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PART I. DISEASES AND PROBLEMS DISTINGUISHED BY WHO AND FAO  
DZIAŁ I. CHOROBY I PROBLEMY WYRÓŻNIONE PRZEZ WHO I FAO

DEMENTIA IN THE AGING POPULATION OF POLAND:  
CHALLENGES FOR MEDICAL AND SOCIAL CARE

ZESPOŁY OTĘPIENNE W STARZEJĄCYM SIĘ SPOŁECZEŃSTWIE POLSKI  
JAKO PROBLEM MEDYCZNY I SPOŁECZNY

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Summary

With a projected rise in the percentage of elderly people in the population of Poland, the incidence of neurodegenerative diseases, including dementia, will increase. The aim of this paper is to present dementia as an increasing health and social problem in the aging Polish population. In 2015, the number of people with dementia of the Alzheimer's type in Poland was estimated to be between 360,000 and 470,000, which indicates a growth of almost 20% compared to 2005. The onset of dementia symptoms causes a relatively rapid impairment of patients' daily functioning, creating the need for assistance by others. In Poland, caring for an elderly person with dementia is primarily non-institutional and provided by the closest family members in a home setting. Due to the shrinking care potential of Polish families, one should expect a growing need for formal forms of support to ensure proper care for elderly individuals with dementia. At present, Poland has a poorly developed system of formal assistance for dependent elderly people and the existing infrastructure of formal care services includes only a small proportion of potential beneficiaries. The prospect of further aging of the Polish population along with the growing risk of dementia and the shrinking family care potential justify the development and implementation of a comprehensive Alzheimer's Plan at the central and local level of our country.

**Keywords:** dementia, population aging, formal and informal care

Streszczenie

Wraz z prognozowanym wzrostem odsetki osób w starszym wieku w populacji Polski, rosnąć będzie częstość występowania chorób neurodegeneracyjnych, w tym zespołów otępiennych. Celem pracy jest przedstawienie otępienia jako narastającego problemu medycznego i społecznego w starzejącej się populacji Polski. W 2015 r. liczbę osób z otępieniem typu alzheimerowskiego w Polsce szacowano w przedziale 360-470 tys., co oznacza wzrost o niemal 20% w porównaniu do 2005 r. Wystąpienie objawów otępiennych dość szybko upośledza codzienne funkcjonowanie chorego, rodząc konieczność zapewnienia pomocy ze strony innych osób. W Polsce opieka nad osobą starszą z otępieniem to głównie opieka pozainstytucjonalna, sprawowana przez członków najbliższej rodziny we własnym domu. Ze względu na zmniejszający się potencjał pielęgnacyjny polskich rodzin, należy spodziewać się coraz większego zapotrzebowania na formalne formy wsparcia w opiece nad osobami starszymi z otępieniem. Na obecną chwilę Polska jest państwem o słabo rozwiniętym systemie formalnej pomocy dla niesamodzielnych osób starszych, a istniejąca infrastruktura formalnych usług opiekuńczych obejmuje margines potencjalnych świadczeniobiorców. Ze względu na prognozowane dalsze starzenie się populacji Polski, rosnące ryzyko wzrostu zachorowań na otępienie oraz zmniejszający się potencjał opiekuńczy rodziny konieczne jest stworzenie i wdrożenie kompleksowego Planu Alzheimerowskiego, zarówno na poziomie centralnym jak i lokalnym naszego kraju.

**Słowa kluczowe:** otępienie, starzenie się populacji, opieka formalna i nieformalna

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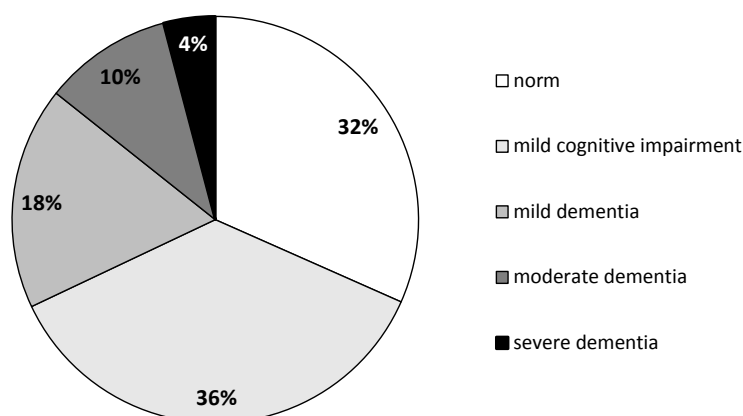
## Introduction

There is an urgent need to improve understanding and awareness of dementia across all levels of Polish society. This is especially true for health and social policy makers, who have an opportunity to improve the quality of life of both patients with this devastating disease and their caregivers. In 2012, the WHO declared dementia to be a public health issue in the face of rapid global population aging [1]. Although the condition mainly affects older people, it is not part of normal aging.

### *Demographics and epidemiology of dementia in Poland*

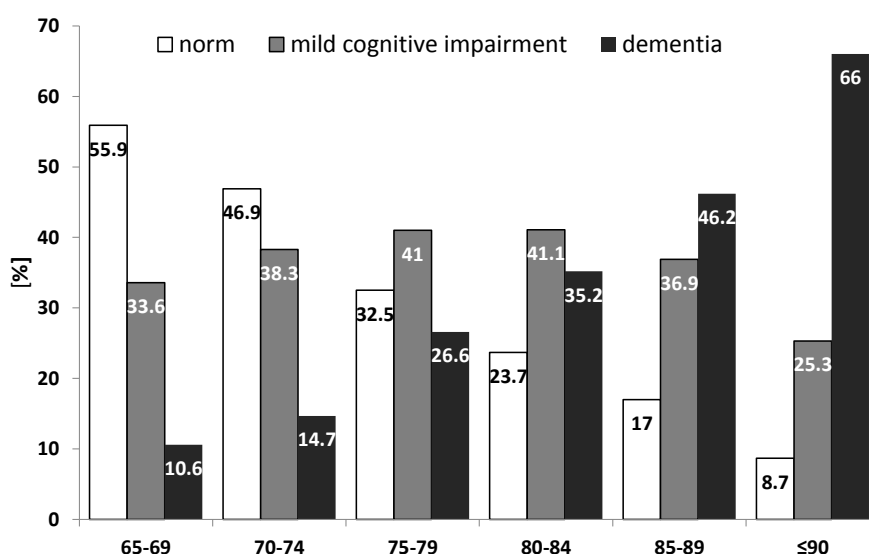
The process of aging has become more noticeable in the Polish population and the growth rate of the aged population is likely to increase in the near future. According to data from the Central Statistical Office (GUS), there were about 6.5 million people aged  $\geq 65$  years in Poland in 2017, accounting for 17% of the total population [2], and the number is expected to nearly double to over 11 million (32.7%) by 2050 [3]. Moreover, the percentage of the oldest old (80+) will increase within this time frame from 1.63 million (4.2% of the general population in 2017) to 3.54 million (10.4% in 2050). Along with the aging of the population, the risk for neurodegenerative diseases, including dementia, rises. The prevalence of dementia dramatically increases in the older and oldest age groups [4], and the incidence rates for dementia including dementia of the Alzheimer's type (DAT) increase across the 5-year age groups from 2.8 per 1000 person-years within 65-69 years up to 56.1 per 1000 person-years in the older than 90-year group [5].

In Poland, epidemiological studies on dementia are scarce and limited to selected urban environments. The PolSenior study, which was conducted 10 years ago and involved cognitive function screening, was the only epidemiological analysis of dementia covering the entire Polish population. The study included 4,979 respondents aged 65+ years divided into six 5-year cohorts, and 716 respondents aged between 55 and 59 years. The Mini-Mental State Examination and the Clock Drawing Test were used to assess cognitive function. Among people aged 65+, cognitive impairment of varying severity was detected in 68.4% of the respondents and normal cognitive function in only 31.6% of the respondents (Figure 1). Dementia was diagnosed in one in 10 respondents (10.6%) and mild cognitive dysfunction was observed in every third respondent (33.6%) in the 65-69-year-old cohort. In the oldest cohort (90+ years), normal cognitive function was reported for only 8.7% of the respondents, mild cognitive impairment for 25.3%, and dementia for 66% (Figure 2) [6]. Nevertheless, from the epidemiological point of view, the cohort design of the study precludes the precise estimation of dementia prevalence in Poland due to an over-representation of the condition in the oldest old and an under-representation of the disease in the youngest age groups. In 2015, the number of people with DAT was estimated in the range of 360-470 thousand [7, 8], which indicates a growth of almost 20% compared to 2005. It is emphasized that while in the years 2005–2010 the annual growth rate of new DAT cases remained at a level not exceeding 2%, while in 2010–2015 this rate was already 3%–4% [8]. The increase in these parameters is likely due to the aging of the population and probably an increase in society's awareness about brain diseases leading to dementia. On the other hand, the true prevalence of dementia in Poland is most probably much higher due to missed or delayed diagnoses, as it is in other countries [9].



**Figure 1.** Cognitive status of older Polish population – results of the PolSenior study

Source: Klich-Rączka A, Siuda J, Piotrowicz K, Boczarska-Jedynak M, Skalska A, Krzystanek E, et al. [Cognitive impairment in the elderly]. In: Mossakowska M, Więcek A, Błędowski P, editors. [Medical, psychological, sociological and economic aspects of population aging in Poland]. Poznań: Termedia Wydawnictwa Medyczne; 2012. p. 112 (in Polish).



**Figure 2.** Cognitive status of older Polish population divided into age groups – results of the PolSenior study

Source: Klich-Rączka A, Siuda J, Piotrowicz K, Boczarska-Jedynak M, Skalska A, Krzystanek E, et al. [Cognitive impairment in the elderly]. In: Mossakowska M, Więcek A, Błędowski P, editors. [Medical, psychological, sociological and economic aspects of population aging in Poland]. Poznań: Termedia Wydawnictwa Medyczne; 2012. p. 114 (in Polish).

Due to the rapid increase in the number of older adults in the Polish population, there seems to be an urgent need for early diagnosis and treatment of dementia, as well as the development of a service support network not only for patients, but above all for the family caregivers of those afflicted with dementia. The current solutions of the senior policymakers in Poland fail to address the specifics of dementia-related problems. The key government programs for seniors, both those already implemented (“The Assumptions of the Long-Term Senior Policy in Poland for the period 2014–2020”, “Program for Social Activity of Older People for the years 2014–2020”) as well as those planned (“Social Policy for Older People 2030. Safety-Participation-Solidarity”) lack solutions for both people affected by dementia and their caregivers. In 2011, at the initiative of the Polish Alliance for Alzheimer’s Organizations, a project was developed for the 2011 National Alzheimer’s Program for Poland. This included recommendations for the organization of medical and social assistance for elderly people with dementia [10]. Thus far, however, this document has not been given a legal framework by public authorities, which could be the first step towards the systemic solving of the health and care problems of people with dementia. It should be added that Alzheimer’s Plans have long been adopted in many European countries.

### The aim of the work

The aim of this paper is to present dementia as an increasing health and social problem in the aging Polish population by investigating the nature of dementia and its impact on health and social services as well as informal caregiving.

### Dementia as a medical problem

#### *Definition and types of dementia*

Dementia is a clinical syndrome of brain disease involving gradual and progressive memory loss in line with other cognitive disorders that cause difficulties in daily living, with the exception of consciousness confusions (ICD-10). The typical presentation of dementia, apart from memory deterioration, is: problems with spatial orientation, language, judgment, reasoning (including prominent apraxia), and executive functions causing difficulties in daily living [11]. It has been shown that DAT is the most common cause of dementia in older age [1]. The course of the disease is progressive and long-lasting, usually beginning from a clinically asymptomatic stage lasting even several years or mimicking age-associated memory impairment through gradually progressing signs of impaired cognition (mild cognitive impairment) to the core symptoms of dementia [12]. The variety of symptoms changes with the phase of the disease, which is accompanied by anxiety, agitation and/or behavioral

disorders. The medical diagnosis of probable DAT is usually delayed due to social unawareness of dementia, the insidious onset of the disease, lack of proper knowledge in family practitioners and unsatisfactory access to specialists in Poland. The diagnostic process is complex and time consuming. It is important to rule out treatable and potentially reversible causes of dementia in individual patients, including depression, drug-induced memory loss, delirium, sleep apnea, recurrent hypoglycemia, vitamin B12 deficiency, hypothyreosis, and others, although this group of cognitive disorders accounts for a rather small proportion of potentially reversible dementias.

In the older population, most dementia results from DAT coexisting with multi-infarct dementia (MID). The latter presents as recurrent small cortical or subcortical strokes that are too small to manifest focal neurological deficits, however they may play an important role in the occurrence and severity of DAT symptoms. MID and DAT both frequently coexist in the same persons [13]. Other types of dementia are next most common, like dementia with Lewy bodies (DLB) and Parkinson's dementia. They account for up to 25% of all dementias and symptoms may overlap with DAT and MID [14]. Also, frontotemporal dementia, progressive supranuclear palsy, corticobasal degeneration, normal pressure hydrocephalus, and others should be ruled out. The most prevalent types of dementia share typical features, however they differ in the character of symptoms, sequence of symptoms, associated signs and behaviors.

Depressive *pseudodementia* is a term referring to patients who have mostly reversible impairments of cognitive function due to depression. Depression may precede or coexist with dementia and can produce cognitive deficits. A careful trial of an antidepressant is justified to improve overall functioning and quality of life.

#### *Clinical picture and stages of dementia*

According to ICD-10, the stages of dementia severity for any type of dementia are described as mild, moderate, or severe.

