T_1, and the spin-spin, T_2, relaxation times are different in diseased tissue as compared to that of normal tissue.

Aim. Here we present measurements of spin-lattice relaxation time T_1 on a Magnetic Resonance Imaging scaner with field strength 1.5 Tesla.

Material and methods. Measurements of T_1 relaxation time and analysis of literature.

Results. We provide procedure for measurements of T_1 relaxation time with field strength 1.5 Tesla and present a discussion of current applications.

Keywords. Magnetic Resonance Imaging; T_1 relaxation; field strength 1.5 Tesla

Introduction

Magnetic Resonance Imaging (MRI) has been shown to be very useful tool for imaging of anatomy and morphology as well as the chemical composition of tissue. MRI is based on hydrogen nuclei, and does not involve emission of weak ionizing radiation as in Computed Tomography (CT) techniques. MRI is most commonly used for samples containing ^{1}H nuclei in high concentration in magnetic fields that range between 0.05 – 14 Tesla. Briefly, MRI evaluates the physical properties of the sample area relative to neighboring areas. MRI *in vivo* is mainly used to image anatomical and morphological changes in the human body. The main applications of MRI *in vitro* are monitoring of water and other solvents, controlled release of dosage forms, hydration and diffusion. Currently, MRI is used as a standard test in central nervous system, heart, muscle, or soft tissue imaging. MRI is one of the most popular diagnostic methods available

Corresponding author: Dorota Bartusik-Aebisher, E-mail: dbartusik-aebisher@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 10.07.2018 | Accepted: 23.08.2018
Publication date: September 2018

Bober Z, Aebisher D, Truszkiewicz A, Ożóg Ł, Bartusik-Aebisher D. *The usefulness of relaxation time using MRI measurements.* Eur J Clin Exp Med. 2018;16(3):224–227. doi: 10.15584/ejcem.2018.3.8

to modern medicine and, in addition, with high sensitivity and specificity, it is considered to be the most accurate method of medical imaging. In the opinion of clinicians and researchers, MRI is one of the most accurate noninvasive imaging methods available.[1] This method allows one to make sections in any plane of both living organisms and non-anatomical structures. The signal that we receive in MRI is dependent on the object being tested and its properties, but also on the individual protocol created.[2] In MRI, we have the ability to obtain data with morphological, functional and metabolic information. This allows one to see changes in the chemical composition of tumor tissue and then make a diagnosis of whether a drug works properly. For a sample placed in a strong magnetic field, you can operate with radio frequencies of a specific frequency. The nucleus absorbs the energy of the transmitted waves, rendering it to emit waves of the same frequency.[3] In MRI there are two relaxation times which strongly depend upon the local molecular environment: the first is T_1 (the spin lattice relaxation time) and the second T_2 (the spin–spin relaxation time). T_1 describes the exponential recovery of the equilibrium longitudinal magnetization that is aligned with the applied magnetic field. T_2 describes the exponential decay of the precessing component of the magnetization, and hence also the decay of the MR signal.[4] In our work presented here we optimized sequence and measurd T_1 and T_2 relaxations time on a 1.5 Tesla General Electric Healthcare MRI scaner. For the phantoms we used a solution of $CuSO_4$ and sugar.

Material and Method

Measurements of T_1 relaxation time were made using a 1.5 Tesla Magnetic Resonance Imager (Optima MR360 Advance, General Electric Healthcare). Three prepared containers with a solution of $CuSO_4$ and water at a concentration of 0.1 %, 0.2 %, 0.4 % and a mixture of sugar and water at a concentration of 2.5%, 5% and 10% were placed in the magnet. The samples were then scanned using Fast Spin Echo sequences with a coronal projection using a 4 channel small flex coil with a matrix size of 320 × 224, a field of view of 10 cm × 10 cm, and a slice thickness of 2 mm. The T_1 relaxation time was measured using the saturation recovery method with a TE of 3 ms and TR values of 30 ms to 15000 ms. Based on the generated image sequence, the MR signal was read from the region of interest that covered the same area in each sample.

In the next step, sparkling Vitamin C tablets from Efferta Sp. z o.o. with a weight of 4g containg 80 mg of vitamin C was used. A minimum amount of water was given to the container in which the tablet was placed, then measurements were made using magnetic resonance field with a 1.5 Tesla Optima MR360 model from General Electric Healthcare. In addition, the composition of the tablets were acidity regulators: citric acid and sodium carbonates, glucose, flavors, sweeteners: aspartame, saccharine and riboflavin. The relaxation time T_1 was then measured. A sample was prepared with a dissolved vitamin C tablet in 5 ml of water, then placed in a magnet and the sample was scanned using the FSE sequence in a coronal projection using a 4-channel small flex coil with a 320 × 224 size matrix, a 10 cm × 10 cm field of view and a distance between layers of 1 mm. The relaxation time T_1 was determined at a constant echo time TE = 3 ms and TR values from 50 ms to 15000 ms. Measurements were made for three successive layers.

Results

The relaxation times of all the mixtures of $CuSO_4$ and water are plotted in Figure 1 and mixtures of sugar and water are presented in Figure 2. Figures show the effect of the $CuSO_4$ and sugar concentrations on the T_1 relaxation time. The T_1 relaxation time decreased as the $CuSO_4$ and sugar concentration increases.

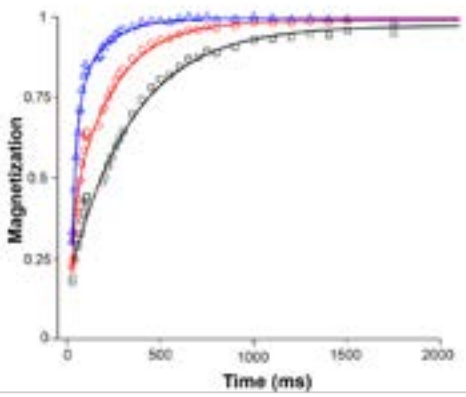

Fig. 1. T_1 relaxation curves for water solution with $CuSO_4$ concentration of 0.1% (black square), 0.2% (red circle) and 0.4% (blue triangle)

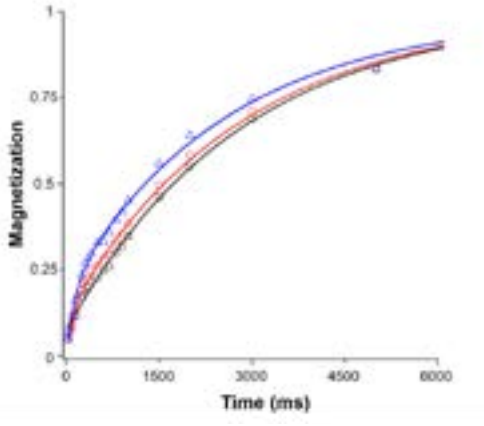

Fig. 2. T_1 relaxation curves for water solution with sugar concentration of 2.5% (black square), 5% (red circle) and 10% (blue triangle)

In Table 1 are listed results of T_1 time measurement for $CuSO_4$ at concentrations of 0.1%; 0.2%; 0.4% and results for sugar mixtures with water of various concentration.

Table 1. Relaxation time T1 results for $CuSO_4$ and sugar solution

	$CuSO_4$ in H_2O			
Concentration (%)	0	0.1 ±	0.2	0.4
T_1 (ms)	3100 ± 15	250 ± 4	155 ± 10	59 ± 4
	Sugar in H_2O			
Concentration (%)	0	2.5	5	10
T_1 (ms)	3100 ± 12	2950 ± 7	2450 ± 10	2150 ± 12

The obtained results showed that an increase of both sugar and $CuSO_4$ in solution causes T_1 shortening. The initial concentration of $CuSO_4$ was 0.1% and for this solution we measured a 250 ms relaxation time. When concentrations of $CuSO_4$ increased two-fold, T_1 decreased about 38%. When concentrations of $CuSO_4$ increased four-fold to 0.4%, the decrease of T_1 was 76.4%. We observed a consistent relation between increased concentration of $CuSO_4$ agent and measured T_1.

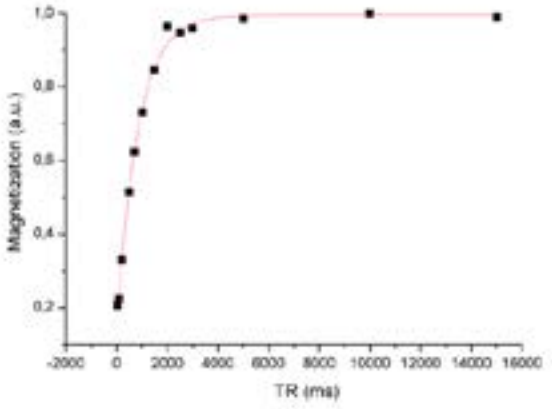

Fig. 3. Relaxation curve T_1 for water solution of vitamin C (tablet + 5ml of water) On the basis of the relaxation curve T_1, the longitudinal relaxation time T_1 = 710.86 ms was determined

We used solution of sugar in H_2O to confirm the sensitivity of T_1 measurements to concentration. When sugar concentration in H_2O was increased from 2.5% to 5%, T_1 decreased about 17%, and for a concentration at 10%, we measured a 28% decrease of T_1, when compared to solution of concentration 2.5%. In the next step we carefully revised all quantitative measurements of T_1 done at 1.5 T. We found that quantitative MRI measurements have been used in several studies to investigate vegetal tissues.[5] The transverse relaxation time T_2 is known to be related to the water status in cell compartments which encompasses water content, water mobility and interactions between water and macromolecules.[6] In general, the lower the molecular mobility, the shorter the T_2 relaxation time, so that the signal from water bound within a polymer matrix decays away faster (1-100 ms) than that from free water. In solids, the signal decays away in less than 100 μs and this is usually not sufficient for spatial encoding to be applied.

Measurements of the relaxation curve T_1 were made for water solutions of vitamin C (tablet + 5 ml of water, Fig. 3). On the basis of the relaxation curve T_1, the longitudinal relaxation time T_1 = 710.86 ms was determined.

Current applications

T_1 and T_2 relaxation times have been measured on human tissue samples of adipose, muscle, bone marrow and osteolytic skeletal metastases at temperatures ranging from +37°C to −10°C.[7] Relative signal intensities for T_1, proton density and T_2-weighted imaging sequences were also calculated. T_1 and T_2 of adipose tissue decreased almost linearly with decreasing temperature while for muscle, bone marrow and metastases T_1 and T_2 decreased slightly to moderately, with temperature reduction to about −5 °C at which temperature a sudden marked decrease occurred.[ref] Calculated signal intensities showed a decrease in image contrast with temperature reduction and reversal of contrast between adipose tissue and the other tested tissues with all imaging sequences at temperatures around 0°C.[7] The aim of the study was to examine the validity and reliability of a quantifiable measure of inflammation using magnetic resonance imaging (MRI) in children with juvenile dermatomyositis (JDM). Ten children with active JDM, 10 with inactive JDM and 20 healthy children completed the study. There was no significant difference in ages between the three groups. The MRI T_2 relaxation times were significantly increased in active JDM compared with inactive JDM and healthy children (P = 0.05), indicating a detectable increase in inflammation within the muscles. There were also good correlations between the MRI scores and the measures of muscle strength and function; however, there was no correlation between the MRI and muscle enzymes. The MRI T_2 relaxation time can be used as a quantitative measure of muscle inflammation and it has good correlations with other measures of disease activity.[8] To pool and summarize published data from magnetic resonance longitudinal relaxation measurements of the human lung at 1.5 T to provide a reliable basis of T_1 relaxation time constants of healthy lung tissue both under respiration of room air and of pure oxygen were measured. In particular, the oxygen-induced shortening of T_1 was evaluated.[9]

Several circumstances may explain the great variation in reported proton T_1 and T_2 relaxation times usual-

Table 2. Relaxation time

CLINICAL scaners				
Relaxation Time			a magnetic field	Ref
T_1	2300 to 3100 ms	H_2O	1.5 T	Kjaer 1987
T_1	1520 ms	H_2O, after distillation	1.5 T	Jerome 2016
T_1	1321.5 ms ± 2.14%,	mean tissue water	3 T	Knight-Scott 2016
T_2	65.2 ms ± 2.45%,	mean tissue water	3 T	Knight-Scott 2016
T_1	2950 ms (20° C)	Oxygen-free water		Simpson 1958
T_1	1377 ± 37.1	Water in soleus muscle	3 T	Kršňák 2004
T_1	1387 ±12.3	tibialis anterior	3 T	Kršňák 2004
T_2	31,3 ±1.2	Water in soleus muscle	3 T	Kršňák 2004
T_2	28,4 ±0.7	tibialis anterior	3 T	Kršňák 2004
EXPERIMENTAL				
Relaxation Time			a magnetic field	Ref
T_1	3905±311.3	H_2O	400MHz Bruker spectrometr	Kamaly, 2010
T_1	Fraction of Water 0ml: 1537	H_2O/D_2O mixtures with and without 0.2 g of albumin.	BRUKER AVANCE-400 MHZ proton NMRspectrometer operating at 400.132 MHz.	Bilgin Zengin, 2012
T_1	3300	95% H_2O	Bruker DRX 500 MHz spectrometer	Eykyn 2005

ly seen. This study was designed to evaluate the accuracy of relaxation time measurements by magnetic resonance imaging (MRI) operating at 1.5 Tesla. Using a phantom of nine boxes with different concentrations of $CuSO_4$ and correlating the calculated T_1 and T_2 values with reference values obtained by two spectrometers (corrected to MRI-proton frequency = 64 MHz) we found a maximum deviation of about 10 per cent. Measurements performed on a large water phantom in order to evaluate the homogeneity in the imaging plane showed a variation of less than 10 per cent within 10 cm from the center of the magnet in all three imaging planes. Changing the gradient field strength apparently had no influence on the T_2 values recorded. Consequently, diffusion processes seem without significance. It is concluded that proton T_1 and T_2 relaxation times covering the majority of the biologic range can be measured by MRI with an overall accuracy of 5 to 10 per cent.