- In the mild stage of dementia, the person is able to function independently, although they have memory lapses that affect daily life, like forgetting words and recent events or misplacing things. Typical signs of the mild stage of dementia are memory loss of recent events, changes in personality (more subdued or withdrawn), difficulties with problem-solving tasks, managing finances, and organizing or expressing thoughts.
- In moderate dementia, people need more assistance in daily functioning. Performing daily activities and self-care (getting dressed, bathing, and grooming) becomes harder. A progression of memory loss, confusion, poor judgement, agitation, unfounded suspicion and changes in sleep patterns can be observed.
- In the severe stage of dementia, further deterioration of cognitive functioning is observed. A severe loss of the ability to communicate dominates along with disabilities in basic activities of daily living (eating, swallowing) and failure in bladder and bowel control.

Disruptive behavior like aggression (verbal and/or physical agitation, aggression, delusions or hallucinations, poor hygiene, insomnia, incontinence) or confusion can co-occur in all stages of dementia, quite frequently precipitated by environmental or potentially modifiable factors (noise, darkness, sleep disorders, urinary or other infections, inappropriate medications, etc.). They require an adjusted approach and substantial engagement of family members.

#### *Dementia as a major cause of disability in later life*

According to the Global Burden of Disease, dementia is one of the main causes of disability in older adults. It contributes to 11.2% of all years lived with disability compared with stroke (9.5%), musculoskeletal disorders (8.9%), heart diseases (5%), and cancer (2.4%) [15].

#### *Early diagnosis of dementia, a condition for early management and care planning*

In contrast to other long-term diseases, dementia screening, diagnosing, management and care currently constitutes only a small proportion of the general practitioner's (GP) time and workload. In Poland, dementia is rarely suspected by a GP, especially in the first phase of the disease when a patient may complain about many other co-existing conditions. Any postponement of the right diagnosis delays proper treatment and care, which results in further neuropsychological degradation and disability in daily living. The problem of underdiagnosing dementia in Poland probably results from the lack of specialty knowledge and diagnostic skills in primary care medical staff, as well as the case-complexity and inability to access specialists (geriatricians, neurologists, psychiatrists). A dementia diagnosis is a shared responsibility between the GP and specialists [16]. Dementia



in older adults is usually one of many chronic conditions. The first signs of the disease may be masked by other health conditions and atypical complaints.

Proper treatment, management and care plans for people with dementia depend on the type of dementia from the beginning. The diagnostic process is long and time-consuming due to the need to complete many additional examinations, including assessment for delirium and depression, identification of other chronic conditions (e.g. sensory impairment), functional assessments, mental status examination, and laboratory examinations to rule out potentially reversible causes of dementia and delirium. The process goes beyond primary care. The patient requires a referral to a specialist (geriatrician, neurologist, or psychiatrist) and many tests. The results of selected laboratory examinations, computed tomography or magnetic resonance imaging of the head, as well as neuropsychological testing are complex. Obtaining and interpreting them is time-consuming. The examinations are extended in time and engage many professionals, but the process is an essential prerequisite for establishing the most probable reason for dementia.

#### *General principles of dementia management*

After diagnosing dementia, the patient and his family must be involved in developing a care plan to address the health and care problems and their implications. The plan should be flexible, allowing for any revision appropriate to the circumstances. The components of dementia management are as follows:

- optimize the patient's physical and mental functions through physical activity,
- provide ongoing care and treatment of underlying conditions (e.g. Parkinson's disease, depression, hypertension and other cardiovascular diseases, diabetes), avoiding drugs with adverse effects in the central nervous system,
- assess the environment and provide advice on any changes, if needed,
- inform and prepare the person for changes in location,
- avoid stressful situations and be friendly towards the patient,
- identify and manage behavioral symptoms and complications (wandering, dangerous driving, agitation, aggressiveness, malnutrition, incontinence),
- provide information to the patient and family (about the disease, extent of impairment, prognosis),
- provide social service information to the patient and family caregivers,
- protect the caregiver from burnout and other effects of caregiver stress.

#### *Pharmacological management*

The approach to pharmacological treatment of dementia involves four rules:

1. avoid drugs that worsen cognitive function, especially those with anticholinergic activity,
2. use medications that enhance cognitive functions (donepezil, rivastigmine, memantine),
3. treat coexisting depression,
4. drug treatment of complications like paranoia, delusions, psychosis, agitation.

Antidepressants may provide benefits in patients with dementia [15, 17]. Antipsychotic treatment in dementia is highly controversial due to the high risk of death. It is better to find a potential underlying cause that precipitates the behavioral or psychotic complications to be eliminated. Experimental use of paracetamol sometimes provides symptom resolution, since pain may be especially hard to detect in demented patients.

#### **Dementia as a social problem**

The onset of dementia symptoms causes a relatively rapid impairment of patients' daily functioning, forcing the need for assistance provided by others. The provided care becomes increasingly absorbing and challenging as the disease progresses. In the early stages of the disease, the assistance is provided mainly in the area of more complex activities, such as making payments and administering medications, etc. Over time, however, assistance is needed even when performing simple daily activities, such as self-care or meal preparation. In the most advanced stages of dementia, patients are unable to function independently and require 24-hour care [18]. Due to behavior disorders (wandering, aggression, cursing) and psychotic symptoms (hallucinations, delusions) which frequently accompany dementia, the care poses a particular challenge.

### *Family caregiving*

Dementia affects the functioning of entire families faced with the need to provide demanding care for their afflicted relatives. In Poland, caring for an elderly person with dementia can be primarily described as non-institutional and provided by the closest family members in a home setting. Typically, one person in the family becomes the main caregiver, carrying the basic burden of care and responsibility. This often leads to negative consequences in the form of social isolation, neglect of their own needs, and often diseases [19]. Usually spouses or children (predominantly women) of the affected individuals become the caregivers [8, 20]. They are often older adults themselves, who also have to deal with their own health issues. In the case of younger caregivers (primarily children), taking care of their parent may force a total change in the organization of family and work life [21].

Considering the demographic forecasts, a significant decline in the care potential of Polish families should be expected in the near future. According to the Central Statistical Office (GUS) forecasts, the so-called generational support ratio, which indicates the potential possibility of supporting older generations resulting from the age structure of the population, will systematically decrease in the next decades. The potential support ratio, i.e. the number of people aged 15–64 years per one older person aged 65 years or older, will decrease from 458 in 2013 to 169 in 2050; whereas the parent support ratio, which is the number of persons 85 years old and over per 100 people aged 50 to 64 years, will increase from 8 in 2013 to 38 in 2050 [22]. The shrinking care potential of Polish families results in a growing need for formal forms of support to ensure proper care for dependent elderly individuals.

### *Formal support system*

Formal support in providing care for patients with dementia should be comprehensive and include health, social and psychological services in both community-based and institutional care. The support should be provided not only to patients but also to their caregivers. An appropriate formal support network is necessary to provide proper care for elderly patients affected by dementia as well as to reduce the excessive care load of their caregivers.

There are three basic instruments of formal support for a family caring for an elderly dependent person. The first one is financial support in the form of cash payments to the caregivers and those in their charge. The second one is to enable or facilitate combining the caregiver's work with their care-related responsibilities [23]. The third (and most likely the most important) form of support is access to care services relieving the caregivers of their duties, including periodic respite care. This form of help improves not only the quality of care provided to the elderly, but also the mental and physical condition of the caregiver [24]. Comparative research from six European countries, which was conducted as part of the EUROFAMCARE project, demonstrated a correlation between fewer unmet social needs and a greater number of social and environmental services available for patients and their caregivers. However, such a relationship was not found for the 'richest' offer of health services [25].

In Poland, the estimated monthly costs associated with caring for a person with dementia are about 690 PLN [8]. State financial support received by Polish seniors in the form of an allowance or care allowance does not cover even half of this amount. There are no solutions in Poland that would make it easier for caregivers to combine care with work. Quite the contrary, the current system eliminates caregivers from the labor market, as they are entitled to financial support (520 PLN per month) only if they abandon their professional work for care. As shown in the report of the Supreme Chamber of Control (NIK), the support system in the form of care services provided to elderly individuals in the place of residence is still insufficient. Although these services are managed within the scope of self-government's own tasks, which are of a mandatory nature, almost 20% of municipalities fail to offer such support to seniors. In 2016, about 1% of the population over 60 years old took advantage of care services in the place of residence [26]. As a result, the whole care process is a burden for the family and privately paid caregivers. In the case of patients with no family, a care gap emerges, increasing the risk of negligence [27].

In addition to formal organizational state assistance, support may be also provided by foundations and associations, including a wide range of Alzheimer's associations. Currently, there are 35 non-governmental organizations in Poland working in the area of dementia [28]. Their activities are focused on providing support to patients and their caregivers through support groups, guidebooks, help lines, conferences, as well as trainings for doctors, nurses, social workers, and caregivers. Furthermore, foundations and associations also offer day-time and 24-hour centers for dementia patients [18]. Such facilities are most often located in large urban areas (Warsaw, Poznan, Krakow), which may be an access barrier for patients from smaller towns or rural areas.

If adequate care in a home setting is not possible, a patient with dementia could theoretically be placed in a part-time (daytime) or full-time (24-hour) care institution. There are only a few such institutions in Poland, and they are mainly located in urban areas. In practice, however, such institutions are unavailable or difficult to access due to the limited number of places and thus long waiting time. Daytime support centers function in Poland as part of social welfare structures or non-governmental organizations. They offer several hours of care during the day, usually on weekdays. Stationary care facilities are mainly state social welfare homes or long-term care centers (state or private). Usually, the caregivers of patients with end-stage dementia apply for this type of institutional care. Interestingly, dementia is an independent prognostic factor for replacing family care with institutional care already after one year [29]. While the costs of state institutional care are up to 70% of the senior's monthly income (the rest is covered by the local government or the caregiver), the costs of private facilities range between 2400 PLN up to 6000 PLN per month, depending on the standard and the services offered [30].

According to a survey conducted in Poland in 2016 among caregivers of individuals with Alzheimer's disease, the system of support provided by state institutions is far from sufficient. The respondents claimed that they were left to their own devices. From the possible forms of care support, the respondents most often had access to hospital treatment (58%) and community nurse services (48%) (Table 1), while they considered facilitating access to specialists, reimbursement of rehabilitation equipment and hygiene products as well as financial assistance to be most important aspects [8].

**Table 1.** Experiences of the Polish caregivers of people with Alzheimer's disease with the support and care system (in %)

Type of support/care	Taken advantage of	Difficult to access	Quality is good
Hospital treatment	58	51	69
Visiting nurse	48	44	82
Paid caregiver/care	29	43	73
Long-term care facility	24	69	75
Daily care center	22	66	76
Caregiver support group	22	48	80
Paid residential care	21	51	74
Support group for people with Alzheimer's disease	18	43	65
Nursing home	18	72	69
Residential care facility for people with Alzheimer's disease	16	71	58
Voluntary support	15	52	70

Source: Najwyższa Izba Kontroli. [Care of patients with Alzheimer disease and support for their families]. Warszawa: Najwyższa Izba Kontroli; 2017 (in Polish).

## Conclusions

Dementia is a growing challenge to the public health of aging societies in Poland and worldwide. In Poland, the problem of dementia among seniors is often ignored and the disease is diagnosed late. The care needs of patients with dementia are not systematically met by the national health and social care services. Although family care for seniors with dementia is still the primary 'care institution' in Poland, it is becoming increasingly inefficient as a result of demographic changes, including the emigration of young people and the aging of potential caregivers. Lack of a coherent health and social care system for patients with dementia leaves their caregivers without systemic support. This special group of dependent seniors and their caregivers, who are often also dependent and elderly, requires professional care and support, and these go beyond the universal system of inefficient social support in Poland. The existing infrastructure of formal community-based and institutional care services addresses only a small proportion of the potential beneficiaries. The prospect of further aging of the Polish population along with the growing risk of dementia and the shrinking family care potential justify the development and implementation of a comprehensive Alzheimer's Plan at the central and local levels of our country.

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## ATTITUDES OF DIABETIC PATIENTS TOWARD THEIR DISEASE POSTAWY PACJENTÓW CHORYCH NA CUKRZYCĘ WOBEC ICH CHOROBY

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### Authors' contribution

Wkład autorów:

A. Study design/planning

zaplanowanie badań

B. Data collection/entry

zebranie danych

C. Data analysis/statistics

dane – analiza i statystyki

D. Data interpretation

interpretacja danych

E. Preparation of manuscript

przygotowanie artykułu

F. Literature analysis/search

wyszukiwanie i analiza literatury

G. Funds collection

zebranie funduszy

### Summary

**Background.** Education of diabetic patients is integral to effective treatment.

**Material and methods.** In the presented work, we studied Eastern Slovakian patients with diabetes type 2 with or without insulin treatment. We focused on their diabetic self-care and compared their attitudes, education on their disease, and treatment provided by professionals. There were 411 patients in the insulin-treated group. We used the standardized Diabetes Care Profile questionnaire (DCP).

**Results.** The groups had very different attitudes toward diabetic self-care. Patients with provided professional self-care education scored higher in all areas of diabetic care. Appropriate education influenced knowledge and consequently the management and attitudes of diabetic patients toward their disease. Educated patients scored higher in the categories 'Self-care ability', 'Importance of care', 'Self-care adherence', 'Diet adherence', 'Medical barriers', 'Exercise barriers', 'Monitoring barriers' and 'Understanding practice' ( $p < 0.01$ ). Patients who had not received diabetes education presented higher scores in emotional areas, i.e., negative and positive attitudes toward diabetes mellitus ( $p < 0.01$ ).

**Conclusions.** We concluded that it is beneficial for a structured educational process to be integrated in diabetes treatment.