Conclusion

T_1 and T_2 relaxation times are determined largely by the macromolecular environment of hydrogen nuclei. The more macromoleculesin sample, the shorter T_1. Diseased tissues tend to have longer T_1 and T_2 values, and higher spin-densities, than normal tissues.

Acknowledgments

Dorota Bartusik-Aebisher acknowledges support from the National Center of Science NCN (New drug delivery systems-MRI study, Grant OPUS-13 number 2017/25/B/ST4/02481).

References

1. Arbab A, Yocum G, Kalish H, et al. Efficient magnetic cell labeling with protamine sulfate complexed to ferumoxides for cellular MRI. *Blood J*. 2004;104:1217.
2. McKinney JR, Sussman MS, Moineddin R, Amirabadi A, Rayner T, Doria AS. Accuracy of magnetic resonance imaging for measuring maturing cartilage: A phantom study. *Clinics (Sao Paulo)*. 2016;71(7):404-411.
3. Jerome NP, Papoutsaki MV, Orton MR, et al. Development of a temperature-controlled phantom for magnetic resonance quality assurance of diffusion, dynamic, and relaxometry measurements. *Med Phys*. 2016;43(6):2998-3007.
4. Richardson JC, Bowtell R, Mäder K, Melia C. Pharmaceutical applications of magnetic resonance imaging (MRI). *Adv Drug Deliv Rev*. 2005;57,1191.
5. Hills BP, Clark CJ. Quality assessment of horticultural products by NMR. *Ann Rep NMR Spec.* 2003;50:75-120.
6. Van As H, Scheenen T, Vergeldt F. MRI of intact plants. *Photosynth. Res.* 2009;102(2-3):213.
7. Petrén-Mallmin M, EricssonA, Rauschning W, Hemmingsson A. The effect of temperature on MR relaxation times and signal intensities for human tissues. *Magma* 1993;1:176-184.
8. Maillard SM, Jones R, Owens C, et al. Quantitative assessment of MRI T_2 relaxation time of thigh muscles in juvenile dermatomyositis. *Rheumatology (Oxford)*. 2004;43(5):603-608.
9. Dietrich O, Gaass T, Reiser MF. T_1 relaxation time constants, influence of oxygen, and the oxygen transfer function of the human lung at 1.5T-A meta-analysis. *Eur J Radiol*. 2017;86:252-260.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.9

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 228–232

REVIEW PAPER

Łukasz Ożog [1(BDG)], David Aebisher [2(ABDGF)]

Methods of singlet oxygen generation and detection for understanding photodynamic processes

[1] Center for Innovative Research in Medical and Natural Sciences, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[2] Department of Human Immunology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland

ABSTRACT

Introduction. Photodynamic therapy (PDT) is a clinically approved therapeutic procedure that exerts selective cytotoxic activity toward malignant cells.

Aim. Our goal is to present the PDT procedure which involves administration of a photosensitizing agent followed by irradiation at a wavelength corresponding to the absorbance band of the photosensitizer and energy transfer to ground state oxygen to generate cytotoxic singlet oxygen

Material and methods. Analysis of literature.

Results. In this paper we described the basics of PDT and lifetime of singlet oxygen in different media.

Keywords. Photodynamic therapy, lifetime of singlet oxygen, photosensitizing agent

Introduction

Singlet oxygen ($^1O_2$) is a highly reactive oxygen species (ROS) and is the predominant cytotoxic agent produced during photodynamic therapy (PDT).[1] Oxygen in the lowest excited electronic state is a reactive intermediate in many chemical processes.[2] In PDT, we can distinguish several main elements that must be properly selected to make the therapy effective. First, you need a suitable photosensitizing (PS) drug that is given to the patient that, after delivery, accumulates in cells of malignant tissue. The photosensitizer and the applied light in themselves cannot be toxic. The next element is exposing the area to light. The ntensity and duration of light pulses are pre-determined.[3] The luminescence emitted by $^1O_2$ during PDT is very weak, therefore the detection of this signal requires advanced measurement techniques and very sensitive devices. Measurement of the weak near infrared luminescence of $^1O_2$ is possible in cells *in vitro* and tissues *in vivo*.[4] This paper describes the principle of photodynamic therapy, the principles of choice of light sources used, photosensitizers and examples of singlet oxygen measurement methods.

Light sources in PDT

Red light (650 nm - 800 nm) for most tissues has the ability to penetrate several mm.[5] In the case of pho-

Corresponding author: David Aebisher, e-mail: daebisher@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 30.06.2018 | Accepted: 5.08.2018
Publication date: September 2018

Ożog Ł, Aebisher D. *Methods of singlet oxygen generation and detection for understanding photodynamic processes.* Eur J Clin Exp Med. 2018;16(3):228–232. doi: 10.15584/ejcem.2018.3.9

todynamic therapy, wavelengths in this range are the most commonly chosen.[6] The exact excitation wavelength must be properly tuned to match the absorption range of the PS. The use of UV light is also applicable due to the greater absorption of some PS in this wavelength range, however, this range is outside the therapeutic window and has defects such as endogenous stimulation of the PS, as shown by studies conducted by Baier et al. 2006.[5] Short wavelength visible light penetrates tissue to a very small extent compared to red and infrared light, which is why in each case we cannot use any PS and any light source. The sources of light in PDT most often diode lasers due to their small size, price, exposure time and ease of installation.[7,8] Very often for solid tumors, PDT is performed using interstitial fiberoptic light sources illuminated with a light from a single laser.[9] For many skin lesions, non-laser light sources such as filtered lamps or more recently, light emitting diodes [10] are used. Regardless of which light source is used, the light field must be uniform to accurately calculate the dose.

Photosensitizers and synthetic dyes

Photosensitizers are an essential element in PDT. Most of them have a structure similar to that contained in the protoporphyrin prosthetic group. PSs have different absorption ranges that depends on their exact structure.[11-15] The ideal PS should have a strong absorption peak in the spectral range from 650 nm to 800 nm. This is because the absorption of photons with a wavelength > 800 nm is unable to provide sufficient energy for conversion $^3O_2$ to $^1O_2$.[16] Another required feature that an ideal PS should have is a lack of „dark" toxicity and rapid clearance from the body.[17] PSs are usually hydrophobic compounds that diffuse into cells quickly. The lifetime of $^1O_2$ is very short, as shown in Table 1. Because of the short lifetime of singlet oxygen, the distribution of $^1O_2$ in cells is limited to ca. 55 nm.[18]

As has been said before, the absorption of a photon of light having the appropriate energy and wavelength leads to the excitation of a PS electron to an orbital with higher energy. Then, with the appropriate energy transfer, ground state oxygen is converted to singlet oxygen. In Figure 1, the general principle of photodynamic therapy is schematically presented.

Table 1. Lifetime of singlet oxygen in different media

References	Applied light	Dye	Photosensitizer	Media	$^1O_2$ lifetime
Schlothauer J.*et al.*[11]	670 nm	Trypan blue	Tetra (p-sulfophenyl) porphyrin (TPPS)	cell suspensions (intracellular)	0.5 – 1.0 μs
Jiménez-Banzo A. *et al.*[12]	532 nm	3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT)	5,10,15,20-tetrakis(N-methyl-4-pyridyl)-21H,23Hporphine (TMPyP)	cells (Foreskin cells, ATCC CRL-1635)	1.7 μs
			5,10,15,20-tetrakis-(4-sulfonatophenyl)-21H,23H-porphine (TPPS)		1.5 μs
Hatz S. *et al.*[13]	420 nm	Rh123	5,10,15,20-tetrakis(N-methyl-4-pyridyl)-21H,23Hporphine (TMPyP)	HeLa cells in H_2O	≈ 3.2 μs
				HeLa cells in D_2O	≈ 68 μs
Niedre M. *et al.*[14]	630 – 670 nm	-	AlS_4Pc	suspensions of leukemia cells	≈ 0.6 μs
Oelckers S. *et al.*[15]	675 nm	-	pheophorbide-a (PHEO)	red cell ghost suspensions	35 – 100 μs

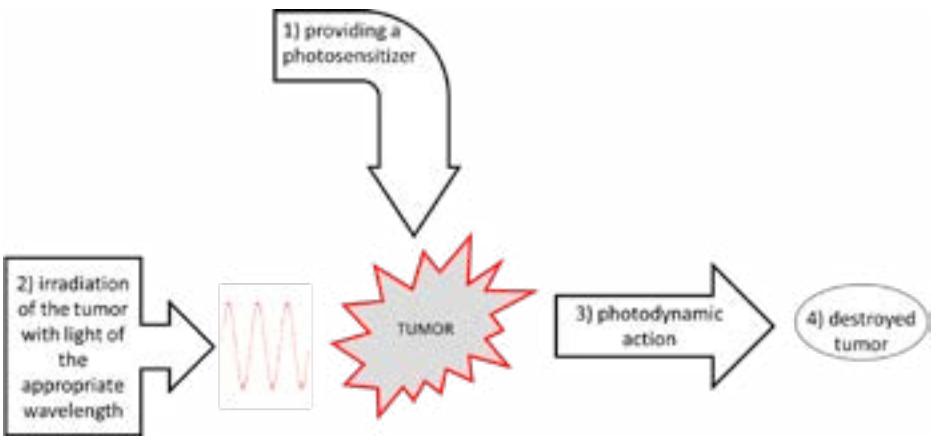

Fig. 1. Schematic of PDT treatment of a tumor

The largest group of PSs that are used in PDT include tetrapyrrole structures. In the case of this group of photosensitizers, singlet oxygen in most cases is produced via a type II mechanism that has been accurately described by Foote.[19] In this process, energy from triplet excited state (T_1) is directly transferred to $^3O_2$ forming $^1O_2$. Only when sensitizer is in the same triplet state multiplicity as ground state oxygen can energy transfer to $^3O_2$ occur.[19] Type I and type II processes occur simultaneously, however, the type II mechanism is the dominant process in photodynamic therapy and is catalytic. The tetrapyrrole structures that play an important role in PDT also include chlorins, bacteriochlorins, and phthalocyanines.[20] One of the most important tetrapyrrole compounds used as a PS in PDT are, inter alia, ALA-induced protoporphyrin IX (Phorphyrin); 5,10,15,20-Tetrakis (1-methylpyridinium-4-yl) porphyrin tosylate; Monoaspartyl chlorin (e6), talaporphin sodium; HPPH (Chlorin); Chloroaluminium sulfonated phthalocyanine (CASP) (Phthalocyanine) or Phthalocyanine RLP068.16 Haematoporphyrin derivative (HpD) and Photofrin were among the first PSs used in PDT and are still widely used.[17]

Another group of PSs is synthetic dyes. An example of such a dye used in PDT is Rose Bengal (RB). RB is a photoactive dye that efficiently generates singlet oxygen. RB has a maximum absorption in the region 540-570 nm.[21] Another example of synthetic dyes are Methylene Blue (MB) and Toluidine Blue (TB). Both of these dyes are characterized by their photobactericidal efficacy. TB exhibits a greater bactericidal activity than MB. The absorption maximum for these dyes is 660 nm and 630 nm respectively.[22,23] In this group there are also dyes that are based on the 4,4-difluoro-4-bora-3a, 4a-diaza-s-indacene (BODIPY) core. They have properties desirable in PDT such as high extinction coefficients, environment insensitivity, and resistance to photobleaching.[24,25] They have heavy halogen atoms in the pyrrole rings. Examples of such dyes are, for example, Zinc (II) -dipicolylamine di-iodo-BODIPY or DIMPy-BODIPY. The synthetic dyes group also includes transition metal compounds and phenalenones.[16] There are also natural products that can act as photosensitizers. These types of PSs are mostly of plant origin. An example of such a PS is, for example, Hypercyol with an absorption maximum at 600 nm. Hypericin is a hydrophobic molecule, which means that it requires a formulation in a drug delivery vehicle.[26, 27] Hypocrellins A and B belong to the PSs of natural origin, along with curcumin and riboflavin used as antimicrobial PS.[29,30]