**Keywords:** education, diabetes mellitus, nursing, attitudes

### Streszczenie

**Wprowadzenie.** Edukacja pacjentów chorych na cukrzycę stanowi integralną część ich skutecznego leczenia.

**Materiał i metody.** W prezentowanym badaniu porównano postawy w zakresie samodzielnej profilaktyki cukrzycy w dwóch grupach pacjentów cierpiących na cukrzycę typu 2, która wymaga insulinoterapii, w odniesieniu do szkoleń edukacyjnych dotyczących ich choroby oraz leczenia prowadzonego przez specjalistów. Badaną grupę stanowiło 411 pacjentów cierpiących na cukrzycę typu 2 leczoną za pomocą insuliny, którzy pochodzą ze wschodniej części Słowacji. Zastosowano standardowy kwestionariusz DCP (ang. Diabetes Care Profile), wykorzystywany do oceny czynników społecznych i psychologicznych wśród cukrzyków.

**Wyniki.** Postawy dwóch porównywanych grup pacjentów wobec cukrzycy różniły się istotnie w zakresie samodzielnej profilaktyki. Pacjenci z zapewnionym profesjonalnym szkoleniem dotyczącym samodzielnej profilaktyki uzyskiwali wyższe oceny we wszystkich obszarach związanych z monitorowaniem i leczeniem cukrzycy. Prawidłowy proces edukacyjny ma wpływ na poziom wiedzy, a tym samym na działania podejmowane przez pacjentów i ich postawy wobec choroby. Pacjenci, którzy otrzymali odpowiednie przeszkolenie, lepiej kontrolowali sfery takie jak „Umiejętności dot. samodzielnej profilaktyki”, „Znaczenie samodzielnej profilaktyki”, „Przestrzeganie zasad samodzielnej profilaktyki”, „Przestrzeganie diety”, „Ograniczenia natury medycznej”, „Ograniczenia w wykonywaniu ćwiczeń”, „Ograniczenia w monitorowaniu” oraz „Rozumienie procedur” ( $p < 0,01$ ). Z kolei pacjenci nieposiadający odpowiedniej wiedzy prezentowali lepsze wyniki w obszarach związanych ze sferą emocjonalną – negatywnym i pozytywnym nastawieniem do cukrzycy ( $p < 0,01$ ).

**Wnioski.** W kontekście uzyskanych wyników, zintegrowanie ustrukturyzowanego procesu edukacyjnego z leczeniem osób chorujących na cukrzycę wydaje się konieczne.

**Słowa kluczowe:** edukacja, cukrzyca, opieka pielęgniarska, postawy

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## Introduction

Diabetes is a chronic disease that requires patients make a multitude of daily self-management decisions and perform complex care activities. Diabetes self-management education and support (DSME/S) provides the foundation for diabetic patients to navigate these decisions and activities and has been shown to improve health outcomes [1, 2, 3]. Diabetes self-management education (DSME) is the process of facilitating the knowledge, skills, and abilities necessary for diabetes self-care. Diabetes self-management support (DSMS) refers to the support needed to implement and sustain coping skills and self-management behaviors. Although many different members of the healthcare team and community contribute to this process, it is important that health care providers and their practice settings have the resources and a systematic referral process to ensure that patients consistently receive both DSME and DSMS. The initial DSME is typically provided by a health professional, whereas ongoing support can be provided by personnel within a practice and by a variety of community-based resources. DSME/S programs are designed to address the patient's health beliefs, cultural needs, current knowledge, physical limitations, emotional concerns, family support, financial status, medical history, health literacy, numeracy, and other factors to help meet the challenges of self-management [1, 2, 4]. The statement of rights and responsibilities of diabetic patients formulated in the Saint Vincent declaration establishes, among other things, the right to continuous education for all diabetic patients and their families. Effective education therefore achieves the objectives of the aforementioned declaration and prevents acute and chronic complications. In addition, it should improve the quality of life of diabetic patients and their families. For this reason, the presented work focuses on the comparison of insulin-treated diabetic patients with and without health professional-provided education. The objective of this work was to monitor, analyze and evaluate differences in attitudes, realization of diabetic self-care and self-monitoring by patients with type 2 diabetes mellitus with insulin treatment in relation to the provided education [5, 6].

## Material and methods

The aim of this study was to investigate the effects of complex education on the attitudes type 2 diabetics have toward their diabetes care management.

500 questionnaires were distributed to patients in Eastern Slovakia (location Košice, Prešov, Sabinov, Vranov nad Topľou) with type 2 diabetes mellitus (DM2T) treated with insulin. 411 questionnaires were returned (response rate 82%). We used the questionnaire "Diabetes Care Profile (DCP)" [7]. The DCP was developed as an instrument to assess social and psychological factors related to diabetes and its treatment. To compare the selected indicators, the sample was divided based on the answers provided for the sections of the DCP questionnaire "Education/Provided Advice" and "Diet". Two groups of patients were selected in relation to the education realized by health professionals (patients with acquired education EP and without education NP). The study was conducted on 411 patients with insulin-treated type 2 diabetes mellitus (DM2T). The inclusion criteria were the adult age of patients, DM2T disease and insulin treatment. The average age of respondents was 62.9 years. The major age groups were late adulthood and presenium.

### *Data analysis*

For the purpose of the presented study, a standardized questionnaire for acquisition of needed information, "Diabetes Care Profile", was used. SPSS 15.0 was used for statistical analysis of the obtained data. T- and F-tests were used to compare the studied groups to determine statistical differences (p – statistic value, M – mean, SD – standard deviation).

We focused on the education provided by health professionals (doctor, nurse, nutrition assistant) in the fields of podiatry, physical exercise, diet and the necessity of adherence to the diet, meal planning, measurement of food weight and the use of special diabetic menus. In terms of education in the area of podiatry, 100% of respondents from the first EP group answered positively to this item, while 98.5% of respondents from the second NP group gave a negative response. 96% of EP respondents received consultations about physical exercise, and about 91% of NP respondents answered negatively. The EP were fully educated about issues of diabetic diet, its importance, dietary adherence and measurement of food weight; the NP were not (negative responses). In terms of formal education through repeated meetings with an expert in the field of diabetic education, 75% of EP answered positively and 96% of NP negatively. Based on these findings, the whole sample of respondents was divided into two groups. The educated patients (EP) comprised 232 patients, and the 'not educated patients' (NP) comprised 179 patients (Table 1).

**Table 1.** Characteristic of respondents

Characteristic	EDUCATED PATIENTS (EP)		NOT EDUCATED PATIENTS (NP)	
	n (232)	%	n (179)	%
Gender				
Male	94	40%	68	38%
Female	128	60%	111	62%
Education				
Primary school graduate or less	69	30%	52	29%
Secondary school graduate or more	162	70%	127	71%
Age (M $\pm$ SD)	62.8 $\pm$ 11.26		63.1 $\pm$ 11.12	
Duration of diabetes mellitus (M $\pm$ SD)	11.2 $\pm$ 7.17		10.8 $\pm$ 6.72	
HbA <sub>1c</sub> (M $\pm$ SD)	8.84 $\pm$ 1.54		8.85 $\pm$ 2.0	p = 0.72
BMI (M $\pm$ SD)	29.93 $\pm$ 5.30		30.42 $\pm$ 4.59	p = 0.52

N – number, M – mean, SD – standard deviation

### Ethics

Research took place in accordance with the Helsinki Declaration and a local ethical committee approved the study. All participants signed an informed consent document.

### Results

The majority of respondents were female. The EP group was 60% female and 40% male. The NP group was 62% female and 38% men (Table 1). The prevailing **age** in the EP group was 51–60 years (38.8%) while for the NP group, it was 61–70 years (48%). The mean age was 62.2 years for the EP respondents (SD 11.26) and 62.4 years (SD 11.12) for NP.

**The total duration of diabetes** for the whole study group of respondents was 11.12 years (SD 7.12). The EP group's mean duration was 11.2 years (SD 7.17) and the NP group's mean duration was 10.8 (SD 6.72). For both groups' mean duration, the largest category was 10–14 years. Only 13% of EP and 9% of NP had a **BMI** in the normal range. T-tests did not show any significant differences in BMI in the studied groups (p = 0.52). **Glycated hemoglobin levels (HbA<sub>1c</sub>)** were 8.84  $\pm$  1.54 for EP and 8.85  $\pm$  2.0 for NP. Differences were not statistically significant (p = 0.72) (Table 1).

Table 2 presents a summary of the results for each DCP scale. We analyzed the effects of education. The 16 subscales of the DCP were compared for the educated and non-educated groups of patients (Table 2).

**Table 2.** Summary DCP scale

Scale	EP		NP		p
	M	SD	M	SD	
Control problems	3.36	0.89	2.59	0.91	0.000***
Social and personal factors	2.94	1.17	2.46	1.1	0.000***
Positive attitude	2.35	0.92	3.41	1.09	0.000***
Negative attitude	1.78	1.17	2.78	0.88	0.000***
Self-care ability	3.68	0.95	2.19	0.97	0.000***
Importance of care	3.03	1.49	2.04	0.93	0.000***
Self-care adherence	3.51	0.92	2.09	0.94	0.000***
Diet adherence	3.47	1.11	2.55	0.83	0.000***
Medical barriers	2.86	1.34	2.27	1.16	0.000***
Exercise barriers	2.8	1.28	2.14	0.89	0.000***
Monitoring barriers	3.47	1.18	2.16	1	0.000***
Understanding management practice	3.24	1.24	2.84	1.06	0.000***
Long-term care benefits	3.49	1.05	3	1.13	0.000***
Support needs	3.78	0.91	3.48	1.04	0.011*
Support	3.66	0.91	3.31	1.24	0.007*
Support attitudes	3.25	1.19	2.12	0.95	0.000***

\* p < 0.05; \*\* p < 0.01; \*\*\* p < 0.001, M – mean, SD – standard deviation, EP – educated patient, NP – not educated patient



Educated patients reported higher 'Self-care ability', 'Importance of care', 'Self-care adherence', 'Diet adherence', 'Medical barriers', 'Exercise barriers', 'Monitoring barriers' and 'Understanding practice' ( $p < 0.01$ ). Not educated patients presented higher scores in emotional areas – negative and positive attitude to diabetes mellitus ( $p < 0.01$ ).

**Understanding about diabetic care** in the DCP focused on the assessment of lifestyle knowledge. The patients were evaluated on 12 items of diabetic self-treatment from 1–5 on the Likert scale (1 = poor, 5 = excellent). The results confirmed statistically significant differences in lifestyle knowledge of patients with diabetes (Table 3).

**Table 3.** Evaluation of knowledge on lifestyle

Evaluated knowledge	EP		NP		p
	M	SD	M	SD	
a) overall diabetes care	3.36	0.89	2.59	0.91	0.000***
b) coping with stress	2.94	1.17	2.46	1.1	0.000***
c) diabetic diet	3.41	0.92	2.35	1.09	0.000***
d) role of physical exercise in diabetes care	2.78	1.17	1.78	0.88	0.000***
e) medications you are taking	3.68	0.95	2.19	0.97	0.000***
f) how to use results of self-monitoring of blood glucose	3.03	1.49	2.04	0.93	0.000***
g) effects of diet, physical exercises and medicines on amount of glucose in blood	3.51	0.92	2.09	0.94	0.000***
h) prevention and treatment of high blood sugar	3.47	1.11	2.55	0.83	0.000***
i) prevention and treatment of low blood sugar	2.86	1.34	2.27	1.16	0.000***
j) prevention of long-term complications of diabetes (chronic complications)	2.8	1.28	2.14	0.89	0.000***
k) foot care	3.47	1.18	2.16	1	0.000***
l) benefits of self-monitoring blood glucose	3.25	1.19	2.12	0.95	0.000***

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ , M – mean, SD – standard deviation, EP – educated patient, NP – not educated patient

**The importance of long-term diabetes care** and effects of long-term care on possible health problems related to the development of chronic diabetic complications were studied. In this area, significantly different attitudes toward these problems were observed, where the studied group of the EP demonstrated a more positive attitude toward prevention of possible complications. The highest level of significance was recorded in the prevention of foot and renal problems ( $p < 0.001$ ). Statistically significant differences were also found for monitoring eye problems ( $p < 0.01$ ), risk of developing atherosclerosis ( $p < 0.05$ ) and heart disease ( $p < 0.05$ ). The results of the EP and NP groups in relation to their attitudes toward the importance of long-term treatment and control of DM are presented in Table 4.

**Table 4.** Attitudes toward importance of long-term treatment and control of diabetes

Effects of long-term self-care	EP		NP		p
	M	SD	M	SD	
a) eye problems	3.85	0.99	3.47	1.18	0.004**
b) renal problems	3.76	1.08	3.29	1.09	0.000***
c) foot problems	3.94	0.93	3.39	1.14	0.000***
d) atherosclerosis	3.63	0.97	3.34	1.1	0.020*
e) heart diseases	3.68	0.88	3.43	1.11	0.047*

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ , M – mean, SD – standard deviation, EP – educated patient, NP – not educated patient

Using descriptive statistics, we found that 48% of the EP and 43% of the NP have well-controlled blood sugar. Self-monitoring of glycosuria and acetonuria was performed by only 16% of the EP and 17% of the NP.

For self-monitoring, the most frequent obstacles to realization are listed in Table 5 and were statistically significant ( $p < 0.05$ ). Another obstacle to self-monitoring at the level of significance ( $p < 0.05$ ) was that the respondents do not like performing self-monitoring, with positive scores for the EP –  $1.61 \pm 1.01$ , the NP –  $2.1 \pm 1.35$ . Another self-monitoring barrier was a lack of test materials, with the EP having greater access (Table 5) (EP 1.76

$\pm 1.12$ , NP  $2.32 \pm 1.29$ ;  $p < 0.01$ ). The NP group ( $2.49 \pm 1.17$ ) found self-monitoring more expensive than the EP group ( $1.91 \pm 1.16$ ) ( $p < 0.01$ ). Further significant differences in the terms of obstacles to self-monitoring were recorded in the following areas: assessment of blood sugar levels too complicated ( $p < 0.05$ ), inability to do it on their own ( $p < 0.01$ ), glycemic levels do not change very often ( $p < 0.01$ ) and discomfort when repeatedly pricking their fingers ( $p < 0.05$ ). All of these obstacles to self-monitoring were statistically significant (Table 5).

**Table 5.** Obstacles to self-monitoring

You did not measure the glucose in your blood as recommended because:	EP		NP		P
	M	SD	M	SD	
a) you forgot it	2.12	1.2	1.9	1.2	0.325
b) you do not believe it is useful	1.49	1.07	2	1.44	0.019*
c) you did not have enough time or a suitable place for it	1.58	0.96	1.83	1.12	0.163
d) you do not like it	1.61	1.01	2.1	1.35	0.016*
e) you ran out of test materials	1.76	1.12	2.32	1.29	0.006**
f) it is too expensive	1.91	1.16	2.49	1.17	0.003**
g) it is complicated	1.38	0.82	1.71	1.11	0.048*
h) it is difficult to read the test results	1.45	0.9	1.67	1.11	0.200
i) I cannot do it on my own	1.37	0.86	1.95	1.36	0.003**
j) your blood sugar level does not change very often	2.06	1.34	2.8	1.41	0.0015**
k) repeated finger pricks are painful	2.22	1.27	2.74	1.35	0.019*

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ , M – mean, SD – standard deviation, EP – educated patient, NP – not educated patient

**For monitoring of obstacles to self-monitoring and self-care** we studied how the patients assess their practical skills using the Likert scale of assessment (1 – weak, 5 – perfect). We recorded significant differences in the responses, where the EP group assessed their skills better. Significant differences were monitored in skills related to adherence to diet and monitoring blood sugar levels ( $p < 0.05$ ), control and maintenance of a healthy body weight ( $p < 0.01$ ), prevention of diabetes complications ( $p < 0.05$ ), taking care of feet ( $p < 0.05$ ), and taking care of eyes ( $p < 0.05$ ) (Table 6).

**Table 6.** Skills related to self-monitoring and self-care of patients with diabetes

Evaluation of skills	EP		NP		P
	M	SD	M	SD	
a) follow diet and test blood sugar	3.27	1.06	2.92	1.22	0.045*
b) control and maintain healthy body weight	3.27	0.93	2.80	1.28	0.002**
c) get physical activity	2.62	1.37	2.28	1.07	0.066
d) take insulin/medicines	3.64	0.95	3.41	1.31	0.175
e) monitor blood sugar levels	3.40	1.01	3.20	1.43	0.269
f) take care of feet	3.19	1.02	2.77	1.14	0.010*
g) prevent complications of diabetes	3.04	1.16	2.67	1.26	0.041*
h) take care of eyes	3.09	0.96	2.74	1.08	0.022*
i) consume alcohol with diabetes	3.21	1.34	2.91	1.25	0.124

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

## Discussion

Diabetes is rapidly becoming the scourge of the modern world. The increasing number of diabetics is linked to the pandemic of obesity and metabolic syndrome, the aging population, as well as stricter diagnostic criteria. In 2016, there were 370,000 registered patients with diabetes in Slovakia. The number of diabetic ambulances and healthcare staff in Slovakia has clearly not developed in conformity with the high growth of diabetic patients and patients at risk of developing diabetes [8]. In addition, the study revealed that nurses mentioned the lack of time as the biggest problem in education of patients with DM. Other problems in the education of patients defined by nurses included the lack of equipment and educational standards.

Diabetes patients should consider **diabetes education** as an opportunity to solve emotional, social, behavioral, spiritual and psychological, as well as physical problems associated with this disease. The educational

process should help patients further develop their knowledge, skills, attitudes and self-confidence necessary for effective health decisions. Strengthening attitudes toward self-care among patients with diabetes is a subject of psychosociological studies that help individuals develop their skills and introspection by determining objectives, solving problems, managing stress, and looking for social assistance and motivation. Patients should be able to make informed decisions about their diabetic care [9, 10]. Collaborative decision-making represents a conceptual shift in the relationship between patients and educators. Patients are no longer only customers using medical services; they become active partners in providing medical care [5, 11, 12]. In the international literature, we often read about the education concentrating on the self-management of the disease, i.e., Diabetes Self-Management Education (DSME). The issue of education of diabetes patients in the area of self-management of their disease is considered one of the most important priority areas, and is related to self-care. Every diabetic patient should obtain knowledge and skills necessary for the diabetic self-care through education and re-education. The objective of educational meetings is to regularly assess the overall level of self-care by diabetes patients [13, 14, 15]. Our study's questionnaire did not exactly follow the difference between ESMS and ESME.

**Diabetic self-care** represents the ability of a diabetic patient to manage overall self-care and everyday activities related to diabetes including blood glucose monitoring, taking medications, balanced eating and physical activity [16]. In terms of diabetes self-care, the healthcare provider acts as an educator with influence on their patient's health. As this kind of medical care is unique, effective communication between patients and health care providers is vital [15, 17]. Overall health professional – patient education relates to many variables, including the patients' satisfaction and diabetic care abilities [18, 19, 20].

In our research, we monitored the respondents' **diabetic self-care ability, understanding of its importance and compliance**. The objective was to find out if the attitudes of the groups differed significantly. The studied groups differed significantly in all four studied items. Fitzgerald et al. [21] studied the influence of treatment modality and ethnicity on the attitudes of diabetic patients toward their disease. The respondents were divided into 4 groups (2 ethnic groups and 2 treatment groups). 6 out of 16 sections of the DCP (control, social and personal factors, positive and negative attitudes, ability of diabetic self-care and barriers to physical exercises) were significantly affected by treatment modality. The four groups had statistically significant differences in their attitudes toward the disease. Gurková et al. [22] argued that patients who acquired an intensive educational program practiced all important self-care activities to a greater extent than patients who acquired the education from outpatient care. The structured educational program was provided for patients with types 1 and 2 diabetes with intensified insulin therapy. The objective was to improve diabetic metabolic compensation and re-education. The educational program for patients with DM1T was realized in the form of 10-day intensive education courses with a maximum of 10 participants per group. The clinical efficiency of the program in terms of changes in behavior and satisfaction with the treatment was not continuously assessed. Statistical comparison using the chi-square test revealed significant differences in the self-management of DM (based on saccharide units,  $p < 0.05$ ). There were no statistically significant differences in the areas of regular self-monitoring, changes in insulin dosage in relation to specific situations and recordkeeping of hypoglycemia [22]. We obtained similar results in this paper, where in the area of diet adherence, adherence to meal plans and measuring/weighting of food were statistically significant between the groups ( $p < 0.05$ ).

Patient education is an ongoing process, which should be aimed at helping patients better manage glycemic control, overcome behavioral and psychological barriers, improve self-management skills, and become empowered to make informed choices [9, 12, 18, 23, 24].

Based on our results, we recommend:

1. In each care provision, assessment of the patient with DM is important: A. Assessing the level of knowledge and skills; B. Values, attitudes, norms, and beliefs; C. Aids, means, external conditions (necessary for achieving educational goals); D. Will, Willingness, Motivation to Learn (Compliance / Adherence); E. The occurrence of negative emotions (fear, anxiety, anger, helplessness, guilt, suffering, and depression); F. Age, gender, level of education, and social status; G. Duration of DM, repeated hospitalization, and membership in self-help diabetic club.
2. The results of our study emphasize the importance of reinforcement of diabetes education including management of diet through stakeholders (healthcare providers, health facilities) to encourage them to understand disease management better, for more appropriate self-care and better quality of life.
3. The overall purpose of proper dietary management is to prevent early organ complications.
4. As diabetes is a lifelong disease, proper therapy methods with a special emphasis on diet should be given by healthcare providers to control the disease, reduce symptoms, and prevent complications.
5. The patients should also have good knowledge about the disease and diet. Healthcare providers must therefore recommend patients make changes in their nutritional habits and food preparation. Active and effective dietary education may prevent the onset of diabetes and its complications [11, 14, 25].

## Conclusions

Dimensions of systematic assessment in the educational process have been shown to be important factors influencing learning. Diabetes patients can change their behavior. Research data indicate that a solid knowledge base provided to patients has a significant impact on therapy outcomes. Methodological drawbacks of our work were the unrepresentative nature of the set and the study design. The selection of respondents to the sample was intentional; the study was a cross-sectional study. Random sampling, more respondents, and the design of a prospective intervention study would address the shortcomings of this selection and design study from the generalization aspect. The results of our study may be the starting point for implementing longitudinal studies assessing the change in self-management activities based on educational programs. Based on the results of DM activities at the level of the whole sample of respondents, it is clear that there is a need for more complex continuing education in outpatient care aimed at identifying and managing patient risk behavior.

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## ESTIMATION OF FUNCTIONAL RESERVES OF THE BODY AND RISK OF CARDIOVASCULAR EVENTS IN PATIENTS WITH MYOCARDIAL INFARCTION WITH COMORBID PATHOLOGY UNDERGOING REHABILITATION

### OCENA REZERW FUNKCJONALNYCH ORGANIZMU ORAZ RYZYKA ZDARZEŃ SERCOWO-NACZYNIOWYCH U PACJENTÓW PO PRZEBYTYM ZAWALE MIĘŚNIA SERCOWEGO Z ROZPOZNANIEM CHOROÓB WSPÓŁWYSTĘPUJĄCYCH BĘDĄCYCH W TRAKCIE REHABILITACJI

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#### Authors' contribution

Wkład autorów:

A. Study design/planning

zaprojektowanie badań

B. Data collection/entry

zebranie danych

C. Data analysis/statistics

dane – analiza i statystyki

D. Data interpretation

interpretacja danych

E. Preparation of manuscript

przygotowanie artykułu

F. Literature analysis/search

wyszukiwanie i analiza literatury

G. Funds collection

zebranie funduszy

#### Summary

**Background.** Cardiovascular diseases are the leading cause of death worldwide. In Ukraine, cardiovascular mortality is 66.7%.

**Material and methods.** We examined 371 patients with myocardial infarction (MI) with comorbid pathology who had undergone 90 days of rehabilitation. We studied the possibility of quantitative estimation of comorbid pathology, the condition of functional reserves in patients with MI, their connection with clinical markers of reduced exercise tolerance and comorbidity index.

**Results.** We established close correlations between the six-minute walk tests conducted on the 10<sup>th</sup>, 30<sup>th</sup> and 90<sup>th</sup> days of rehabilitation (6MWT10, 6MWT30 and 6MWT90) with age of patients (r6MWT10 = -0.199; r6MWT30 = -0.287; r6MWT90 = -0.410 P < 0.05), SpO<sub>2</sub> (r6MWT10 = -0.399; r6MWT30 = -0.265; r6MWT90 = -0.248; P < 0.05), left ventricular ejection fraction (r6MWT10 = 0.706; r6MWT30 = -0.670; r6MWT90 = -0.583; P < 0.0001), troponin levels (r6MWT10 = -0.210; r6MWT30 = -0.312; P < 0.05); creatinine (r6MWT10 = -0.148; P < 0.05) and Charlson comorbidity index (r6MWT10 = -0.323; r6MWT30 = -0.398; r6MWT90 = -0.427; P < 0.0001).

**Conclusions.** Markers of reduced exercise tolerance in patients with MI were age, SpO<sub>2</sub>, ejection fraction, levels of troponin, creatinine, lymphocytes, Charlson comorbidity index.

**Keywords:** rehabilitation, acute myocardial infarction, Charlson comorbidity index, six-minute walk test

#### Streszczenie

**Wprowadzenie.** Choroby układu krążenia są główną przyczyną śmiertelności na całym świecie. Na Ukrainie wskaźnik śmiertelności związanej z chorobami układu krążenia wynosi 66,7%.

**Materiał i metody.** Badaniem objęto 371 pacjentów po przebytych zawale mięśnia sercowego (MI) z rozpoznaniem chorób współistniejących, będących w trakcie 90-dniowej rehabilitacji. Przeanalizowano możliwość ilościowego oszacowania chorób współistniejących, stanu rezerw funkcjonalnych u pacjentów po przebytych zawale mięśnia sercowego oraz związku pomiędzy klinicznymi markerami obniżonej tolerancji wysiłku a wskaźnikami zachorowalności.

**Wyniki.** Ścisła korelacja pomiędzy testem marszu sześciominutowego przeprowadzonym w 10, 30 i 90 dniu rehabilitacji (6MWT10, 6MWT30 i 6MWT90) a wiekiem pacjentów (r6MWT10 = -0,199; r6MWT30 = -0,287; r6MWT90 = -0,410 P < 0,05), SpO<sub>2</sub> (r6MWT10 = -0,399; r6MWT30 = -0,265; r6MWT90 = -0,248; P < 0,05), frakcją wyrzutową lewej komory (r6MWT10 = 0,706; r6MWT30 = -0,670; r6MWT90 = -0,583; P < 0,0001), poziomami troponiny (r6MWT10 = -0,210; r6MWT30 = -0,312; P < 0,05); kreatyniny (r6MWT10 = -0,148; P < 0,05) oraz wskaźnikiem chorób współistniejących Charlsona (r6MWT10 = -0,323; r6MWT30 = -0,398; r6MWT90 = -0,427; P < 0,0001).

**Wnioski.** Markerami obniżonej tolerancji wysiłku u pacjentów z MI był wiek, SpO<sub>2</sub>, frakcja wyrzutowa, poziom troponiny, kreatyniny, limfocytów oraz wskaźnik chorób współistniejących Charlsona.