Detection equipment

Different methods of measurement are used to detect $^1O_2$ luminescence. The main detection methods are an-

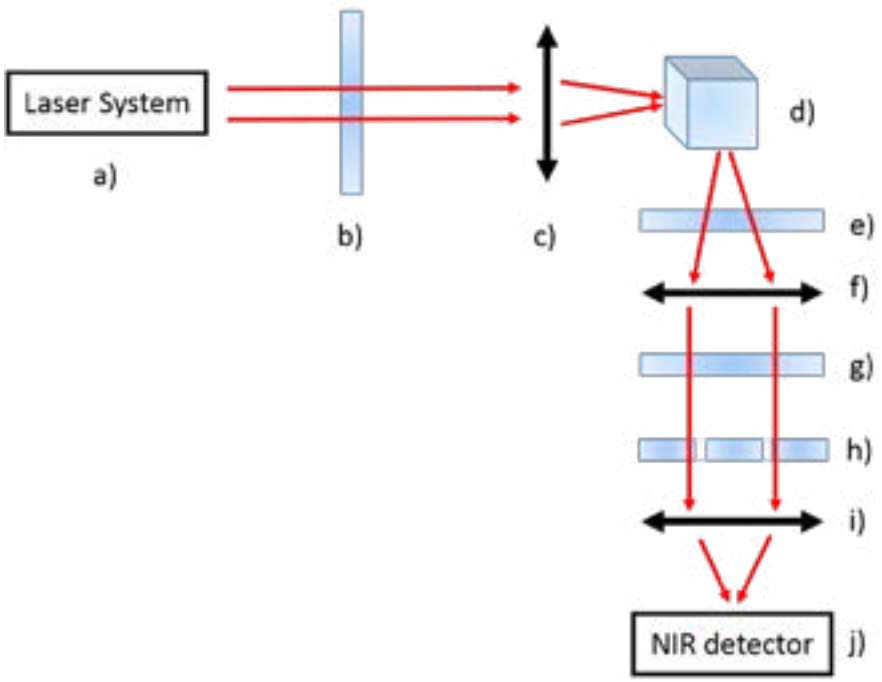

Fig. 2. An optical excitation and detection system scheme for measurement singlet oxygen lifetime; a) laser system (light source); b) bandpass filter centered at the excitation wavelength; c) lens used to focus light onto the sample; d) cuvette with a sample (made of quartz); e) and g) long pass filters to remove unwanted scattered excitation light and fluorescence from the sample (typical 1000 nm and 800 nm); f) lens to collimate light from the sample; h) bandpass filters (1270 nm corresponds to the peak of the $^1O_2$ luminescence spectrum; typically 1200 nm and 1330 nm filters which lie outside the $^1O_2$ band used to determine the background fluorescence); i) lens used to focus light onto the detector window; j) detector allows extremely sensitive detection in the 1200 - 1330 nm ranges.

alogue detectors, which are usually based on semiconductor diodes and photon counting techniques using near-infrared photomultipliers (NIR-PMT). Detection of singlet oxygen luminescence (around 1270 nm) is very difficult due to the very weak signal caused by the low quantum yield of the transition.[31] Cryogenic germanium diodes were used often to detect singlet oxygen luminescence, however, it is even more important to provide quantitative information, even in water where $^1O_2$ lifetime is 3.8×10^{-6} s. [32] To improve the sensitivity of measurements using semiconductor detectors, a differentiation technique is used. The use of two photodiodes enabled simultaneous measurement of the sample and the background, giving a signal as a difference, as shown in studies carried out by Kiryu et al. in 1999.[32] Currently, one of the most accurate methods of singlet oxygen detection is measurement using near infrared photomultipliers whose sensitivity in the 1270 nm region is almost an order of magnitude greater than that of Ge diodes (germanium).[6] The experimental setup for the lifetime of singlet oxygen using NIR detector is shown in Figure 2.

In vitro measurements of singlet oxygen luminescence require the use of not only sensitive detectors, but also a range of optical elements such as lenses, optical filters and cuvettes. Lenses are used for focusing light onto the sample and collimating light from the sample. Optical filters are used, among others, to remove unwanted scattered excitation light and fluorescence from the sample. When testing near-infrared luminescence emission from singlet oxygen using optical detectors, it is required that the detector be characterized by high sensitivity with a low signal-to-noise ratio. In addition, the signal obtained requires careful analysis to separate the true $^1O_2$ signal from scattered light and from phosphorescence and delayed fluorescence emissions from other molecules.[33] Due to its high reactivity, $^1O_2$ is characterized by having the shortest lifetime in the aquatic environment of all the reactive oxygen species (ROS).[34] For this reason, designing sensors to detect it is one of the most difficult tasks. Researchers are increasingly working on a singlet oxygen detection system based on a photomultiplier, which uses optical fibers to direct and collect signals directly from the PDT site.[35,36,37] The power of the signal received in this way is much smaller compared to the configuration of the free NIR space of the detector.[36] However, the use of a fiber optic enables, for example, the provision of a suitable dose of PDT by collecting signals through a tip placed directly in the tissue of the patient (interstitial). Recently, many researchers have proposed detectors based on superconducting single-photon detectors (SNSPDS) working at cryogenic temperatures.[36] However, this technique has disadvantages such as high cost, complexity and size.

Conclusions

PDT has the potential to meet many currently unmet medical needs in cancer treatment. The ability to detect singlet oxygen luminescence is critical in any prediction of appropriate dosimetry.

References

1. Weishaupt KR, Gomer CJ, Dougherty TJ. Identification of singlet oxygen as the cytotoxic agen in photo-inactivation of a murine tumor. *Cancer Res*. 1976;36:2326-2329.
2. DeRosa MC, Crutchley RJ. Photosensitized singlet oxygen and its applications. *Coord Chem Rev*. 2002;233-234:351-371.
3. Fisher AM, Rucker N, Wong S, Gomer CJ. Differential photosensitivity in wild-type and mutant p53 human colon carcinoma cell lines. *J Photochem Photobiol B*. 1998;42(2):104-107.
4. Niedre MJ, Secord AJ, Patterson MS, Wilson BC. In vitro tests of the validity of singlet oxygen luminescence measurements as a dose metric in photodynamic therapy. *Cancer Res*. 2003;63(22):7986-7994.
5. Baier J, Maisch T, Maier M, Engel E, Landthaler M, Bäumler W. Singlet oxygen generation by UVA light exposure of endogenous photosensitizers. *Biophysical Journal*. 2006;91(4):1452-1459.
6. Moseley H. Light distribution and calibration of commercial PDT LED arrays. *Photochem Photobiol Sci*. 2005;4(11):911-914.
7. Juzeniene A, Juzenas P, Ma LW, Iani V, Moan J. Effectiveness of different light sources for 5-aminolevulinic acid photodynamic therapy. *Lasers Med Sci*. 2004;19(3):139-149.
8. Szeimies RM, Morton CA, Sidoroff A, Braathen LR. Photodynamic therapy for non-melanoma skin cancer. *Acta Derm Venereol*. 2005;85(6):483-490.
9. Dickey DJ, Xiao Z, Partridge KJ, Moore RB, Tulip J. Fractionated PDT light delivery system based on fiber optic switching technology. *Therapeutic Laser Applications and Laser-Tissue Interactions*. Proc. 2003;SPIE 5142. doi: 10.1117/12.499868.
10. Brancaleon L, Moseley H. Laser and non-laser light sources for photodynamic therapy. *Lasers Med Sci*. 2002;17:173-186.
11. Schlothauer J, Hackbarth S, Röder B. A new benchmark for time-resolved detection of singlet oxygen luminescence - revealing the evolution of lifetime in living cells with low dose illumination. *Laser Phys Lett*. 2009;6(3):216-221.
12. Jiménez-Banzo A, Sagristà ML, Mora M, Nonell S. Kinetics of singlet oxygen photosensitization in human skin fibroblasts. *Free Radic Biol Med*. 2008;44(11):1926-1934.
13. Hatz S, Lambert JD, Ogilby PR. Measuring the lifetime of singlet oxygen in a single cell: addressing the issue of cell viability. *Photochem Photobiol Sci*. 2007;6(10):1106-1116.
14. Niedre M, Patterson MS, Wilson BC. Direct near-infrared luminescence detection of singlet oxygen generated by photodynamic therapy in cells in vitro and tissues in vivo. *Photochem Photobiol*. 2002;75(4):382-391.

15. Oelckers S, Ziegler T, Michler I, Röder B. Time-resolved detection of singlet oxygen luminescence in red-cell ghost suspensions: concerning a signal component that can be attributed to $^1O_2$ luminescence from the inside of a native membrane. *J Photochem Photobiol B*. 1999;53(1-3):121-127.
16. Abrahamse H, Hamblin MR. New photosensitizers for photodynamic therapy. *Biochem J*. 2016;473(4):347-364.
17. Allison RR, Sibata CH. Oncologic photodynamic therapy photosensitizers: a clinical review. *Photodiagnosis Photodyn Ther*. 2010;7(2):61-75.
18. Dysart JS, Patterson MS. Characterization of Photofrin photobleaching for singlet oxygen dose estimation during photodynamic therapy of MLL cells in vitro. *Phys Med Biol*. 2005;50(11):2597-2616.
19. Foote CS. Mechanisms of photosensitized oxidation. There are several different types of photosensitized oxidation which may be important in biological systems. *Science*. 1968;162(3857):963-970.
20. Battersby AR. Tetrapyrroles: the pigments of life. *Nat Prod Rep*. 2000;17(6):507-526.
21. Bhowmik BB, Ganguly P. Photophysics of xanthene dyes in surfactant solution. *Spectrochim Acta A Mol Biomol Spectrosc*. 2005;61(9):1997-2003.
22. Usacheva MN, Teichert MC, Biel MA. Comparison of the methylene blue and toluidine blue photobactericidal efficacy against gram-positive and gram-negative microorganisms. *Lasers Surg Med*. 2001;29(2):165-173.
23. Usacheva MN, Teichert MC, Biel MA. The role of the methylene blue and toluidine blue monomersand dimers in the photoinactivation of bacteria. *J Photochem Photobiol B*. 2003;71:87-98.
24. Kamkaew A, Lim SH, Lee HB, Kiew LV, Chung LY, Burgess K. BODIPY dyes in photodynamic therapy. *Chem Soc Rev*. 2013;42(1):77-88.
25. Yogo T, Urano Y, Ishitsuka Y, Maniwa F, Nagano T. Highly efficient and photostable photosensitizer based on BODIPY chromophore. *J Am Chem Soc*. 2005;127(35):12162-12163.
26. Theodossiou TA, Hothersall JS, De Witte PA, Pantos A, Agostinis P. The multifaceted photocytotoxic profile of hypericin. *Mol Pharm*. 2009;6(6):1775-1789.
27. Liu X, Jiang C, Li Y, et al. Evaluation of hypericin: effect of aggregation on targeting biodistribution. *J Pharm Sci*. 2015;104(1):215-222.
28. Zhenjun D, Lown JW. Hypocrellins and their use in photosensitization. *Photochem Photobiol*. 1990;52(3): 609-616.
29. Bernd A. Visible light and/or UVA offer a strong amplification of the anti-tumor effect of curcumin. *Phytochem Rev*. 2014;13:183-189.
30. Makdoumi K, Bäckman A, Mortensen J, Crafoord S. Evaluation of antibacterial efficacy of photo-activated riboflavin using ultraviolet light (UVA). *Graefes Arch Clin Exp Ophthalmol*. 2010;248(2):207-212.
31. Schweitzer C, Schmidt R. Physical mechanisms of generation and deactivation of singlet oxygen. *Chem Rev*. 2003;103(5):1685-1757.
32. Kiryu C, Makiuchi M, Miyazaki J, Fujinaga T, Kakinuma K. Physiological production of singlet molecular oxygen in the myeloperoxidase-H2O2-chloride system. *FEBS Lett*. 1999;443(2):154-158.
33. Fischer BB, Hideg E, Krieger-Liszkay A. Production, detection, and signaling of singlet oxygen in photosynthetic organisms. *Antioxid Redox Signal*. 2013;18(16): 2145-2162.
34. Dickinson BC, Chang CJ. Chemistry and biology of reactive oxygen species in signaling or stress responses. *Nat Chem Biol*. 2011;7(8):504-511.
35. Kim IW, Park JM, Roh YJ, Kim JH, Choi MG, Hasan T. Direct measurement of singlet oxygen by using a photomultiplier tube-based detection system. *J Photochem Photobiol B*. 2016;159:14-23.
36. Gemmell NR, McCarthy A, Liu B, et al. Singlet oxygen luminescence detection with a fiber-coupled superconducting nanowire single-photon detector. *Opt Express*. 2013;21(4):5005-5013.
37. Kim IW, Kim JH, Park JM, Choi MG. Abstract 4922: The feasibility of evaluation method for the newly developed Photomultiplier-tube-based singlet oxygen detection system in photodynamic therapy. *Cancer Res*. 2014;74(19):4922.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.10

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 233–238

REVIEW PAPER

Artur Chwalba (FG), Ewa Otto-Buczkowska (FG)

The effect of diabetes on the connective tissue and the bone-joint system

Medical Specialist Centre in Gliwice, Gliwice, Poland

ABSTRACT

Introduction. Diabetes is associated with a number of complications, including renal disease, peripheral neuropathy, retinopathy, and vascular events.