**Słowa kluczowe:** rehabilitacja, ostry zawał mięśnia sercowego, wskaźnik chorób współistniejących Charlsona, test marszu sześciominutowego

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## Introduction

Cardiovascular diseases (CVDs) are the leading cause of death throughout the world. According to the WHO, in 2016, 17.9 million people died from CVDs, 31% of total deaths. In Ukraine, cardiovascular disease-associated deaths comprised 66.7% of the total, the highest in Europe. More than 75% of all cardiovascular deaths occur in low- and middle-income countries. Therefore, the fight against acute myocardial infarction (MI) and its consequences, and achievement of full functional recovery of patients after previous MI is particularly topical [1, 2].

Medical care for patients with coronary heart disease (CHD), including myocardial infarction, is often complicated by concomitant and combined pathology in these patients. Restoration of health of the cardiologic patient, especially after acute coronary events, is complicated by the effect of one or more concomitant diseases and extremely difficult [3, 4]. The problem is magnified by the fact that most research underpinning current treatment recommendations, including post-infarction patients, focuses on uncomplicated pathology. The presence of comorbid pathology (CP) contributes to increased hospital stay duration, disability, limits the possibility of full rehabilitation, increases the number of complications after surgical interventions, affects the prognosis for life, and increases the risk of fatal outcomes [5].

The aim of this study was to quantify the risk that comorbid pathology has on patients who have experienced cardiovascular events and the state of functional reserves in patients with myocardial infarction.

## Material and methods

371 patients with myocardial infarction who had undergone acute rehabilitation period at the Cardiology Department of the Ternopil University Hospital were examined and sequentially included in the local registry. The diagnosis was established based on acting protocols of treatment and rehabilitation [6, 7]. Criteria for inclusion in the study were confirmed diagnosis of MI and written informed consent of patients to participate. Acute infectious and mental illnesses, decompensation of concomitant pathology, hemodynamically significant heart defects and surgical revascularization of the infarct-dependent vessel resulted in exclusion from the study. Charlson comorbidity index (CCI) was used to evaluate the degree of comorbidity in patients with MI with concomitant pathology [8].

Drug therapy included pharmaco-invasive treatment technologies, depending on the time-window of the patients' admission. All patients without contraindications were prescribed the standard therapy recommended by acting protocols [6, 7], which included direct anticoagulants (low molecular weight heparin-enoxaparin at a dose of 1 mg/kg of body weight); antiplatelet drugs (acetylsalicylic acid 75 mg/day, clopidogrel 75 mg/day), statins (atorvastatin 40–80 mg/day);  $\beta$ -blockers (bisoprolol  $5 \pm 1.2$  mg/day) and angiotensin-converting enzyme inhibitors (perindopril, ramipril  $5 \pm 1.3$  mg/day), depending on baseline hemodynamic parameters, nitrates, narcotic analgesics. The indicated therapy was supplemented with appropriate drugs based on the existing comorbid pathology.

Morphometric parameters of intracardiac hemodynamics were evaluated using an echocardioscopic method in one-dimensional, two-dimensional, Doppler (color Doppler) pulse-wave, or continuous-wave (tissue Doppler) modes (Phillips HD 11XE, USA, 2–4 MHz sensor) according to the ultrasound heart examination recommendations given by the American Society for Echocardiography and the European Association for Echocardiography (ASE/EAS 2015).

Electrocardiograms were registered with the help of an UTAS ECG device. Laboratory methods included a general blood test, coagulogram, biochemical blood test (glucose, bilirubin, transaminase, creatinine, urea, uric acid, and lipid blood plasma spectra (total cholesterol, triglycerides, high and low density lipoproteins). Studies were conducted in a certified laboratory unit of the Ternopil University Hospital.

Functional reserves of the cardiovascular system were determined by a method of point scoring of its individual parameters: size of the left ventricular ejection fraction more than 55% = 1 point, 45–55% = 2 points, 30–45% = 3 points and less than 30% = 4 points. In the same way, evaluation of heart failure was performed according to NYHA: FC I = 1 point, FC II = 2 points, FC III = 3 points and FC IV = 4 points and the status of the cardiovascular events risk according to rehabilitation classification (Nikolaev LF, Aronov DM, 1988): FC I = 1 point, FC II = 2 points, FC III = 3 points and FC IV = 4 points. Post-infarction patients were divided into groups of low, medium and high risk, with corresponding assignments of 1, 2 and 3 points [9, 10] based on the GRACE scale and cardiovascular events risk scale (AHA). The six-minute walk test [11] was performed and evaluated on the 10<sup>th</sup>, 30<sup>th</sup> and 90<sup>th</sup> days after hospital admission.

Statistical analysis was performed using MS Excel 2000 and EViews 5.1 software. For quantitative variables average values and standard deviations were calculated, and absolute variables and percentage shares for each

category were calculated for categorical variables. For quantitative variables, the statistical significances for the differences between groups of patients with concomitant pathology and non-concomitant pathology were investigated using student t-tests for independent samples. The comparability analysis on the distribution of qualitative (categorical) characteristics in the groups was carried out using  $\chi^2$  criterion, with categorical variables presented as absolute numbers for each category. The relationships between quantitative indicators were analyzed using the standard Pearson correlation coefficient. Quantitative and categorical (in 2 categories) indicators were analyzed using point biserial correlation coefficients and quantitative and categorical indicators with >2 categories were measured using dispersion ANOVA analysis and coefficient (eta-squared), while the analysis of relationships between two categorical indicators was performed using the Yule's coefficient association, with the connection considered as confirmed when the coefficient of association according to the module exceeded 0.5. Using all other statistical criteria and analysis tools, the differences and connections were taken as statistically significant when  $p < 0.05$  [12, 13].

## Results

Patients with MI were  $66.2 \pm 10.4$  years old, with the time from appearance of the first symptoms of the disease to time of hospitalization being on average  $20.3 \pm 15.1$  hours. There were 249 (67.1%) men and 122 women (32.9%), 73 (19.7%) patients were city-dwellers and 298 (80.3%) were village-dwellers. In the overwhelming number of examined patients (93.8%), concomitant pathology was detected: arterial hypertension affected 84.9%, Diabetes mellitus 25.1%, vascular pathology 24.8% and 10.8% suffered from severe cerebrovascular disease or transient ischemic attacks. Chronic arterial pathology was found in 4.9% of patients, chronic bronchopulmonary diseases in 27.8%; renal pathology in 17.5%, GI pathology in 15.9%, and thyroid pathology in 2.4%. Mortality in the acute MI period was 4.9%.

The vast majority of patients admitted to the clinic (330 or 88.9%) had a typical angina type of myocardial infarction and 370 (96.0%) patients had specific ECG changes. Additional clinical manifestations in patients with acute MI were dyspnea (64.2%), sweating (25.1%), rhythm and conduction disorders (91.1%), cardiac asthma (20.5%), left ventricular aneurysm (24.8%) and epistemic pericarditis (22.1%).

The analysis of exercise tolerance and rehabilitation potential in the study cohort showed that patients undergoing in-patient treatment in the cardiology department had a predominantly high degree of heart failure and reduced cardiac reserve. Thus, a six-minute walk test conducted for the examined patients on the 10<sup>th</sup> day after admission to the clinic was  $76.1 \pm 35.2$  m. On the 30<sup>th</sup> and 90<sup>th</sup> days the results were  $133.8 \pm 49.6$  m and  $207.6 \pm 74.1$  m, respectively. The patients' NYHA functional class was high ( $2.9 \pm 0.7$ ), and the risks according to the GRACE scale and American Heart Association's AAS risk scale were high and very high ( $2.9 \pm 0.3$  and  $2.7 \pm 0.6$ , respectively). Rehabilitation and hemodynamic potential, represented by the functional class for rehabilitation classification and parameters of the left ventricular systolic function as measured with echocardiography, also indicated significant cardiovascular functional reserve depletion. Thus, the functional class according to echocardiography was  $2.9 \pm 0.8$  points, and the rehabilitation classification class was  $3.3 \pm 0.7$ .

We concluded the following from the data. First, the examined patients made a late appeal for medical aid ( $20.34 \pm 15.11$  hours), and accordingly, were not able to have timely revascularization of the infarct-dependent vessel. The patients were also elderly (mean age  $66.16 \pm 10.41$  years) and the majority had comorbidity (93.8%). Most myocardial infarction researchers recognize that the presence of comorbid pathology can significantly negatively affect functional status and cardiovascular reserve [3-5]. These issues are often dealt with by cardiology departments in Ukraine and, accordingly, require specialized rehabilitation protocols. We therefore analyzed the basic functional parameters of patients with MI with CP and the relationship with exercise tolerance and degree of comorbidity.

Study of the basic functional characteristics of patients with MI with CP revealed metabolic disturbances, altered indicators of congestion, altered markers of myocardial necrosis of various severity degrees, as well as the presence of moderately expressed hyperdynamic syndrome of cardiovascular system functioning in the examined patients, which was compensatory in nature (Table 1).

**Table 1.** Basic functional parameters in patients with acute myocardial infarction (M $\pm$ SD)

Factor	Patients without CP (M $\pm$ SD)	Patients with CP (M $\pm$ SD)	p-value (t-test)
HR in the acute phase of MI, bpm	79.773 $\pm$ 22.467	84.716 $\pm$ 25.925	0.383
SBP in the acute phase of MI, mm Hg	127.045 $\pm$ 20.797	133.994 $\pm$ 30.644	0.295
DBP in the acute phase of MI, mm Hg	77.955 $\pm$ 11.303	82.464 $\pm$ 16.093	0.197



LVEF, %	51.500±6.048	45.817±7.620	0.001
RR breaths/min	18.409	20.464	1.593
Erythrocytes, x10 <sup>12</sup> /L	4.631±0.455	4.306±0.697	0.032
Hemoglobin, g/L	135.773±25.396	130.406±21.783	0.268
Leukocytes, x10 <sup>9</sup> /L	8.874±2.738	9.317±3.745	0.586
Lymphocytes, %	27.773±15.430	20.257±11.751	0.005
Thrombocytes, x10 <sup>9</sup> /L	162.833±56.747	195.099±87.633	0.380
ESR, mm/h	13.182±9.752	17.732±14.576	0.150
Glucose, mmol/L	5.635±1.304	8.921±4.687	0.002
Bilirubin, mg/L	13.386±11.326	10.760±6.931	0.101
Creatinine, mcmol/L	83.864±23.234	106.834±89.725	0.232
Troponin T, ng/ml	1040.351±322.958	1257.691±887.421	0.014
TC, mmol/L	5.211±1.689	4.832±1.463	0.245
HDL, mmol/L	1.209±0.394	1.166±0.633	0.768
LDL, mmol/L	3.749±1.547	3.228±1.282	0.098
Fibrinogen, g/L	4.245±1.092	4.939±4.403	0.462
INR, u/L	1.111±0.115	1.101±0.290	0.866
SpO <sub>2</sub> , %	96.000±1.569	94.199±4.155	0.107
CCI, points	2.259±1.324	4.714±1.765	<0.0001
6MWT <sub>10</sub> , m	128.769±24.032	72.32±32.79	<0.0001
6MWT <sub>30</sub> , m	201.154±46.07	128.742±46.054	<0.0001
6MWT <sub>90</sub> , m	307.308±79.594	200±67.868	<0.0001

Note. CP – comorbid pathology, HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, LVEF – left ventricular ejection fraction, RR – respiratory rate, INR – international normalized ratio, TC – total cholesterol, HDL – high-density lipoproteins, LDL – low-density lipoproteins, SpO<sub>2</sub> – arterial oxygen saturation, CCI – Charlson comorbidity index, 6MWT<sub>10</sub> – six-minute walk test on the 10<sup>th</sup> day of rehabilitation, 6MWT<sub>30</sub> – six-minute walk test on the 30<sup>th</sup> day of rehabilitation, 6MWT<sub>90</sub> – six-minute walk test on the 90<sup>th</sup> day of rehabilitation

Glycemic levels, the number of erythrocytes and lymphocytes in the peripheral blood, as well as the concentration of a specific marker of troponin T myocardial necrosis differed significantly in patients with MI, which developed in a background of concomitant pathology in comparison with patients without comorbidity, indicating a deeper expression of metabolic changes and the exhaustion of the adaptive capacity of the body. Tests of physical activity tolerance (6MWT on the 10<sup>th</sup>, 30<sup>th</sup> and 90<sup>th</sup> days of rehabilitation) and left ventricular ejection fraction, reflecting the degree of violation of the systolic function of the heart were also relatively lower in patients with comorbidity.

In order to detect early prognostic markers of the response to the motor regimen expansion in post-infarction patients, the relationships between the results of the six-minute walk test at the stages of rehabilitation with functional clinical, laboratory and hemodynamic parameters were analyzed. We found that 6MWT<sub>10</sub> was directly correlated with systolic blood pressure (SBP) in the first day of MI, the number of lymphocytes in peripheral blood, levels of total cholesterol (TC), low-density lipoprotein (LDL), oxygen saturation (SpO<sub>2</sub>). Left ventricular ejection fraction (LVEF) was inversely correlated with age, frequency of respiratory movements (RR), number of leukocytes in peripheral blood, levels of aspartate aminotransferase (AAT), creatinine, troponin T and Charlson comorbidity index (CCI) (Table 2).