Aim. Article presents the research results reported in the scientific literature about the influence of diabetes on connective tissue and the bone-joint system.

Material and methods. Analysis of literature.

Conclusion. Due to its multi-systemic nature, the development of additional manifestations, such as musculoskeletal complications, is possible including, for example diabetic osteopathy, limited joint mobility, joint disorders, and other, many of which are subclinical and correlated with the disease duration and its inadequate control. They should be recognized and treated properly, because their management improves the patients' quality of life.

Keywords. diabetes mellitus, diabetic osteopathy, limited joint mobility, joint disorders

Introduction

Concomitant metabolic disorders affect many organs and systems including the motor organs – bones, joints, and soft tissues. These changes are related to other disorders: angiopathy and neuropathy.[1] Changes in motor organs have a diversified picture.

As opposed to vascular complications, musculoskeletal manifestations of diabetes are common, but not life threatening. They are an important cause of morbidity, pain, and disability. They usually occur in patients with poorly controlled diabetes of long duration and in those who suffer from other more serious complications.[2]

Among the musculoskeletal complications of diabetes, two basic groups can be identified:[3]

- effects of diabetes on the muscle tissues
- effects of diabetes on joints and the connective tissue.

An extensive discussion of these diseases has been presented by Brazilian authors.[4]

The review of these musculoskeletal manifestations in diabetic patients has been also presented by Polish authors.[5] In this paper we wish to recall some of these musculoskeletal manifestations based on the literature data and our own observations.

Corresponding author: Ewa Otto-Buczkowska, e-mail: em.buczkowski@pro.onet.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 28.10.2016 | Accepted: 12.07.2018
Publication date: September 2018

Chwalba A, Otto-Buczkowska E. *The effect of diabetes on the connective tissue and the bone-joint system*. Eur J Clin Exp Med. 2018;16(3):233–238. doi: 10.15584/ejcem.2018.3.10

Diabetic osteopathy

Even though studies on the pathogenesis of diabetic osteopathy have a considerably long history, there are many mechanisms leading to metabolic disorders of bones in diabetes mellitus that have not been explained. As a consequence of diabetes, processes of rebuilding and creation of bones are both disordered. There are experimental studies on rats conducted, aimed to explain mechanisms of metabolic disorders of bones in diabetes mellitus.[6] Both types 1 and 2 of diabetes mellitus constitute a risk factor for bone fractures.[7]

Based on a meta-analysis comprising long-term studies on the risk of bone fracture in diabetic patients, Adami stated that in patients with type 1 diabetes, an increased risk of fracture is associated with a decreased BMD level, while in patients with type 2 diabetes this risk exists despite a correct or increased BMD level.[8] The author presented the results of an overview of relevant literature data from January 1970 to November 2008, relating to the correlation between the bone mass and an increased risk of fragility fracture in patients with diabetes.

The same observations are described by other authors. An important difference, however, is that in type 1 diabetes, the risk of fracture is associated with a lower level of bone mineral density, while patients with type 2 diabetes usually have a correct or even increased BMD level.[9]

Many researchers confirm that the risk of fracture occurs in patients with type 2 diabetes despite a BMD level within the normal range.[10,11]

Much attention is devoted to pathophysiology of bone changes in diabetes.[12]

An extensive discussion of this issue has been recently presented by Ferrari.[13] The author analyzes mechanisms that may lead to an increased risk of fractures in diabetic patients.

The risk of bone fracture concerns especially patients with uncontrolled diabetes.[14,15]

Some scientists claim that the loss of bone mass occurs both in patients with type 1 and type 2 diabetes. Other authors state that osteopathy in young patients with type 1 diabetes is in fact a diabetes-related complication, whereas in older patients with type 2 diabetes it is actually gerontic osteoporosis, and diabetes only plays a role of and enhancer of this process.

In the opinion of the majority of researchers, the patient's age when diabetes is diagnosed has a great effect on the occurrence of bone lesions. It seems that patients with diabetes diagnosed in their growth period, prior to skeletal maturation, are particularly predisposed.

Additionally, the role of calcitonin secretion disorders, diagnosed in diabetic patients, has not been explained yet. Considering the vitamin D insufficiency as one of the causes of diabetic osteopathy, as well as potential vitamin D metabolism disorders at the final stages of its transformation, is controversial, although it seems that a decrease of the biological activity of this metabolite or a drop in the number of receptors in the target tissue are more possible than the deficiency of 1,25(OH)2D. Opinions about the PTH secretion in diabetic patients and its relevance to the occurrence of diabetic osteopathy are differentiated.

In recent years, a whole series of studies on bones density and bones turnover in patients, mainly in children and adolescents with type 1 diabetes, were published.[16-18]

It was stated that the bone status of adolescents with type 1 diabetes mellitus assessed with QUS differs from that of their healthy peers and is dependent on long-term metabolic control.[19]

Results of these investigations are equivocal. Most of them state that bone density in patients with diabetes is lower than in their healthy peers; however, this decrease concerns unequally individual cases of bone meshwork (cortical bone, spongy bone).

The most frequently observed changes did not reveal any association with the stage of metabolic balance in diabetes mellitus; however, Valerio et al., who studied the effect of diabetes on the bone density and the resorption processes in 27 juvenile patients (aged 13.1 ± 1.7) with type 1 diabetes lasting 6.9 ± 3.0 years, concluded that incorrect metabolic control in diabetes mellitus in puberty may constitute a risk factor of the osteopathy progression in adult age, whereas optimized metabolic control in growing children may prevent the osteoporosis occurrence in their later life.[20]

It is assumed that an increased tendency for the occurrence of VF (vertebral fracture) in diabetic patients with a correct level of BMD (bone mineral density) is an effect of concomitant obesity and hyperglycemia, which was proven in Japanese studies conducted in a group of male patients with type 2 diabetes.[21]

Japanese authors propose a range of factors that may prove important in the risk assessment of fractures in patients with type 2 diabetes. It was shown that the serum level of the insulin-like growth factor-I (IGF-I) may be useful in the assessment of the intensification of vertebral fractures (VFs).[22]

Another factor considered by authors as useful in the risk assessment of vertebral fractures is the OC/BAP coefficient (osteocalcin/bone-specific alkaline phosphatase). The OC/BAP ratio could be clinically useful for assessing the risk of vertebral fractures regardless of BMD. [23]

Authors indicate the usefulness of the serum adiponectin level for the BMD evaluation in patients with type 2 diabetes.[24] The correlation between the state of bones and the level of adiponectin was investigated also by Polish authors.[25]

The authors conducted a study on the effect of metabolic control of diabetes on selected bone turn-

over markers, the bone mineral density, and serum adiponectin concentrations in post-menopausal women with newly diagnosed Type 2 diabetes. They found that the level of adiponectin is inversely correlated with the bone mineral density of the entire body.

Osteoporotic fractures may be affected by medications applied in the course of diabetes treatment. It is assumed that such an influence may be exerted by thiazolidinediones (TZD). It was stated that the application of these medications may increase the risk of fracture. In vitro studies suggest to the contrary that incretin medications have a positive effect on the metabolism of bones.[9,26]

Currently, studies on the effect of metformin on the metabolism of bones are being conducted. Further randomized trials are required concerning this issue.[27]

During the First International Symposium on Diabetes and Bone in Rome in November 2014, the risk of the increased incidence of fractures due to a rapid rise in the number of diabetic patients was considered as a serious problem, also from the financial perspective.[28]

Limited joint mobility syndrome - LJMS

The LJM - limited join mobility syndrome is a diabetes complication well known for a long time, but recently it is getting more interesting to scientists.[29] Many diabetes complications are induced by changes in the collagen structure.[30,31] Probably, changes in the collagen structure induce the LJM syndrome, and advanced glycation end-products may play a role in this process.[32]

In the opinion of many scientists, symptoms of LJM may be far ahead of other chronic diabetes complications; therefore, they could be used as their risk factor.

The LJM syndrome results in the limited joints mobility that affects the metacarpal-phalanx joints and the interphalangeal joint of the 5th finger, usually in the beginning. Afterwards, changes progress gradually through the carpal tunnel and the cubits to the shoulder. Currently, it is known that LJM may also affects lower limbs or joints of the cervical and thoracic-lumbar spine. These changes may be unnoticed by patients as they do not cause any pain.

Previous observations allow to state that the LJM syndrome occurs more often in diabetic patients than in non-diabetic subjects. It is a complication that occurs relatively early both in children and adolescents, as well as in adults with type 1 and 2 diabetes.[33-35]

Initially, studies on LJM were conducted mainly in patients with type 1 diabetes. This syndrome was diagnosed for the first time in juvenile patients in 1974 by A.L. Rosenbloom. Later investigations carried out by this author revealed that improved metabolic control in diabetes mellitus has a significant effect on the decrease of the LJM incidence.[36]

Lindsay et al. performed a retrospective analysis of the LJM incidence in patients with type 1 diabetes.[37] Authors revealed that a better diabetic treatment and improved metabolic control in diabetes mellitus distinctly decrease the LJM occurrence.

The first studies on the LJM incidence in Poland were conducted by Petrulewicz-Salamon.[35] They involved 51 patients with type 1 diabetes at ages of 11-57 (average: 26.6) and the diabetes duration from 1 to 34 years (average: 10.9 years). The LJM syndrome was diagnosed in 21 patients (41.18% of all the patients). The LJM syndrome was associated with other chronic complications (retinopathy, neuropathy, nephropathy and hypertension).

In particular, the group of patients with type 1 diabetes and LJM as the only chronic diabetic complication was very interesting. There were 8 patients (~30% of all subjects) aged 11-20 who had suffered from diabetes for 1-9 years. It may confirm the fact referred to in the subject literature that the LJM syndrome can foreshadow other chronic complications and its occurrence requires tightening of the metabolic balance criteria.

Currently, there are more and more cases where LJM is diagnosed in patients with type 2 diabetes. A comprehensive analysis of the incidence of musculoskeletal disorders of the hand in patients with type 2 diabetes has been carried out by Mustafa et al.[38]

Authors paid attention to the incidence of concomitant retinopathy and hypertension. Other scientists have focused on the association between diabetes mellitus and several pathologic conditions of the hand.[39] In the group of 200 diabetic patients, 30% of patients had neuropathy, 37.5% had nephropathy, and 44.5% had retinopathy. In the study population, 67% of patients were having one or more hand disorders. The most commonly recognized maladies are limited joint mobility, Dupuytren's disease, the trigger finger, and carpal tunnel syndrome. The incidence of these hand disorders has increased in the setting of diabetes.

The LJM syndrome is a diabetic complication that is linked to micro- and macroangiopathy. Correct metabolic control of glycaemia is very important in the LJM prophylaxis.[40,41]

Diagnosis of the LJM syndrome.

The basic test in the diagnosis of LJM is the assessment of the degree of the adherence of the palm to a flat surface. The correct result is when palms adhere to the surface with all of their surface area. Another preliminary test is the verification whether palms fit together in a 'prayer sign'. In both test fingers should be splayed. In the LJM syndrome palms do not fit together and do not adhere closely to the flat surface.[1,42,43]

The evaluation should include the thickening of tissues surrounding the joints. Inability to lift a skin fold,

especially on the dorsal side of the hand, indicates abnormality. The assessment of straightening of the carpus and cubit, of the flexion of the ankle, as well as the verification of the mobility of the cervical and thoracic-lumbar spine are necessary. The changes of joints are accompanied by skin lesions: thickening, tension and waxy appearance, predominantly on the dorsal side of palms and lower arms.

LJM is considered as the one of the complications in juvenile patients with type 1 diabetes that occur the earliest. In the subject literature, it is highlighted that the LJM syndrome may foreshadow other chronic complications, and thus it requires tightening of the metabolic balance criteria. The tests of fitting palms together ('prayer sign') and adhering hands to a flat surface, which are easy to perform, are useful in the assessment of the mobility of joints.

Screening tests are important, because the LJM syndrome does not cause pain, therefore its progression can be underplayed by both medical staff and the patient. An early diagnosis of LJM is an indication for physical rehabilitation to prevent the patient from becoming disabled.

The tendency to collapses in LJM patients constitutes a serious problem. Patients with LJMS had a moderate risk of falls compared with those without LJMS, which was of low risk. [44]

Joint disorders in diabetes mellitus

Joint disorders, both of the inflammatory and degenerative nature, have always been diagnosed in diabetic patients, but they have not been considered from the etiological perspective. In recent years there have been more and more studies devoted to the concomitance of diabetes and joint disorders and the possibility of establishing a cause and effect relationship.

The relationships between diabetes and joint lesions are differentiated. Autoimmune processes that lead to the destruction of beta cells and the progression of type 1 diabetes, are similar to the mechanisms of the synovial membrane annihilation in joints constituting a base for the rheumatoid joint inflammation. In both of these disorders, increased levels of inflammation markers are confirmed, such as C Reactive Protein (CRP), interleukin 6 (IL-6,) or the tumor necrosis factor - alpha (TNF-a).

In type 2 diabetes, degenerative processes of joints are observed.[45]

In OA (osteoarthritis, arthrosis deformans), like in type 2 diabetes, two risk factors play a significant role: obesity and age.[46]

Therefore, in the prevention of both disorders, the dietary treatment (to reduce the body mass), as well as physical activity are of fundamental importance. Diabetes mellitus is associated with a large variety of rheumatic manifestations.[47,48,49]

Conclusion

Diabetes mellitus accounts for a number of vascular complications, which impair patient survival. Musculoskeletal complications are also found, and, although assigned with lower importance than the vascular ones, they significantly compromise the patients' quality of life.

The musculoskeletal complications of diabetes can be manifested in different ways. They could be syndromes of the limited joint mobility, osteoporosis, diffuse idiopathic skeletal hyperostosis, neuropathies, or diabetic muscle infarction.

Most of these disorders can be diagnosed clinically, but some radiological examination may help, especially in the differential diagnosis. No specific treatment is available, and treatments used in the general population are also recommended for diabetic subjects. Infectious complications affecting the musculoskeletal system are common in diabetic patients. Many musculoskeletal manifestations are subclinical and correlated with the disease duration and its inadequate control. They should be recognized and treated properly, because their management improves the patients' quality of life.

References

1. Otto-Buczkowska E. *Diabetes mellitus influence on motor organs*. Otto-Buczkowska E ed. Type 1 diabetes mellitus. Wrocław: Cornetis; 2006:369-376.
2. Merashli M, Chowdhury TA, Jawad AS. Musculoskeletal manifestations of diabetes mellitus. *QJM.* 2015;108:853-857.
3. Singla R, Gupta Y, Kalra S. Musculoskeletal effects of diabetes mellitus. *J Pak Med Assoc.* 2015;65:1024-1027.
4. Silva MB, Skare TL. Musculoskeletal disorders in diabetes mellitus. *Rev Bras Reumatol.* 2012;52:601-609.
5. Parada-Turska J, Majdan M. Motor system in diabetic patients. *Post Hig.* 2005;59: 236-244.
6. Fajardo RJ, Karim L, Calley VI, Bouxsein ML. A review of rodent models of type 2 diabetic skeletal fragility. *J Bone Miner Res.* 2014;29:1025-1040.
7. Sellmeyer DE, Civitelli R, Hofbauer LC, Khosla S, Lecka-Czernik B, Schwartz AV. Skeletal metabolism, fracture risk, and fracture outcomes in type 1 and type 2 diabetes. *Diabetes.* 2016;65:1757-1766.
8. Adami S. Bone health in diabetes: considerations for clinical management. *Curr Med Res Opin.* 2009;25:1057-1072.
9. Montagnani A, Gonnelli S, Alessandri M, Nuti R. Osteoporosis and risk of fracture in patients with diabetes: an update. *Aging Clin Exp Res.* 2011;23:84-90.
10. Dede AD, Tournis S, Dontas I, Trovas G. Type 2 diabetes mellitus and fracture risk. *Metabolism.* 2014;63:1480-1490.
11. Shanbhogue VV, Mitchell DM, Rosen CJ, Bouxsein ML. Type 2 diabetes and the skeleton: new insights into sweet bones. *Lancet Diabetes Endocrinol.* 2016;4:159-173.
12. Sellmeyer DE, Civitelli R, Hofbauer LC, Khosla S, Lecka-Czernik B, Schwartz AV. Skeletal metabolism, fracture

risk, and fracture outcomes in type 1 and type 2 diabetes. *Diabetes.* 2016;65:1757-1766.
13. Ferrari S. Diabetes and Bone. *Calcif Tissue Int.* 2017;100:107-108.
14. Dhaliwal R, Cibula D, Ghosh C, Weinstock RS, Moses AM, Bone quality assessment in type 2 diabetes mellitus. *Osteoporos Int.* 2014;25:1969-1973.
15. Kim JH, Choi HJ, Ku EJ, et al. Trabecular bone score as an indicator for skeletal deterioration in diabetes. *J Clin Endocrinol Metab*. 2015;100:475-482.
16. Chobot AP, Haffke A, Polanska J, et al. Quantitative ultrasound bone measurements in pre-pubertal children with type 1 diabetes. *Ultrasound Med Biol.* 2012;38: 1109-1115.
17. Heilman K, Zilmer M, Zilmer K, Tillmann V. Lower bone mineral density in children with type 1 diabetes is associated with poor glycemic control and higher serum ICAM-1 and urinary isoprostane levels. *J Bone Miner Metab*. 2009;27:598-604.
18. Brandao FR, Vicente EJ, Daltro CH, Sacramento M, Moreira A, Adan L. Bone metabolism is linked to disease duration and metabolic control in type 1 diabetes mellitus. *Diabetes Res Clin Pract.* 2007;78:334-339.
19. Chobot AP, Haffke A, Polanska J, et al. Bone status in adolescents with type 1 diabetes. *Diabetologia.* 2010;53:1754-1760.
20. Valerio G, del Puente A, Esposito-del Puente A, Buono P, Mozzillo E, Franzese A. The lumbar bone mineral density is affected by long-term poor metabolic control in adolescents with type 1 diabetes mellitus. *Horm Res.* 2002;58:266-272.
21. Kanazawa I, Yamaguchi T, Yamamoto M, Yamauchi M, Yano S, Sugimoto T. Combination of obesity with hyperglycemia is a risk factor for the presence of vertebral fractures in type 2 diabetic men. *Calcif Tissue Int.* 2008;83:324-331.
22. Kanazawa I, Yamaguchi T, Sugimoto T. Serum insulin-like growth factor-I is a marker for assessing the severity of vertebral fractures in postmenopausal women with type 2 diabetes mellitus. *Osteoporos Int*. 2011;22:1191-1198.
23. Kanazawa I, Yamaguchi T, Yamamoto M, Yamauchi M, Yano S, Sugimoto T. Serum osteocalcin/bone-specific alkaline phosphatase ratio is a predictor for the presence of vertebral fractures in men with type 2 diabetes. *Calcif Tissue Int.* 2009;85:228-234.
24. Kanazawa I, Yamaguchi T, Sugimoto T. Baseline serum total adiponectin level is positively associated with changes in bone mineral density after 1-year treatment of type 2 diabetes mellitus. *Metabolism.* 2010;59:1252-1256.
25. Miazgowski T, Noworyta-Ziętara M, Safranow K, Ziemak J, Widecka K. Serum adiponectin, bone mineral density and bone turnover markers in post-menopausal women with newly diagnosed Type 2 diabetes: a 12-month follow-up. *Diabet Med.* 2012;29:62-69.
26. Hayakawa N, Suzuki A. Diabetes mellitus and osteoporosis. Effect of antidiabetic medicine on osteoporotic fracture. *Clin Calcium.* 2012;22:1383-1390.
27. McCarthy AD, Cortizo AM, Sedlinsky C. Metformin revisited: Does this regulator of AMP-activated protein kinase secondarily affect bone metabolism and prevent diabetic osteopathy. *World J Diabetes.* 2016;7:122-133.
28. Epstein S, Defeudis G, Manfrini S, Napoli N, Pozzilli P. Scientific Committee of the First International Symposium on Diabetes and Bone. Diabetes and disordered bone metabolism (diabetic osteodystrophy): time for recognition. *Osteoporos Int*. 2016;27:1931-1951.
29. Otto-Buczkowska E. Is LJM syndrome a problem in diabetic patients? *Pol Med Rodz.* 2004;6:1039-1041.
30. Monnier VM, Sell DR, Strauch C, et al. DCCT Research Group. The association between skin collagen glucosepane and past progression of microvascular and neuropathic complications in type 1 diabetes. *J Diabetes Complications.* 2013;27: 141-149.
31. Genuth S, Sun W, Cleary P, Gao X, Sell DR, Lachin J. DCCT/EDIC Research Group, Monnier VM. Skin advanced glycation end products glucosepane and methylglyoxal hydroimidazolone are independently associated with long-term microvascular complication progression of type 1 diabetes. *Diabetes.* 2015;64:266-278.
32. Abate M, Schiavone C, Pelotti P, Salini V. Limited joint mobility (LJM) in elderly subjects with type II diabetes mellitus. *Arch Gerontol Geriatr.* 2011;53:135-140.
33. Pandey A, Usman K, Reddy H, Gutch M, Jain N, Qidwai S. Prevalence of hand disorders in type 2 diabetes mellitus and its correlation with microvascular complications. *Ann Med Health Sci Res.* 2013;3:349–354.
34. Petrulewicz-Salamon I, Otto Buczkowska E. Limited joint mobility in diabetic patients. Part I. *Med Metabol.* 2005;9:52-60.
35. Petrulewicz-Salamon I. The influence of diabetes mellitus on joint mobility. *Ortop Traumatol Rehabil.* 2006;8:555-565.
36. Rosenbloom AL. Limited joint mobility in childhood diabetes: discovery, description, and decline. *J Clin Endocrinol Metab.* 2013;98:466-473.
37. Lindsay JR, Kennedy L, Atkinson AB, et al. Reduced prevalence of limited joint mobility in type 1 diabetes in a U.K. clinic population over a 20-year period. *Diabetes Care*. 2005;28:658-661.
38. Mustafa KN, Khader YS, Bsoul AK, Ajlouni K. Musculoskeletal disorders of the hand in type 2 diabetes mellitus: prevalence and its associated factors. *Int J Rheum Dis.* 2016;19:730-735.
39. Pandey A, Usman K, Reddy H, Gutch M, Jain N, Qidwai S. Prevalence of hand disorders in type 2 diabetes mellitus and its correlation with microvascular complications. *Ann Med Health Sci Res.* 2013;3:349-354.
40. Gerrits EG, Landman GW, Nijenhuis-Rosien L, Bilo HJ. Limited joint mobility syndrome in diabetes mellitus: A minireview. *World J Diabetes.* 2015;6:1108-1112.
41. Upreti V, Vasdev V, Dhull P, Patnaik SK. Prayer sign in diabetes mellitus. *Indian J Endocrinol Metab.* 2013;17:769–770.

42. Kamińska-Winciorek G, Jarosz-Chobot P, Otto-Buczkowska E. Cheiroartropatia – Limited Joint Mobility – early diabetic complication? *Prz Dermatol.* 2007;94:17-22.
43. Petrulewicz-Salamon I, Jarosz-Chobot P, Polańska J, Otto--Buczkowska E. LJM in diabetes mellitus: assessment of incidence and selected clinical risk factors. *Diabetol Pol.* 2006;13:115-116.
44. López-Martín I, Benito Ortiz L, Rodríguez-Borlado B, Cano Langreo M, García-Martínez FJ, Martín Rodríguez MF. Association between limited joint mobility syndrome and risk of accidental falls in diabetic patients. *Semergen.* 2015;41:70-75.
45. Walsh JS, Vilaca T. Obesity, Type 2 Diabetes and Bone in Adults. *Calcif Tissue Int*. 2017;100:528-535.
46. Bhat TA, Dhar SA, Dar TA, et al. The Musculoskeletal Manifestations of Type 2 Diabetes Mellitus in a Kashmiri Population. *Int J Health Sci (Qassim).* 2016;10: 57-68.
47. Al-Homood IA. Rheumatic conditions in patients with diabetes mellitus. *Clin Rheumatol.* 2013;32:527-533.
48. Serban AL, Udrea GF. Rheumatic manifestations in diabetic patients. *J Med Life*. 2012;5:252-257.
49. Burner TW, Rosenthal AK. Diabetes and rheumatic diseases. *Curr Opin Rheumatol.* 2009;21:50-54.