**Table 2.** Dependence of 6MWT<sub>10</sub> on clinical functional indices in patients with MI with comorbid pathology

Index	Correlation	T-criteria	p-value
Age, years	-0.199	-2.765	0.006
SBP in the first day of MI, mm Hg	0.179	2.477	0.014
LVEF, %	0.670	10.573	<0.0001
RR, breaths/min	-0.318	-4.543	<0.0001
Hemoglobin, g/L	0.053	0.716	0.475
Leukocytes, x10 <sup>9</sup> /L	-0.156	-2.128	0.035
SBP in the first day of MI, mm Hg	0.179	2.477	0.014
Stab, %	-0.056	-0.753	0.452

ESR, mm/h	-0.07	-0.943	0.347
Lymphocytes, %	0.303	4.287	<0.0001
Glucose, mmol/L	-0.136	-1.836	0.068
AAT, mmol/L	-0.288	-4.084	<0.0001
Creatinine, $\mu\text{mol/L}$	-0.148	-2.035	0.043
Fibrinogen, g/L	0.023	0.312	0.756
Troponin T, ng/ml	-0.21	-2.437	0.016
TC, mmol/L	0.195	2.634	0.009
HDL, mmol/L	0.131	1.678	0.095
LDL, mmol/L	0.213	2.823	0.005
SpO <sub>2</sub> , %	0.399	5.766	<0.0001
CCI, points	-0.323	-4.658	<0.0001

Note. CP – comorbid pathology, HR – heart rate, SBP – systolic blood pressure, LVEF – left ventricular ejection fraction, RR – respiratory rate, ESR – erythrocyte sedimentation rate, AAT – aspartate aminotransferase, TC – total cholesterol, HDL – high-density lipoproteins, LDL – low-density lipoproteins, SpO<sub>2</sub> – arterial oxygen saturation, CCI – Charlson comorbidity index

We measured the same variables on the 30<sup>th</sup> day of patient treatment (Table 3). 6MWT<sub>30</sub> was directly correlated with LVEF, SpO<sub>2</sub>, the number of lymphocytes in the peripheral blood, the levels of total cholesterol, low-density lipoproteins. 6MWT<sub>30</sub> was inversely correlated with age, heart rate, respiratory frequency, AAT levels, troponin T and comorbidity index.

**Table 3.** Dependence of 6MWT<sub>30</sub> on clinical functional indices in patients with MI with comorbid pathology

Index	Correlation	T-criteria	p-value
Age, years	-0.287	-3.955	<0.0001
HR in acute period of MI, bpm	-0.259	-3.54	0.001
SBP in the acute period of MI, mm Hg	0.129	1.722	0.087
LVEF, %	0.583	8.394	<0.0001
RR, breaths/min	-0.357	-5.014	<0.0001
Hemoglobin, g/L	0.018	0.23	0.818
Leukocytes, $\times 10^9/\text{L}$	-0.003	-0.035	0.972
Stab, %	0.008	0.105	0.917
ESR, mm/h	-0.148	-1.954	0.052
Lymphocytes, %	0.278	3.767	<0.0001
Glucose, mmol/L	-0.078	-1.001	0.318
AAT, mmol/L	-0.209	-2.803	0.006
Creatinine, $\mu\text{mol/L}$	-0.086	-1.129	0.261
Fibrinogen, g/L	-0.034	-0.438	0.662
Troponin, ng/ml	-0.312	-3.616	<0.0001
TC, mmol/L	0.254	3.362	0.001
HDL, mmol/L	0.141	1.755	0.081
LDL, mmol/L	0.319	4.256	<0.0001
SpO <sub>2</sub> , %	0.265	3.522	0.001
CCI, points	-0.398	-5.718	<0.0001

Note. CP – comorbid pathology, HR – heart rate, SBP – systolic blood pressure, LVEF – left ventricular ejection fraction, RR – respiratory rate, ESR – erythrocyte sedimentation rate, AAT – aspartate aminotransferase, TC – total cholesterol, HDL – high-density lipoproteins, LDL – low-density lipoproteins, SpO<sub>2</sub> – arterial oxygen saturation, CCI – Charlson comorbidity index

In the analysis of 6MWT<sub>90</sub> (Table 4), we found that this parameter was directly related to systolic blood pressure, left ventricular ejection fraction, the number of lymphocytes in the peripheral blood, the levels of cholesterol, low-density lipoproteins, SpO<sub>2</sub>, but inversely correlated with age, heart rate, respiratory rate and comorbidity index.

**Table 4.** Dependence of 6MWT<sub>90</sub> on clinical functional indices in patients with MI with comorbid pathology

Index	Correlation	T-criteria	p-value
Age, years	-0.41	-5.892	<0.0001
HR in the first day of MI, bpm	-0.179	-2.386	0.018
SBP in the first day of MI, mm Hg	0.205	2.741	0.007
LVEF, %	0.583	8.394	<0.0001
RR, breaths/min	-0.298	-4.067	<0.0001
Hemoglobin, g/L	0.115	1.494	0.137
Leukocytes, x10 <sup>9</sup> /L	0.034	0.436	0.664
Stab, %	-0.057	-0.735	0.463
ESR, mm/h	-0.171	-2.255	0.025
Lymphocytes, %	0.294	3.993	<0.0001
Glucose, mmol/L	-0.112	-1.441	0.151
AAT, mmol/L	-0.105	-1.378	0.17
Creatinine, mcmol/L	-0.135	-1.771	0.078
Fibrinogen, g/L	-0.014	-0.178	0.859
Troponin, ng/ml	-0.072	-0.788	0.432
TC, mmol/L	0.202	2.627	0.009
HDL, mmol/L	0.111	1.371	0.172
LDL, mmol/L	0.285	3.74	<0.0001
SpO <sub>2</sub> , %	0.248	3.255	0.001
CCI, points	-0.427	-6.186	<0.0001

Note. CP – comorbid pathology, HR – heart rate, SBP – systolic blood pressure, LVEF – left ventricular ejection fraction, RR – respiratory rate, ESR – erythrocyte sedimentation rate, AAT – aspartate aminotransferase, TC – total cholesterol, HDL – high-density lipoproteins, LDL – low-density lipoproteins, SpO<sub>2</sub> – arterial oxygen saturation, CCI – Charlson comorbidity index

As our results show, most of these dependency factors are repeated at all three stages of rehabilitation, and therefore their significant impact on exercise tolerance during a 90-day period of the cardio-rehabilitation program is evident. In summary, we can conclude that patients with MI with comorbid pathology and high indices of age, respiratory rate, heart rate, levels of AAT, creatinine, troponin T and CCI, as well as low indices of systolic blood pressure on the first day of MI, levels of cholesterol, low-density lipoproteins and SpO<sub>2</sub> and LVEF have significantly lower tolerance to physical activity at all stages of rehabilitation. Therefore, the above parameters can be considered excellent functional clinical, hemodynamic and laboratory markers of reduced exercise tolerance and can be used to measure the response to increased physical activity as well as predict the tolerability of rehabilitation measures in patients with myocardial infarction in combination with comorbid pathology.

The Charlson comorbidity index is a special marker highly correlated with functional clinical, hemodynamic and laboratory indices and indices of exercise tolerance. This index is obviously superior to other multi-morbidity indices due to the relative simplicity of its definition and validity when evaluating the degree of comorbidity in many clinical trials [15-17]. The present study, together with previous studies [18, 19], confirmed the possibility of using the CCI to quantify the degree of comorbidity in patients with myocardial infarction with different comorbid pathology and predict exercise tolerance responses during rehabilitation stages.

## Discussion

The process of rehabilitation of a patient with MI with CP is a complex multi-level task. Moreover, the higher the degree of comorbidity of the patient and the more systems affected by pathological processes that developed prior to the myocardial infarction, the more difficult is the task of predicting the patient's response to increased physical activity. In this regard, patients with comorbidity, especially the elderly and those with many comorbid conditions, as a rule, are deprived of the possibility of active rehabilitation. However, studies suggest that all groups of patients with acute cardiovascular disease, independent of the degree of comorbidity, benefit from cardiopulmonary rehabilitation. Therefore, the presence of comorbid pathology should not interfere with the implementation of rehabilitation programs in such patients [20, 21] and, of course, the process of cardio-rehabilitation should not impair the general functional state of the body.

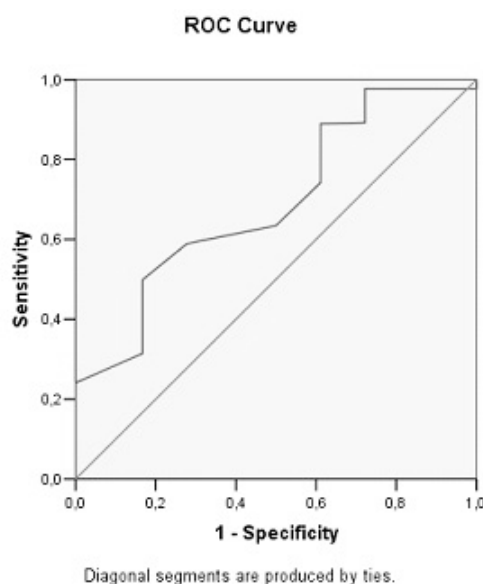
Approaches to the rehabilitation process in comorbid patients should be different from standard rehab programs, since the body's response to the standard load in such patients may be inadequate, hence the need for an active search of highly specific markers and valid methods of risk stratification for cardiovascular events (CVE) in the presence of multimorbid conditions. This requires a weighted integrated approach with an estimate of total risk [22-24]. In this plan, the Charlson comorbidity index and the six-minute walking test seem promising as rather universal combinations of assessment of degree of comorbidity and exercise tolerance. These two indicators of the general condition of a patient have a strong evidence base for the reliability of the estimated potential for various diseases [8, 25]. Our previous studies analyzed the relationship of CCI and 6MWT with the main functional indicators of patients with MI in combination with arterial hypertension, diabetes mellitus, pulmonary pathology and other diseases, and also the trends observed in the evaluation of these markers of the rehabilitation potential [19, 26-28]. In this study, we searched not only early markers for the reduction of overall function of the patient with MI with CP and their rehabilitation potential, but also the possibility of using CCI and 6MWT as integral calculators of the total risk of a comorbid patient.

Previous studies of Charlson comorbidity indices at different values of ejection fraction and 6MWT at rehabilitation stages revealed that the maximum correlation between specificity and sensitivity was observed at CCI > 2. Evaluation of the dependence of comorbidity index on the left ventricular ejection fraction showed that individuals with a higher degree of comorbidity (CCI > 2) had significantly lower values of left ventricle systolic function (LVEF < 46.5%), with 83% specificity and 50% sensitivity, with the predictive value of a positive result being 98% (Table 5, Figure 1).

**Table 5.** Matrix of sensitivity and specificity determination of comorbidity index at different values of ejection fraction

	Sensitivity	Comorbidity index specificity	Prognostic value of positive result
42.5	0.241	1	1
46.5	0.499	0.833	0.983
54.5	0.893	0.278	0.960
55.5	0.921	0.278	0.962

Note. 95% confidence interval (0.573-0.807),  $p = 0.007$



**Figure 1.** ROC-curve of sensitivity and specificity of comorbidity index with different values of ejection fraction

Note. Area under the curve 68.96%, standard error 0.060;  $p = 0.007$

In this study, we analyzed the interdependence of the Charlson comorbidity index and the six-minute walk test at different stages of rehabilitation. It turned out that  $6MWT_{10}$ ,  $6MWT_{30}$  and  $6MWT_{90}$ , which reflect the exercise tolerance, respectively, in the acute, early and late outpatient phases of the rehabilitation process, were significantly lower in patients with a higher degree of comorbidity. The maximum specificity (89%) and the prognostic value of a positive result (98%) for  $6MWT_{10}$  with CCI > 2, was observed at 62.5 m. We therefore recommend this target distance for passing a six-minute test on the 10<sup>th</sup> day of rehabilitation of post-infarction

patients when a degree of Charlson comorbidity is above 2 points. For 6MWT<sub>30'</sub>, the maximum specificity (94%) and the predictive value of a positive result (99%) were obtained with a 6MWT<sub>30'</sub> value of 103.5 m. Accordingly, the target six-minute walk test level by the end of the first month of the rehabilitation period in patients with MI with the CCI > 2 can be considered 103.5 m. And for 6MWT<sub>90'</sub>, the maximum specificity (59%) and predictive value of the positive result (96%) were obtained at the value of 199 m. The target value of 6MWT by the end of the first month of the rehabilitation period in patients with MI with CCI > 2 is 199 m.

In summary, our results suggest that the Charlson comorbidity index and the six-minute walk test are reliable prognostic markers of exercise tolerance in patients with MI with comorbid pathology at all stages of the rehabilitation process.

## Conclusions

In the 90-day period of post-infarction patient rehabilitation, markers of reduced exercise tolerance were age, respiratory rate, systolic blood pressure, levels of troponin, creatinine, AAT as well as the number of lymphocytes in peripheral blood, levels of cholesterol, low-density lipoproteins, and SpO<sub>2</sub>. These indicators of the functional state of comorbid patients with MI should be used with the aim of preliminary screening to predict the tolerance of rehabilitation measures and control of the response to increased physical activity.

The Charlson comorbidity index and the six-minute walk test at certain stages of rehabilitation should be considered integral specific markers of the functional state of the body in patients with myocardial infarction with concomitant pathology. Target values of 6MWT in patients with MI with CCI > 2 can be considered: on the 10<sup>th</sup> day of rehabilitation 32.5 m, by the end of the first month of the rehabilitation period – 103.5 m and on the 90<sup>th</sup> day – 199 m.