© Wydawnictwo UR 2018
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2018.3.11

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 239–244

REVIEW PAPER

Adrian Truszkiewicz [1(BDG)], David Aebisher [2(ABDGF)], Łukasz Ożog [3(BDG)], Dorota Bartusik-Aebisher [4(ABDGF)]

Physical fatigue measured by functional MRI

[1] Department of Electroradiology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[2] Department of Human Immunology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[3] Center for Innovative Research in Medical and Natural Sciences, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland
[4] Department of Experimental and Clinical Pharmacology, Faculty of Medicine, University of Rzeszów, Rzeszów, Poland

ABSTRACT

Introduction. Physical fatigue is a physiological condition that can be measured by functional Magnetic Resonance Imaging (fMRI).

Aim. Therefore, this work aims to present the research results currently reported in the scientific literature between the years 2014 and 2018 in the field of chronic fatigue syndrome using the functional MRI method.

Material and methods. Analysis of literature.

Results. We reviewed here the differences between temporary and chronic fatigue.

Keywords. functional MRI, physical fatigue, physiological condition, temporary and chronic fatigue

Rationale for the fMRI study

Physical fatigue is a physiological condition that is manifested in a temporary-transient decrease in the ability to work and a decrease in mobility. Chronic fatigue syndrome is a complex problem which manifests in visual impairment, heart palpitations, increased hair loss, lack of concentration, memory problems as well as frequent headaches and numbness of the hand. The above mentioned symptoms may be accompanied by many diseases of various etiology, e.g. depression, neurostemia, multiple sclerosis, or some infections.[1] The etiology of fatigue is not well understood and scientific research conducted to elucidate the mechanisms of fatigue are necessary to efficiently diagnose chronic fatigue syndrome. The fMRI technique is based on the influence of a strong magnetic field and an electromagnetic wave at a strictly defined frequency on the nucleus of chemical elements with non-zero spin. This variant of MRI is currently the key non-invasive technique for brain imaging. This technique has excellent spatial and temporal resolution and is sensitive to changes in signal strength depending on the degree of blood oxygenation. It is

Corresponding author: Dorota Bartusik-Aebisher, E-mail: dbartusik-aebisher@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 20.07.2018 | Accepted: 29.08.2018
Publication date: September 2018

Truszkiewicz A, Aebisher D, Ożog Ł, Bartusik-Aebisher D. *Physical fatigue measured by functional MRI.* Eur J Clin Exp Med. 2018;16(3):239–244. doi: 10.15584/ejcem.2018.3.11

known that levels of blood oxygenation in the brain vary depending on the activity of neurons, and these differences can be used to detect brain activity. This is due to the increased demand for energy and oxygen in the area of increased brain activity. The basis of this imaging is the so-called Blood Oxygenation-Level Dependent (BOLD) contrast that depends on the level of oxygen in the blood. fMRI has many clinical applications and is used to validate neuroimaging, and to search for brain markers in psychiatry, which makes it a technique at the borderline of clinical and experimental-methodological sciences. Blood Oxygenation-Level Dependent contrast is one of the best-known techniques of fMRI that can be used to map blood oxygenation in the brain. The use of this technique allows for identification of brain tumors and patients with epilepsy. This technique demonstrates early promise and can also play a role in providing future diagnostic and prognostic information in patients with neurological and psychiatric diseases and opens up a wide range of possibilities for chronic fatigue syndrome testing. Based on studies available in the literature, it is very likely that fatigue assessment is not possible using MRI based T_1 spin-lattice relaxation and spin-spin relaxation T_2 of water alone.[2] Fatigue, being a physiological reaction with variations in hemoglobin, can be imaged by fMRI. Fatigue is often reported by patients who have had a mild brain injury which affects the ability of people to return to work in a reasonable timeframe.[3] A study by Möller et al. subjected 10 patients with mild cognitive impairment and fatigue (5 women and 5 men) to fMRI after suffering a stroke.[3] The paradigm of the study was based on patients maintaining constant attention to a task being carried out under fMRI monitoring. This task was a response time to a visible stimulus. The research did not show any group differences regarding age, education, body weight or the consumption of caffeine on the day of the study. The authors of this study showed that patients could be identified as suffering from chronic fatigue after mild stroke compared to the control group by fMRI. Measurements of regional cerebral blood flow and quantitative mapping of joints can also provide an objective assessment of fatigue during a continuous vigilance test. As a result, the authors of this study confirmed that the fMRI technique can be used to assess chronic fatigue in patients after mild stroke.

Subjective fatigue is also a typical symptom of diseases such as multiple sclerosis, Parkinson's disease or stroke. Pardini et al.[4] examined 14 patients with multiple sclerosis by fMRI. The task that the patients were asked to do was to touch their other fingers with their thumb. The sequence was attempted at a frequency generated by a 2 Hz metronome. A force measurement was also carried out by application of a special glove adapted for this task. The obtained results showed a strong correlation between the time accuracy of the performed task and the feeling of chronic fatigue.[4] Other authors point to the potential adaptation of the brain to fatigue. Perhaps it is related to a feedback loop effect in which the brain tries to maintain the initial efficiency.[5] In many studies, authors point to activation regions affected by fatigue located in the cerebellum and frontal cortex.[4,6,7] Other studies of fatigue in patients with multiple sclerosis checked how quickly task ability was regained after deterioration resulting from the task performed initially. A total of 14 patients were subjected to a deterioration of spatial and temporal accuracy in the first part of the task consisting of a sequence of touching the other fingers with the thumb of the right hand. The second part of the study showed that after a short 5-minute rest, a return of temporal accuracy, but not spatial. After rest, the activity of activated regions obtained values similar to baseline values except in the amygdala by fMRI. This suggests that patients that have been in a state of fatigue from the beginning of the task showed an increased BOLD signal in subcortical structures that are known to be recruited in healthy patients only when dealing with fatigue to improve motor performance. On the basis of research it can be said that rehabilitation treatment brings much better results than pharmacological treatment.[8] Results have been presented that the rehabilitation of people with multiple sclerosis reporting only fatigue symptoms should be the treatment of choice. It should be noted that only a small group of people will feel the benefits of such treatment. The study included a small group of people and the extent of efficacy in other subgroups of multiple sclerosis patients is unknown. It seems that the above observations may be related only to the initial stage of the disease. The next steps should take into account future consequences of the choice or resignation from pharmacological treatment in this regard. Interesting research results were presented in 2015 by Hampson and colleagues.[9] Twenty three patients were examined after recovery from breast cancer. Visible persistent fatigue associated with breast cancer was associated with reduced sleep quality, cognitive impairment, and ultimately depression. These studies from 2015 appear to be one of the first fMRI applications in the analysis of fatigue in patients with breast cancer. As a result of the analysis, an area in the frontal lobe was identified using fMRI analysis techniques which may be a potential region to track fatigue in patients. Higher fatigue is also indicated in the parietal region of cancer patients during fMRI tests.[6] Increased fatigue coexists with worsening physical functioning and cognitive impairment. With such an analysis, the effects of oncological therapy should be taken into account, which in itself has a great impact on the emotional and physical state of the patient where fatigue is just one of many side effects. In recent years, populations have access to mod-

Table 1. Background of Imaging procedures and Image processing

References	Imaging procedures	Image processing
Frank S. *et al.* 2010[11]	blood oxygen-level dependent (BOLD) fMRI data were obtained by using a 3.0 T MRI scanner	analysis of the fMRI data was performed with Statistical Parametric Mapping software (SPM5)
Vocks S. *et al.* 2011[12]	BOLD contrast images were acquired using an echo-planar (EPI) technique; images were acquired using a 1.5 T MRI scanner; additionally an MRI compatible finger clip pulse oximeter was used to measure heart rate	pre-processing and statistical analyses of the fMRI data were performed using the Statistical Parametric Mapping software (SPM5)
Chin SH *et al.* 2018[13]	fMRI data were acquired using an echo planar imaging sequence; T1-weighted MPRAGE scan was also collected using a 3.0 T MRI scanner	all structural and functional raw data images were converted to NIfTI format using the dcm2nii converter (Rorden & Brett, 2005). Freesurfer (autorecon1) was used for structural image preprocessing and FMRIB Software Library (FSL; Version 6.00, Oxford, UK) for functional image preprocessing and analysis; the FEAT tool in FSL was used to analyze the fMRI data
Picchioni D. *et al.* 2008[14]	(BOLD) fMRI was acquired on a 3.0 T MRI scanner; single-shot echo-planar images were collected from 28 oblique-axial slices covering most of the brain; 3D T1-weighted MPRAGE images were collected	fMRI analysis was performed using IDL 6.2 (ITT visual information solutions, Boulder, CO, USA), Statistical Parametric Mapping software (SPM2) and Analysis of Functional Neuro Images (AFNI); IDL and SPM2 were used for pre-processing the data while AFNI was used for additional pre-processing and for the statistical analyses
Wang Y. *et al.* 2016[10]	images were acquired in a 3.0 T MRI scanner; functional data comprised 1008 vol acquired with T2*-weighted gradient echo planar imaging sequences	all preprocessing steps were carried out using the Data Processing Assistant for Resting-State fMRI V2.0; after preprocessing, Statistical Parametric Mapping software (SPM12) was used to analyze the imaging data
Lange G. *et al.* 2005[15]	imaging was performed on a 1.5 T MRI scanner; initial T1-weighted sagittal localizer was acquired to determine the location of the MR images; T1-weighted axial images encompassing the whole brain were acquired	the functional neuroimaging data were analyzed using Statistical Parametric Mapping software (SPM99)
Porubská K. *et al.* 2006[16]	fMRI data were obtained using a 1.5 T MRI scanner; Functional T2*-weighted images were acquired in axial orientation using echo-planar imaging (EPI)	preprocessing and statistical analyses were carried out using Statistical Parametric Mapping software (SPM2)
van Duinen H. *et al.* 2007[17]	3.0 T MRI scanner was used; fMRI data were acquired using an echo planar imaging sequence; additionally T1-weighted anatomical images of the entire brain were obtained	the fMRI data were preprocessed using Statistical Parametric Mapping software (SPM2)
Jacobson A. *et al.* 2010[18]	T1-weighted whole brain MP-RAGE sequence were performed using 3.0 T MRI scanner	analysis of Functional Neuro Images (AFNI) software was used in all of the processing and analyses of the structural and functional data
Tsai P-J. *et al.* 2014[19]	MRI data were acquired using a 3.0 T scanner; T1-weighted anatomical images (3D-MPRAGE) were acquired prior to functional scans for geometric localization	all fMRI data were preprocessed by Statistical Parametric Mapping (SPM5)
Thomas R.J. 2005[20]	imaging was performed on a 3.0 T MRI scanner; a gradient echo T2*-weighted sequence was used to obtain BOLD contrast data; high resolution T1-weighted scan was used as an intermediate step for functional overlays prior to transformation into the threedimensional space	preprocessing included motion correction, spatial smoothing, linear trend removal and temporal high-pass filtering using the Brain Voyager 2000 (Brain Innovation, Maastricht, The Netherlands) software package

ern electronic entertainment technologies, of which one of the most important is three-dimensional (3D) tv technology. For example, when watching television programs, the deoxy- and oxyhemoglobin concentrations are significantly increased, which is associated with increased blood supply to the brain. Increasing the blood supply to the brain also at the same time indicates an increased energy demand. In addition, the metabolic rate drops significantly due to fatigue.[7] Researchers examined 40 participants randomly selected who were to

Table 2. Background of Imaging procedures and Image processing

References	Aim	Methods	Results and Conclusions
Frank S. *et al.* 2010[11]	Explanation of the neural basis of human eating behavior using fMRI	the modulating effects of calorie content and hunger on food processing related brain activity were study using fMRI	the calorie content of food pictures modulates the activation of brain areas related to reward processing and even early visual areas
Vocks S. *et al.* 2011[12]	assessment hunger- and satiety-dependent alterations in the gustatory processing of stimulated with food in anorexia nervosa were study using fMRI	females in hunger condition and in satiety condition (females with restricting-type anorexia nervosa and healthy females) drank chocolate milk and water via a tube in a blocked design during image acquisition	neuronal responses evoked by gustatory stimulation differ depending on hunger and satiety; activations located in the amygdala and in the extra striate body area might reflect fear of weight gain
Chin SH *et al.* 2018[13]	influence of self-reported hunger in behavioral and fMRI food-cue reactivity (fMRI-FCR)	required rating images of food and matched objects were presented during fMRI-FCR study; hunger, satiety, thirst, fullness and emptiness were measured pre- and post-scan	few self-reported hunger, satiety or related constructs appear to moderate fMRI-FCR in certain brain regions such as the amygdala and the orbitofrontal cortex; this results suggest that controlling for these constructs in the analyses of fMRI data derived from food-cue reactivity paradigms is likely to have minimal to no influence on the overall interpretation of findings in fMRI-FCR studies
Picchioni D. *et al.* 2008[14]	ascertainment differences in regional brain activity between stage-1 sleep immediately following wake and immediately preceding stage-2 sleep	brain activity between the first 30 s of stage 1 (early stage 1), the last 30 s of stage 1 (late stage 1), and isolated wake were compared; data were collected during daytime fMRI sessions with simultaneous EEG acquisition	activity in anatomically identifiable, volumetric brain regions exhibit differences during stage-1 sleep that would not have been detected with the EEG
Wang Y. *et al.* 2016[10]	restraint status modulated attentional bias to food cues and the different neural activations associated with these responses were study using fMRI	fMRI study was conducted in restraint eaters and unrestraint eaters exposed to high/low-energy food and neutral images while performing a two-choice oddball task	restrained eaters responded more quickly to high-energy food images than to neutral and low-energy food images; restrained eaters showed faster reaction times, hyperactivation in a much wider array of reward (e.g., insula/orbitofrontal cortex), attention (superior frontal gyrus) and visual processing (e.g., superior temporal gyrus) regions, and hypo-activation in cognitive control areas (e.g., anterior cingulate) in response to high-energy food cues; potential neural bases of restrained eaters may help clarify why dieting to lose or maintain weight is so often unsuccessful
Lange G. *et al.* 2005[15]	BOLD fMRI study of verbal working memory; study of cognitive complaints in Chronic Fatigue Syndrome (CFS)	BOLD signal changes between Controls and individuals with CFS who had documented difficulties in complex auditory information processing (Study 1) and those who did not (Study 2) in response to performance on a simple auditory monitoring and a complex auditory information processing task were compared in fMRI study	individuals with CFS are able to process challenging auditory information as accurately as Controls but utilize more extensive regions of the network associated with the verbal working memory system; individuals with CFS have to exert greater effort to process auditory information

Porubská K. *et al.* 2006[16]	the neuroanatomical correlates of eating behavior and its influences on the central nervous processing in humans were studied	fMRI technique was used to measure the cortical activation in lean healthy humans during visual stimulation with food-related and nonfood pictures after a fasting period of at least 5 h	the food stimuli elicited a significantly greater activity in the left orbitofrontal cortex and the insular/opercula cortex bilaterally with a stronger focus on the left side; ratings of appetite during the presentation of food-related stimuli modulated the activity in the insula bilaterally, the left operculum and the right putamen
van Duinen H. *et al.* 2007[17]	investigation effects of motor fatigue on brain activation in humans using fMRI	brain activation that correlated with muscle activity during brief contractions at different force levels and sustained contractions inducing motor fatigue were studied using fMRI; studied changes in brain activation due to motor fatigue over time; investigated cross-over effects of fatigue by comparing brain activation before and after the fatiguing condition during simple and high-order motor tasks using fMRI	several motor areas in the brain showed increased activity with increased muscle activity, both during force modulation and motor fatigue; after fatigue increased activation in orbitofrontal areas was found; the activity in the supplementary motor area and frontal areas is affected by motor fatigue
Jacobson A. *et al.* 2010[18]	examination age-related changes in gustatory processing during hedonic assessment	caffeine, citric acid, sucrose, and NaCl were administered orally during two event-related fMRI sessions, one during hunger and one after a pre-load	increased activity of the insula was seen in both age groups during hunger; hunger and satiety differentially affected the hemodynamic response, resulting in positive global activation during hunger and negative during satiety in both age groups; in a state of hunger, the frequency and consistency of positive activation in gustatory and reward processing regions was greater in older adults
Tsai PJ. *et al.* 2014[19]	the sleep regulation a network-specific process and the awakening state dependent on the previous sleep stages were studied	simultaneous EEG and fMRI recordings healthy male participants, along pre-sleep, nocturnal sleep and awakening were studied	the regional specificity and the stage effect were verified in support of the local awakening concept; sleep regulation leads to the reorganization of brain networks upon awakening
Thomas R.J. 2005[20]	to demonstrate dynamic changes in cerebral functional activation during a working memory task in a state of severe excessive daytime sleepiness	fMRI was used to map cerebral activation during the performance of a 2-back verbal working memory task; scans were performed, until the subjects felt they could not continue	fatigue in the executive cortical network may be demonstrated by a progressive reduction in regional cerebral activation across scans, which may be prevented by stimulant use
Wirsich J. *et al.* 2017[21]	resting-state fMRI to explored the whole brain functional connectivity effects of modafinil, donepezil and memantine in normal and sleep-deprived brain states in order to reveal the functional subnetworks modified by these medications, while controlling for sleep stages extracted from a simultaneous EEG recording	simultaneous EEG-fMRI in order to investigate the effects of donepezil and memantine before and after sleep deprivation (SD); the SD approach has been previously proposed as a model for cognitive impairment in healthy subjects	a network linked to sleep is interacting with sleep deprivation but not with medication intake; donepezil induced whole brain connectivity alterations forming a network separated from the changes induced by sleep and SD; a result shows possibilities to check for the validity of pharmacological resting-state analysis of the tested medications without the need of taking into account the subject specific vigilance

watch 3D or 2D television chessboards. The stimulus of the study was 2 hours in duration. Analysis of the results confirmed that subjects watching 3D TV had visual fatigue. This was also confirmed by an analysis of fMRI images showing that long-term 3D TV viewing leads to larger changes in activated brain regions than those in a 2D TV viewing group. In a paper from 2016, the existence of a mechanism was postulated that compensates for fatigue in the brain and which attempts cognition. [10] Understanding the compensation mechanism

can be helpful in understanding the phenomenon of fatigue itself and to therapeutic actions. In their research, they indicated the frontal lobe as the region responsible for the compensation mechanism. At the moment, research is being carried out in several centers concerning the mechanisms of fatigue. Understanding the mechanism of fatigue in the brain by fMRI and the postulated compensating mechanism will be very important for improvements in the quality of life for patients suffering from chronic fatigue syndrome.

Conclusion

Functional MRI has many clinical applications and is used to validate neuroimaging, and to search for brain markers in psychiatry, which makes it a technique at the borderline of clinical and experimental-methodological sciences. Blood Oxygenation-Level Dependent contrast is one of the best-known techniques of fMRI that can be used to map blood oxygenation in the brain. The use of this technique allows for identification of brain tumors and patients with epilepsy. This technique demonstrates early promise and can also play a role in providing future diagnostic and prognostic information in patients with neurological and psychiatric diseases and opens up a wide range of possibilities for chronic fatigue syndrome testing.

Acknowledgments

Dorota Bartusik-Aebisher acknowledges support from the National Center of Science NCN (New drug delivery systems-MRI study, Grant OPUS-13 number 2017/25/B/ST4/02481).

References

1. Jodzio K, Treder N. Poglądy na przewlekłe zmęczenie i jego wpływ na zachowanie w XIX wieku i na początku XX wieku [Ideas about chronic fatigue and its impact on behaviour in nineteenth century and at the beginning of the twentieth century]. *Psychiatria i Psychoterapia*. 2014;10:11-22.
2. Rocca MA, Parisi L, Pagani E, et al. Regional but not global brain damage contributes to fatigue in multiple sclerosis. *Radiology*. 2014;273(2):511-20.
3. Möller MC, Nordin LE, Bartfai A, et al. Fatigue and cognitive fatigability in mild traumatic brain injury are correlated with altered neural activity during vigilance test performance. *Front Neurol.* 2017;8:496.
4. Pardini M, Bonzano L, Mancardi GL, et al. Frontal networks play a role in fatigue perception in multiple sclerosis. *Behav Neurosci.* 2010;124(3):329-36.
5. Wang C, Trongnetrpunya A, Samuel IB, et al. Compensatory neural activity in response to cognitive fatigue. J Neurosci. 2016;36(14): 3919-24.
6. Menning S, de Ruiter MB, Veltman DJ, et al. Changes in brain activation in breast cancer patients depend on cognitive domain and treatment type. *PloS one.* 2017;12(3):e0171724.
7. Chen C, Wang J, Li K, et al. Visual fatigue caused by watching 3DTV:an fMRI study. *Biomed Eng online*. 2015;14(1):12.
8. Asano M, Finlayson ML. Meta-analysis of three different types of fatigue management interventions for people with multiple sclerosis: exercise, education, and medication. *Mult Scler Int.* 2014;2014:798285.
9. Hampson JP, Zick SM, Khabir T, et al. Altered resting brain connectivity in persistent cancer related fatigue. *NeuroImage Clin.* 2015;8:305–313.
10. Wang Y, Dong D, Todd J, et al. Neural correlates of restrained eaters' high susceptibility to food cues: An fMRI study. *Neurosci Lett.* 2016; 631:56–62.
11. Frank S, Laharnar N, Kullmann S, et al. Processing of food pictures: influence of hunger, gender and calorie content. *Brain Res.* 2010;1350:159–166.
12. Vocks S, Herpertz S, Rosenberger C, et al. Effects of gustatory stimulation on brain activity during hunger and satiety in females with restricting-type anorexia nervosa: An fMRI study. *J Psych Res.* 2011;45(3):395-403.
13. Chin SH, Kahathuduwa CN, Stearns MB, et al. Is hunger important to model in fMRI visual food-cue reactivity paradigms in adults with obesity and how should this be done? *Appetite*. 2018;120:388-397.
14. Picchioni D, Fukunagab M, Carr WS, et al. fMRI differences between early and late stage-1 sleep. *Neurosci Lett.* 2008;441(1):81–85.
15. Lange G, Steffener J, Cook DB, et al. Objective evidence of cognitive complaints in Chronic Fatigue Syndrome: A BOLD fMRI study of verbal working memory. *NeuroImage*. 2005;26(2):513–524.
16. Porubska´K, Veit R, Preissl H, et al. Subjective feeling of appetite modulates brain activity: An fMRI study. *NeuroImage.* 2006;32(3):1273 –1280.
17. van Duinen H, Renken R, Maurits N, et al. Effects of motor fatigue on human brain activity, an fMRI study. *NeuroImage.* 2007;35(4):1438–1449.
18. Jacobson A, Green E, Murphy C. Age-related functional changes in gustatory and reward processing regions:An fMRI study. *NeuroImage.* 2010;53(2):602–610.
19. Tsai PJ, Chen SC, Hsu CY, et al. Local awakening: Regional reorganizations of brain oscillations after sleep. *NeuroImage.* 2014;102(2):894–903.
20. Thomas RJ. Fatigue in the executive cortical network demonstrated in narcoleptics using functional magnetic resonance imaging - a preliminary study. *Sleep Med*. 2005;6(5):399–406.
21. Wirsich J, Rey M, Guye M, et al. Brain networks are independently modulated by donepezil, sleep, and sleep deprivation. *Brain Topogr*. 2017:23. doi: 10.1007/s10548-017-0608-5.

ISSN 2544-1361 (online); ISSN 2544-2406

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2018; 16 (3): 245–248

Instructions for Authors

ETHICAL GUIDELINES

The Editorial Office of the European Journal of Clinical and Experimental Medicine (Eur J Clin Exp Med) acknowledges the Declaration of Helsinki guidelines, therefore the Authors are expected to ensure that every research conducted with the participation of men follows the abovementioned rules. It is also required to present a consent of the bioethical committee for performing experiments on people or animals.

SCIENTIFIC RELIABILITY

Ghost-writing and guest authorship are a manifestation of scientific dishonesty. Ghostwriting is a significant impact into preparing an article without revealing it, listing as one of the authors or without being addressed in the notes. Guest authorship (honorary authorship) is when author's participation in the article is little or none and even though the person is named as an author or co-author of the article. To prevent ghostwriting and guest authorship the Editorial Office reports such events by notifying appropriate subjects (institutions employing authors, scientific associations, scientific editors associations, etc.).

PROCEDURE OF REVIEWING

The procedure of reviewing articles lies in compliance with the instructions of the Ministry of Science and Higher Education 'Good practices in reviewing procedures in science' Warsaw, 2011.