## Disclosures and acknowledgements

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## THE INFLUENCE OF SHIFT WORK ON THE OCCURRENCE OF HYPERTENSION, ISCHEMIC HEART DISEASE AND DYSLIPIDEMIA FROM THE PERSPECTIVE OF MINE SHIFT WORKERS

### WPŁYW PRACY ZMIANOWEJ NA WYSTĘPOWANIE NADCIŚNIENIA TĘTNICZEGO, CHOROBY NIEDOKRWIENNEJ SERCA I ZABURZEŃ LIPIDOGRAU W OPINII PRACOWNIKÓW ZMIANOWYCH KOPALNI

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##### Wkład autorów:

- A. Study design/planning  
zaplanowanie badań
- B. Data collection/entry  
zebranie danych
- C. Data analysis/statistics  
dane – analiza i statystyki
- D. Data interpretation  
interpretacja danych
- E. Preparation of manuscript  
przygotowanie artykułu
- F. Literature analysis/search  
wyszukiwanie i analiza literatury
- G. Funds collection  
zebranie funduszy

#### Summary

**Background.** Shift work may affect the occurrence and severity of hypertension, ischemic heart disease and dyslipidemia. The aim of the study was to assess the prevalence of ischemic heart disease, hypertension and dyslipidemia in shift workers. **Material and methods.** The study was carried out in the Bogdanka mine in Łęczna, Poland. The questionnaire, which was designed by the author of this work, was conducted among 700 shift workers who worked underground in the mine. Statistical analysis was performed using STATISTICA v. 7.1 (StatSoft, Poland) software. **Results.** Participants who believed that shift work may lead to deterioration of their health also believed that it may affect the occurrence of ischemic heart disease and hypertension. Almost one in four respondents had blood pressure values of > 139/89 mmHg. Almost one in ten respondents was receiving treatment for hypertension. A small number of respondents reported abnormal total cholesterol, HDL cholesterol and triglyceride levels. **Conclusions.** In the opinion of respondents, shift work can exacerbate hypertension and ischemic heart disease. Abnormal values of total cholesterol and its LDL and HDL fractions increased with age and length of work, while abnormal triglyceride values were reported most frequently by supervisors. It seems necessary to introduce training for shift workers, aimed at presenting them with the principles of prevention of cardiovascular diseases; for example, how to deal with stress, change eating habits, stop smoking and reduce coffee intake, and how to encourage physical activity and good sleep hygiene.

**Keywords:** hypertension, ischemic heart disease, lipids, shift-work

#### Streszczenie

**Wprowadzenie.** Praca zmianowa ma wpływ na występowanie i zaostrzenie nadciśnienia tętniczego, choroby niedokrwiennej serca, czy nieprawidłowych wartości lipidogramu. Celem pracy była ocena występowania u pracowników zmianowych choroby niedokrwiennej serca, nadciśnienia tętniczego i zaburzeń lipidogramu. **Materiał i metody.** Badanie przeprowadzono w kopalni "Bogdanka" w Łęcznej. Kwestionariusz własnej konstrukcji rozdano wśród 700 podziemnych pracowników zmianowych. Analizę statystyczną otrzymanych wyników przeprowadzono w oparciu o program statystyczny STATISTICA v. 7.1 (StatSoft, Polska). **Wyniki.** Osoby potwierdzające, że praca zmianowa może prowadzić do pogorszenia stanu zdrowia, uważały, że może ona wpływać na występowanie zaostrzeń choroby niedokrwiennej serca i nadciśnienia tętniczego. Prawie co czwarty ankietowany miał wartości ciśnienia > 139/89 mmHg. Prawie co dziesiąty ankietowany leczył się na nadciśnienie tętnicze. Nieliczny odsetek ankietowanych zaobserwował u siebie nieprawidłowe wartości cholesterolu HDL, TGL oraz cholesterolu całkowitego. **Wnioski.** W ocenie respondentów praca zmianowa może być przyczyną zaostrzenia nadciśnienia i choroby niedokrwiennej serca. Występowanie nieprawidłowych wartości całkowitego cholesterolu i jego frakcji LDL i HDL wzrastało wraz z wiekiem i długością pracy, natomiast nieprawidłowe wartości TGL najczęściej zgłaszały osoby sprawujące nadzór. Wydaje się koniecznym wprowadzenie szkoleń dla pracowników zmianowych, mających na celu przedstawienie im zasad profilaktyki w chorobach sercowo naczyniowych, przykładowo: jak radzić sobie ze stresem, jak zmienić nawyki żywieniowe, zaprzestanie palenia papierosów i picia kawy, dobrze prowadzona aktywność fizyczna, dobra higiena snu.

**Słowa kluczowe:** nadciśnienie tętnicze, choroba niedokrwienności serca, lipidogram, praca zmianowa

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## Introduction

About 20% of workers in Europe are employed as shift workers, involving night work and extended hours [1, 2]. Shift workers have been demonstrated to be at the increased risk of cardiovascular disease [3, 4]. Shift work is a risk factor for inflammation, elevated blood pressure, hypertension and cardiovascular disease, even after being controlled for traditional risk factors [5]. Shift workers, especially those working night shifts, must function in a setting that is unnatural. Sleep, wakefulness, digestion, adrenaline secretion, body temperature, blood pressure, pulse and many other body functions are regulated by circadian rhythm [6, 7]. In one study, shift work was found to be associated with early manifestations of cardiovascular disease [8]. The evidence suggests different interrelated pathways of how shift work leads to cardiovascular disease [9]. In addition, night shift work affecting cardiometabolic health increases blood pressure [10]. Working shifts may lead to behavioral changes, such as smoking, poor diet and reduced physical activity, which increases the risk of cardiovascular disease. Another theory is that shift work leads to desynchronization of the circadian rhythm and biological clock. A third theory suggests that disruption of the circadian rhythm due to shift work can cause imbalanced autonomic regulation of the cardiovascular system [9]. The aim of this study was to assess the occurrence of ischemic heart disease (IHD), hypertension and dyslipidemia in shift workers.

## Material and methods

The studies were conducted in the Bogdanka mine in Łęczna, Poland. Respondents working underground shifts were randomly selected, independent of their position. 700 workers were interviewed. The questionnaire was designed by the author of this study. In order to verify this scientific tool, a pilot investigation was carried out (50 people). This approach created the final version of the questionnaire. The questionnaire included the following domains: age, education, workplace, length of shift work and the impact of shift work on the occurrence of IHD, hypertension and dyslipidemia. The results were subjected to statistical analysis. In order to identify distinctions and relationships between variables,  $\chi^2$  test was used. For small numbers, Yates correction was applied. A 5% inference error was used. Values with a probability of  $p < 0.05$  were considered statistically significant. The statistical analysis was conducted with STATISTICA v. 7.1 software (StatSoft, Poland).

## Results

Taking into account the self-assessment nature of the study, the relationship between age, education, position and number of years of work and selected cardiovascular diseases was analyzed. Exacerbation of IHD due to shift work was most frequently reported by people with primary education (8.3%) (Table 1). Hypertension was most frequently reported by people aged 51 and over (12.1%), compared to younger respondents ( $p < 0.05$ ). Respondents who believed that shift work can lead to deterioration of their health also believed that shiftwork may affect the occurrence of IHD (3.5%) and hypertension (9.7%) ( $p < 0.05$ ) (Table 2). Almost a quarter of respondents (24.3%) had a blood pressure  $> 139/89$  mmHg. Among respondents with a blood pressure  $> 139/89$  mmHg, 31.9% were men aged 41-50 and 30.3% had worked 21 years and more (Tables 3 and 4). Almost one in ten respondents was being treated for hypertension (8.7%). The number of people treated for hypertension increased significantly with age and work experience (Table 4). Hypertension lasting 6 years and longer was reported by older people with longer work experience (Table 3). Abnormal lipid parameters among respondents were examined. Abnormal total cholesterol values were reported in people aged 51 and over (15.1%) who had worked 21 years and longer (10.3%). Abnormal LDL cholesterol values were reported most often in men aged 41-50 (2.6%) who had worked for 11-20 years (3.0%) ( $p < 0.05$ ). Abnormal HDL cholesterol values were reported significantly often ( $p < 0.05$ ) in people aged 51 and over (6.1%) who had worked 21 years and longer (4.6%) (Tables 5 and 6). Abnormal triglyceride values were most commonly reported in men working in supervisory positions (9.3%  $p < 0.05$ ) (Table 7). Among respondents who said that shift work can lead to deterioration of their health, a small percent reported abnormal values of HDL cholesterol (3.9%), triglycerides (3.9%) which was statistically significant  $p < 0.05$  and total cholesterol (8.7%) which was close to the significant level  $p \leq 0.05$  (Table 8).



**Table 1.** Shift work as the reason for respondents' self-reported exacerbation, ischemic heart disease and hypertension according to their education

		Education						
*		Higher education	Licentiate	Secondary education	Vocational education	Primary education	Summary	Statistic
Shift work as the cause of exacerbation of:	IHD	0 0.0%	0 0.0%	9 4.3%	6 1.6%	2 8.3%	17 2.4%	$\chi^2=10.02$ p=0.04014
	Hypertension	4 5.5%	1 5.3%	14 6.7%	28 7.5%	1 4.2%	48 6.9%	$\chi^2=0.079$ p=0.93966

\* Values do not add up to 100 due to the possibility of multiple choice

**Table 2.** Respondents' opinion on the relationship between shift work and ischemic heart disease and hypertension

*		Shift work as a reason for the deterioration of respondents' health			
		Yes	No	Summary	Statistic
Shift work as the cause of exacerbation of:	IHD	15 3.5%	2 0.7%	17 2.4%	$\chi^2=5.09$ p=0.02407
	Hypertension	42 9.7%	6 2.3%	48 6.9%	$\chi^2=14.22$ p=0.00016

\* Values do not add up to 100 due to the possibility of multiple choice

**Table 3.** The duration of hypertension and pressure values of > 139/89 mmHg by age of respondents

		Age [years]					
Duration of hypertension		21-30	31-40	41-50	51 and more	Summary	Statistic
	1-5	2 100.0%	7 70.0%	22 51.2%	3 50.0%	34 55.7%	$\chi^2=2.86$ p=0.41411
	6 and more	0 0.0%	3 30.0%	21 48.8%	3 50.0%	27 44.3%	
Blood pressure values of > 139/89 mmHg	Yes	13 11.6%	39 18.8%	111 31.9%	7 21.2%	170 24.3%	$\chi^2=24.26$ p=0.00002
	No	99 88.4%	168 81.2%	237 68.1%	26 78.8%	530 75.7%	

**Table 4.** Blood pressure values > 139/89 mmHg and treatment for hypertension with reference the number of years of shift work

		Number of years worked in the shift type				
		1-10	11-20	21 and more	Summary	Statistic
Blood pressure values of > 139/89 mmHg	Yes	30 14.5%	81 27.2%	59 30.3%	170 24.3%	$\chi^2=15.94$ p=0.00035
	No	177 85.5%	217 72.8%	136 69.7%	530 75.7%	
Treatment for hypertension	Yes	6 2.9%	28 9.4%	27 13.8%	61 8.7%	$\chi^2=15.43$ p=0.00045
	No	201 97.1%	270 90.6%	168 86.2%	639 91.3%	

**Table 5.** Dyslipidemia according to age

*		Age [years]					Statistic
		21-30	31-40	41-50	51 and more	Summary	
Dyslipidemic parameters	Total cholesterol	0 0.0%	10 4.8%	36 10.3%	5 15.1%	51 7.3%	$\chi^2=18.49$ p=0.00035
	Cholesterol LDL	0 0.0%	2 1.0%	9 2.6%	0 0.0%	3 9.1%	$\chi^2=12.49$ p=0.00588
	Cholesterol HDL	0 0.0%	1 0.5%	17 4.9%	2 6.1%	20 2.9%	$\chi^2=13.87$ p=0.00308
	Triglycerides	1 0.9%	4 1.9%	10 2.9%	3 9.1%	18 2.6%	$\chi^2=7.32$ p=0.06231

\* values do not add up to 100 due to the possibility of multiple choice

**Table 6.** Dyslipidemic parameters according to number of years of shift work

*		Number of years worked in the shift type				Statistic
		1-10	11-20	21 and more	Summary	
Dyslipidemic parameters	Total cholesterol	2 1.0%	29 9.7%	20 10.3%	51 7.3%	$\chi^2=17.42$ p=0.00016
	Cholesterol LDL	0 0.0%	9 3.0%	5 2.6%	14 2.0%	$\chi^2=6.12$ p=0.04681
	Cholesterol HDL	1 0.5%	10 3.4%	9 4.6%	20 2.9%	$\chi^2=6.64$ p=0.03612
	TGL	3 1.4%	10 3.4%	5 2.6%	18 2.6%	$\chi^2=1.77$ p=0.41228

\* values do not add up to 100 due to the possibility of multiple choice

**Table 7.** Dyslipidemic parameters according to work position

*		Work position			Summary	Statistic
		Supervisor	Miner	Over		
Dyslipidemic parameters	Total cholesterol	5 11.6%	39 7.5%	7 5.0%	51 7.3%	$\chi^2=2.29$ p=0.31869
	Cholesterol LDL	0 0.0%	10 1.9%	4 2.9%	14 2.0%	$\chi^2=1.44$ p=0.48757
	Cholesterol HDL	1 2.3%	16 3.1%	3 2.2%	20 2.9%	$\chi^2=0.39$ p=0.82344
	TGL	4 9.3%	10 1.9%	4 2.9%	18 2.6%	$\chi^2=8.68$ p=0.01306

\* values do not add up to 100 due to the possibility of multiple choice

**Table 8.** Shift work as a cause of deterioration of respondents' health according to dyslipidemia

*		Shift work as a reason for the deterioration of respondents' health			
		Yes	No	Summary	Statistic
Dyslipidemic parameters	Total cholesterol	38 8.7%	13 4.9%	51 7.3%	$\chi^2=3.65$ p=0.05594
	Cholesterol LDL	12 2.8%	2 0.7%	14 2.0%	$\chi^2=3.41$ p=0.06481
	Cholesterol HDL	17 3.9%	3 1.1%	20 2.9%	$\chi^2=4.62$ p=0.03155
	TGL	17 3.9%	1 0.4%	18 2.6%	$\chi^2=8.25$ p=0.00407