By sending their manuscript to the European Journal of Clinical and Experimental Medicine Editorial Office the Authors express their consent to begin the reviewing process and are obliged to propose four Reviewers (name, institution and e-mail address). There can be no conflict of interest between the Author and the proposed Reviewers. They also cannot be associated with the same institution. The Editorial Office reserves the right to choose the reviewers.

Sent publications are subject to an initial evaluation by the Editorial Office. The journal reserves the right to refuse to review the work without asking the reviewers for their opinion, if in the view of the Editorial Staff the paper's essential value or its form does not meet the requirements, or if the theme of the article does not comply with the journal's profile. An incomplete set of documents or articles which are not prepared accordingly to the standards will be sent back to the Authors before the reviewing process along with the information about the deficiencies.

Articles are reviewed by at least two independent reviewers. Manuscripts are accepted if both reviewers agree that the work can be published in its present form. In case of any discrepancies between the two reviewers the paper is directed to the third reviewer, whose decision is final.

The papers are not sent to reviewers working for the same institution as the Author or to people who can remain in conflict of interest with the Author. The papers sent for reviewing are confidential and anonymous (the so-called „double blind review"). Each article is given an editorial number allowing for further identification in the publishing process. The Authors are informed about the results of the reviewing process and receive the actual reviews. The Authors can log on to the system and check at what stage of the process their manuscript is.

Ultimately, the decision concerning accepting the article for publication, accepting for amending or rejecting the article is made by the Editor. The decision cannot be appealed.

A list of all of the reviewers of the published works is announced once a year (http://www.ejcem.ur.edu.pl/en/reviewers-list).

It is required to present a written consent for reprint from a previous publisher for any materials that were published previously (tables, figures). If information in the case description, illustrations or the text allow for identifying any people, their written consent should be delivered.

PREPARING THE ARTICLE

Technical requirements:
The text of a work: interline 1.5, font Times New Roman, 12 points.
Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).
Volume of original, systematic reviews/ reviews papers should not exceed 20 pages, and of clinical observations - 8 pages of a standard computer text (1800 signs on a page).

THE TITLE PAGE

The following information should be given on the **TITLE PAGE:**

- A complete title of the article (max 50 words), titles and subtitles should not be put into quotation marks and ended with a full stop.
- Abbreviated title of the article (*Running Head*).
- Names, last names of the Authors (without degrees and titles).
- Affiliations and participation of all of the Authors (according to a pattern below**).
- Detailed data: name, last name, address, telephone, and email address of the person responsible for preparation of the paper for publication and contact with the Editor.
- The title page should also give information about a source of funding the research (grants, donations, subventions etc.) and conflict of interest.

** A participation in preparation of the article should be determines in accordance with the following categories:
A. Author of the concept and objectives of paper
B. collection of data
C. implementation of research
D. elaborate, analysis and interpretation of data
E. statistical analysis
F. preparation of a manuscript
G. working out the literature
H. obtaining funds

Example:
Jan Kowalski[1 (A,B,C,D,E,F,G)], Anna Nowak[1,2 (A,B,C,E,F)], Adam Wisniewski[1 (A,B,E,F)]
1. The Institute of Physiotherapy, University of Rzeszow, Poland
2. Centre for Innovative Research in Medical and Natural Sciences', Medical Faculty of University of Rzeszow, Poland

The **MAIN BODY** of the manuscript should contain:

- A full title of the article.
- 3–6 keywords, chosen in compliance with the MeSH system (Medical Subject Headings Index Medicus http://www.nlm.nih.gov/mesh/MBrowser.html). Keywords cannot be a repetition of the title. Give a list of Abbreviations in alphabetical order.
- Abstract, which should be maximum 200 words and present a structural construction.

ARRANGEMENT OF TEXT

An original article should contain the following elements:

- Introduction
- Aim of the study
- Material and methods
- Results (used statistical methods should be described in detail in order to allow for verifying the results)
- Discussion
- Conclusion
- References

Case study should contain the following elements:

- Introduction
- Case description
- Discussion
- A summary
- References

Systematic review should contain the following elements:

- Introduction
- Description of the subject literature (a source of publication, data range)
- Analysis of the literature
- A summary
- References

Review article should contain the following elements:

- Introduction
- Body of the subject matter (the problem)
- Conclusion
- References

REFERENCES/ EXAMPLES OF CITATION

References should be prepared according to the AMA style. The list of references should be placed at the end of an article and prepared according to the order of citation in the text.
Citations in the article should be placed after a sentence ending with a full stop and edited as the so called 'superscript'. In-text citations should only be placed at the end of a sentence or a paragraph, not in the middle.
Examples:

- The degree of respiratory muscles fatigue depends on the applied exercise protocol and the research group's fitness level. [1, 2] The greatest load with which a patient continues breathing for at least one minute is a measure of inspiratory muscles strength.[3]
- Diabetes mellitus is associated with a high risk of foot ulcers.[4-6]

A citation should contain a maximum of 6 authors. Wnen an article has more than six authors, only the first three names should be given by adding 'et al.'. If the source

does not have any authors, the citation should begin with the title.

Journal titles should be given in brief according to the Index Medicus standard.

The number of sources cited for an opinion article/ a review article should be between 40 and 50, and from 20 to 40 for other articles. A minimum of 50 % of literature should come from the last 5 years.

The following are examples of individual citations made according to the required rules of editing and punctuation:

Article from a journal, number of authors from 1 to 6	Lee JC, Seo HG, Lee WH, Kim HC, Han TR, Oh BM. Computer-assisted detection of swallowing difficulty. Comput Methods Programs Biomed. 2016;134:79-88. de Kam D, Kamphuis JF, Weerdesteyn V, Geurts AC. The effect of weight-bering asymmetry on dynamic postural stability in people with chronic stroke. Gait Posture. 2016;53:5-10.
Article from a journal, number of authors more than 6	Gonzalez ME, Martin EE, Anwar T, et al. Mesenchymal stem cell-induced DDR2 mediates stromal-breast cancer interactions and metastasis growth. Cell Rep. 2017;18:1215-28. Jordan J, Toplak H, Grassi G, et al.Joint statement of the European Association for the Study of Obesity and the European Society of Hypertension: obesity and heart failure. J Hypertens. 2016;34:1678-88.
Article from an online journal	Coppinger T, Jeanes YM, Hardwick J, Reeves S. Body mass, frequency of eating and breakfast consumption in 9-13-year-olds. J Hum Nutr Diet. 2012;25:43-9. doi: 10.1111/j.1365-277X.2011.01184.x. Cogulu O, Schoumans J, Toruner G, Demkow U, Karaca E, Durmaz AA. Laboratory Genetic Testing in Clinical Practice 2016. Biomed Res Int. 2017;2017:5798714. doi: 10.1155/2017/5798714.
Websites	Cholera in Haiti. Centers for Disease Control and Prevention Web site. http://www.cdc.gov/haiti-cholera/. Published October 22, 2010. Updated January 9, 2012. Accessed February 1, 2012. Address double burden of malnutrition: WHO. World Health Organization site. http://www.searo.who.int/mediacentre/releases/2016/1636/en/. Accessed February 2, 2017.
Book	Naish J, Syndercombe Court D. Medical Sciences. 2nd ed. London, Elsevier;2015. Modlin J, Jenkins P. Decision Analysis in Planning for a Polio Outbreak in the United States. San Francisco, CA:Pediatric Academic Societies;2004.
Chapter in a book	Pignone M, Salazar R. Disease Prevention & Health Promotion. In: Papadakis MA, McPhee S, ed. Current Medical Diagnosis & Treatment. 54th ed. New York, NY: McGraw-Hill Education; 2015:1-19. Solensky R. Drugallergy: desensitization and Treatment of reactions to antibiotics and aspirin. In: Lockey P, ed. Allergens and Allergen Immunotherapy. 3rd ed. New York, NY: Marcel Dekker; 2004:585-606.

NOTE: The editorial board requires consistent and carefully made references prepared according to the above-mentioned AMA standards. Otherwise, the work will be sent back to the authors.

TABLES AND FIGURES

All tables and figures should be inserted in the text. They must have captions.

Tables should have the Arabic Numerals and a caption inserted above a table, in the sequence of appearance of the first reference in the text. One should ensure whether every table is mentioned in the text. When constructing tables, avoid vertical separators.

Figures should have the Arabic Numerals and a caption placed under it. They should be numbered in a sequence of appearance of the first reference in the text. One should ensure whether every figure is mentioned in the text.

If a given figure has already been published, one should give a source and obtain a written consent from a person having copyrights for reprinting the material, with the exception of documents constituting public interest.

ABBREVIATIONS AND SYMBOLS

The Editorial Staff requires using only standard abbreviations. One should not use abbreviations in the title and in the abstracts. A full version of a term, for which a given abbreviation is used must be given before the first appearance of the abbreviation in the text, with the exception of standard units of measurement.

The abbreviation used for European Journal of Clinical and Experimental Medicine is Eur J Clin Exp Med.

The Editorial Staff reserves itself a possibility to introduce amendments without contacting the Author.

The Authors and the reviewers do not receive any compensation for publishing the article.

The Editorial Office does not charge the Authors for publishing the article in the journal.

Papers written incompatibly with the rules determined in the hereby Instructions cannot be published in the European Journal of Clinical and Experimental Medicine.

INSTRUCTIONS FOR SUBMITTING THE MANUSCRIPT

The Editorial Office accepts articles English language. The Authors whose Polish-language article is qualified for

publications are required to translate it into English within 10 days following the date of receiving the information about the article being accepted for publication.

To send the article to the Editor one should use the system ScholarOne Manuscripts which can be found on https://mc04.manuscriptcentral.com/pmur

To submit an article the Author has to be signed in the aforementioned system. The account can be created by clicking on *Register here*.

During the registration one should state his or hers scientific degree, first name, last name, email address. Next one should give his or hers address country, city and postal code. Finally one should set a password and click *Finish*. If the user already has an existing account it is enough to log in at the journal's web site and enter the Author Center.

After logging on to the system, the Authors are obliged to fill standard declarations (check list) concerning funding source, a declaration not to publish the article in other journals, complying with ethical guidelines, consents from all the Authors, transferring copyright, declaration confirming reading the instructions for Authors as well as declaration of revealing any conflict of interest.

The instruction and help can be found on the website: http://mchelp.manuscriptcentral.com/gethelpnow/training/author (Author User Guide file).

SUBMITTING AN ARTICLE

To start sending a new article log in to your user account and click on *Click here to submit a new manuscript* in *Author Resources*.

Step 1. The type, Title & Abstract
At this stage you should choose the type of the article, type in the title, abbreviated title (*Running Head*) and the abstract.

Step 2: Attributes
You should insert 3 key words related to the article.

Step 3: Authors & Institutions
Optionally, you can give the names of all the Authors (it is not necessary). In *Add Author* you should find a co-author by typing his or hers email address. If the co-author does not have an existing account in the system you should click on *Create a new co-author* and follow the instructions.

Step 4: Reviewers
You should pinpoint **four** proposed recommended Reviewers (name, institution and email address). The reviewers **cannot be** in any conflict of interest with the Authors and **cannot** come from the same facility as the Authors. To add a proposed reviewer click on *Add Reviewer.*

Step 5: Details & Comments
During this stage you can add a *Cover Letter*. If there are any funding sources you should list them in *Funding*. In the Check List you should give information concerning: the number of figure, the number of tables, the word count, and confirmation of the declarations: no previous publications of the article, fulfilling ethical requirements, consent of all the Authors for publishing, transferring the copyright, familiarizing with the Instruction for Authors, translating the paper to English and revealing any conflict of interest.

Step 6: File Upload
You should send the article in **two files.** In *FILE DESIGNATION* you should choose *Title Page*, then click *Select File 1* and choose the appropriate document. In *FILE DESIGNATION* you should choose *Main Document,* then click *Select File 2* and choose the main body document. Then click: *Upload Selected Files.*

Step 7: Review & Submit
You should check if the information concerning the metadata is correct. You should click *View PDF proof* and then confirm by clicking *Submit.*

Sending the manuscript continuation:
To continue sending the manuscript click *Unsubmitted and Manuscripts in Draft* in *My Manuscripts* and then click *Click here* to submit a revision.

Revised Manuscripts:
To send an amended manuscript click ‚*Manuscripts with Decision*' in *My Manuscripts* and then click *Click here* to submit a revision.

Checking the status of manuscript:
To check on the status of the article click *Submitted Manuscripts* in *My Manuscripts*. The status of all the sent manuscripts can be checked in *My Manuscripts*.

For the Authors sending their articles to the European Journal of Clinical and Experimental Medicine via the ScholarOne Manuscripts system there is a manual and help which can be found on http://mchelp.manuscriptcentral.com/gethelpnow/training/author/