\* values do not add up to 100 due to the possibility of multiple choice

## Discussion

Epidemiologic studies show an increased prevalence of cardiovascular disease in night workers versus day workers, and field studies in shift workers have shown increased inflammatory markers and blood pressure during or following night work compared to day work or days off [5]. A prospective cohort study examined the relationship between rotating night shift work and coronary artery disease over 24 years of follow-up and found that  $\geq 5$  years of rotating night shift was associated with a significantly increased risk of coronary heart disease [11]. In our study, people who believed that shift work can lead to deterioration of health also believed that shift work may affect the occurrence of IHD (3.5%) and hypertension (9.7%). The study of Asare-Anane showed that hypertension was more prevalent among shift workers aged between 30 and 49 years of age. This study also showed a decreasing trend in the prevalence of hypertension among the shift workers aged 50–59. This observation could be due to more stressful jobs being given to the younger workers and leaving the less stressful jobs for the older workers. Continued shift work could also lead to adaptation of biological rhythms that do not promote hypertension [2]. It has been reported that shift work is associated with an increased prevalence of hypertension, but data are inconclusive [12]. In our study, blood pressure was higher than 139/89 mmHg in one in four workers, with hypertension significantly more frequent among men aged 41–50 (31.9%). In the other studies, elevated cholesterol levels among shift workers were observed and an elevated triglyceride level was reported to be associated with shift work [2, 13]. This may be due to reduced sleep duration associated with the shift work. Reduced sleep has been linked to disruption of biological rhythms and dyslipidemia [2, 14]. Different studies have confirmed a direct relationship between shift work and cardiac disease and dyslipidemia. However, data are conflicting, with Akbari et al. reporting no relationship between shift work and changes in serum triglyceride and cholesterol [15]. In our study, a small percent of respondents reported abnormal values of HDL cholesterol (3.9%), triglycerides (3.9%) and total cholesterol (8.74%),  $p \leq 0.05$ .

## Conclusions

1. In the opinion of respondents in this study, shift work can exacerbate hypertension and ischemic heart disease. One in four respondents reported blood pressure  $> 139/89$  mmHg during regular measurements, out of whom one in ten was being treated for hypertension.
2. Abnormal total cholesterol and LDL and HDL cholesterol fractions increased with age and length of work, while abnormal triglyceride values were reported most frequently by supervisors.
3. It seems necessary to introduce training for shift workers, aimed at presenting them with the principles of prevention of cardiovascular diseases; for example, how to deal with stress, change eating habits, stop smoking and reduce coffee intake, and how to encourage physical activity and good sleep hygiene.

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PART II. PHYSICAL ACTIVITY OF SOCIAL AND PROFESSIONAL GROUPS  
DZIAŁ II. AKTYWNOŚĆ FIZYCZNA GRUP SPOŁECZNYCH I ZAWODOWYCH

PERSONALIZED REHABILITATION THERAPY IN OBESE AND ELDERLY PATIENTS  
UNDERGOING HIP REPLACEMENT SURGERY

PERSONALIZACJA REHABILITACJI U OSÓB OTYŁYCH ORAZ W PODESZŁYM WIEKU  
PODDANYCH ZABIEGOWI ENDOPROTEZOPLASTYKI STAWU BIODROWEGO

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A. Study design/planning  
zaplanowanie badań  
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Summary

Due to aging of the population and the desire of people to maintain the best possible mobility, the demand for hip replacement is increasing. As a result, personalization of physical therapy after surgery is needed to achieve the best possible outcomes. However, patients undergoing hip replacement surgery often have additional factors, such as advanced age and obesity, which may hinder the process of rehabilitation. The aim of this study was to review the need and recommendations for personalized physical therapy before and after hip replacement surgery in patients with co-morbid factors such as advanced age and obesity. The research literature emphasizes the importance of effective recovery following hip replacement surgery. Older patients may require prolonged postoperative rehabilitation due to the type of surgery, muscle weakness or cognitive dysfunction. Proprioception and balance disorders may benefit from training on an unstable surface aimed at learning safe falling and getting up after a fall. Weakened gluteal muscles which may be present in the elderly and obese may benefit from strength training in the preoperative period. Excessive exposure of the elderly and obese to thromboembolic complications necessitate the inclusion in rehabilitation programs of exercises based on active ankle movement.

**Keywords:** rehabilitation, arthroplasty, replacement, hip replacement

Streszczenie

Ze względu na proces starzenia się społeczeństw i dążenia do możliwie najdłuższego zachowania pełnej sprawności funkcjonalnej, zwiększa się zapotrzebowanie na zabiegi endoprotezoplastyki stawu biodrowego. W związku z tym, pojawia się konieczność personalizacji procesu usprawniania związanego z zabiegiem w celu osiągnięcia jak najlepszych końcowych wyników. Należy jednak pamiętać, że pacjenci poddawani zabiegowi endoprotezoplastyki stawu biodrowego często obciążeni są dodatkowymi czynnikami utrudniającymi proces rehabilitacji w postaci zaawansowanego wieku i otyłości. Celem pracy jest zwrócenie uwagi na konieczność personalizacji procesu usprawniania przed i po zabiegu endoprotezoplastyki stawu biodrowego u chorych z dodatkowymi czynnikami obciążającymi w postaci zaawansowanego wieku i otyłości w stosunku do obowiązujących rekomendacji i zaleceń. Najnowsza literatura badawcza szeroko dyskutuje aspekt optymalizacji procesu usprawniania po endoprotezoplastyce stawu biodrowego. Zaawansowany wiek pacjentów może wiązać się z koniecznością wydłużenia czasu rehabilitacji pooperacyjnej. Wynika to z rodzaju dostępu operacyjnego, osłabienia siły mięśniowej czy zaburzeń funkcji poznawczych. Zaburzenia propriocepcji i równowagi przekonują do zastosowania elementów rehabilitacji funkcjonalnej z elementami treningu równoważnego na niestabilnym podłożu, nauki bezpiecznego upadania i wstawania po upadku. Osłabienie siły mięśnia pośladkowego średniego obecne wśród pacjentów starszych i otyłych sugeruje, że wymierne korzyści może mieć stosowanie treningu wzmacniającego jeszcze w okresie przedoperacyjnym. Szczególne narażenie osób starszych i otyłych na powikłania zakrzepowo-zatorowe skłania natomiast do starannego wykonywania ćwiczeń opartych na aktywnym ruchu stawu skokowego.

**Słowa kluczowe:** rehabilitacja, artroplastyka, endoprotezoplastyka, endoprotezoplastyka stawu biodrowego

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## Introduction

The evolution of society brings not only ubiquitous technical and medical benefits, but also serious health problems. Among them, degenerative joint diseases are an important problem resulting, in part, from a sedentary life style and which can, in turn, lead to other health problems, such as obesity. At the same time, we are living longer and we expect that modern medicine will allow us to function well into old age.

One of the ways to optimize recovery following hip replacement is a personalized rehabilitation program, taking into account the co-morbid conditions of advanced age and obesity commonly found in people suffering from joint disease. The two main conditions discussed in this study (older age and obesity) are related to a number of complications of hip replacement surgery including the more frequent need for revision, infection, loosening of the prosthesis, muscle weakness, balance disorders, reduced ability to concentrate and learn and depression [1, 2, 3, 4, 5].

The physical therapy programs currently proposed in the context of hip replacement surgery require solutions that take into account the individual needs of each patient. The program is not only postoperative but also preoperative to identify patients who require special interventions.

## Data justifying the need for personalization of rehabilitation programs

Hip degeneration is the most common form of degenerative disease. Its frequency differs between countries. In Poland 40% of the population have hip degeneration and in Europe and the USA it is 12% [6].

In Poland, 39,854 hip arthroplasty procedures were performed in 2010, and, in 2015, the number of procedures was 46,685 [7]. Internationally, it is expected that the number of hip replacements will increase by 170% by 2030, and that increase will likely be mirrored in Poland [4].

The frequency of osteoarthritis increases with age and is over 60% among people over the age of 65. Given the widespread phenomenon of aging in Europe, osteoarthritis will be a major social problem in the coming decades [8].

A report commissioned by the Ministry of Health in 2015 indicates that the most common reasons for hip replacement (89% of cases) were bilateral osteoarthritis, hip fracture and other forms of arthritis. Revision is most often caused by mechanical complications related to the prostheses, including loosening and infections, and the incidence of complications increases with aggravating factors such as age, obesity or diabetes that increases the risk of infection [7]. According to data from 2015, most surgeries were performed in patients aged 60-69 and 70-79, accounting for 58% of all treatments [7, 9].

Numerous research studies have focused on obesity as a contributor to degeneration of the hip and to post-operative complications. The estimated number of patients with obesity varies in research studies from 41% to 77% [5, 9, 10, 11, 12].

The main treatment of osteoarthritis is hip replacement, supplemented by preoperative and postoperative rehabilitation. As the condition mainly occurs in the elderly, the presence of other factors complicating treatment should be considered. In addition to older age, diabetes, obesity and other co-morbid conditions are common in this group of patients. These aggravating factors underscore the need for personalized physical therapy. An individual approach to each patient, appropriate to his or her current state of health, will permit for the best possible outcome in the shortest possible time.

## Objective

The aim of this work was to review the role of and recommendations for personalized physical rehabilitation before and after hip replacement in patients with additional risk such as advanced age and obesity.

## Recommendations for physical rehabilitation in people undergoing hip replacement

In individual countries, recommendations for physical therapy in persons undergoing hip replacement differ. There are no uniform guidelines for the timing of rehabilitation post-surgery or after discharge from the orthopedic department, or for specific techniques for use in elderly and obese people.

The Global Orthopedic Registry (GLORY) reports that the postoperative hospital stay in the US is 3 days, in Great Britain it is 9 days, in Germany 11 days, and in Japan up to 30 days [13]. Recommendations for physical therapy range from a few days to 2-4 weeks after leaving the orthopedic department. The rehabilitation program focuses on an individual and group occupational therapy as well as functional exercises.

Recommendations from the USA and Canada emphasize the importance of functional strengthening exercises, working in the active range of movement and walking up stairs. Similar recommendations follow recent studies among physiotherapists in Great Britain and the Netherlands [14, 15].

The Polish model of comprehensive care for hip replacement is based on data from the analysis provided by the NFZ Headquarters (National Health Fund), other scientific evidence and expert opinion, in addition to financing data from other countries. The first stage is preoperative care, which includes assessment of eligibility for surgery, selection of the optimal preoperative physical therapy and, if necessary, consultation with physicians of other specialties. At this stage of preparation, patients receive education on the planned stay in the hospital, the use of orthopedic supplies after the procedure, instructions on what movements should not be performed and the overall rehabilitation plan. The patient is also informed on how to adapt the home environment to minimize the risk of complications.

The second stage is hospitalization, during which the patient is directly prepared for the procedure, usually commencing one day before the planned operation. The patient's rehabilitation begins with mobilization on the first day following surgery. The usual time of hospitalization is 5 days, and in the case of elderly people with comorbidities, it is prolonged. During this time, further rehabilitation and patient education take place (outpatient, stationary, home, daily).

The third stage is the post-hospital period, which includes 2-3 therapy visits. During this time, decisions about the scope and timing of further rehabilitation are made. The NFZ model provides for one stay in a day rehabilitation ward and one stay in an outpatient rehabilitation facility in the first one year following the procedure [7].

The recommendations do not take into account individual patient needs. These result from the often advanced age and co-morbid conditions of patients undergoing hip replacement surgery. Similarly, there are patients with obesity who are at risk for more complications and whose regenerative abilities are reduced. The presence of these risk factors significantly affects the outcomes of therapy and should be considered during the planning phase.

### **Considerations for older people undergoing arthroplasty**

Older people require a special approach when preparing for the procedure. After establishing the indications and contraindications for rehabilitation in the pre-operative period, a rehabilitation plan should be introduced, tailored to the patient's needs, preparing for weight bearing and temporary post-operative relative inactivity. Depending on the individual level of functional fitness, the following general exercises are performed: conditioning exercises, simulation of the post-operative situation, learning to change position in bed, self-care and antithrombotic exercises. Particularly important during this period is general exercise to counteract the negative effects of postoperative relative inactivity. They can take the form of various types of endurance training, from walks to exercises on a cycloergometer or treadmill with intensity adjusted to the patient's performance [16].

A separate category of patients are those who, due to coexisting disorders, require an individualized approach. These are people with postural defects or limitations of joint mobility, chronic respiratory diseases, hearing and visual impairment, and reduced cognitive and intellectual abilities [16].

The natural aging process is associated with reduced regenerative ability following surgery. With age, neuromuscular coordination, balance, defensive reactions and cognitive functions deteriorate. Additionally, osteoporosis and muscle loss commonly present in elderly patients.

Research conducted in Japan in the elderly following hip and knee arthroplasty, showed that patients aged 65 and over who underwent surgery reported a reduced quality of life due to pain and the risk of falls. These results emphasize that people over the age of 65 have a much greater risk of falls, necessitating an individually tailored physical therapy program [17].

An unfavorable prognosis among the oldest patients is also associated with impaired cognitive function. In the same research from Japan, it was shown that personalized physical training contributed to a decrease in depressive moods and a more rapid increase in fitness among patients with impaired cognition, giving patients an improved chance to continue a healthy and high-quality life. There was also a correlation between intensive post-operative rehabilitation and improvement in gait within a short time after the procedure. In the event of early discharge from the hospital, the task of the therapist is to teach the patient how to improve gait function at home. Available literature suggests that the greatest improvement in health-related quality of life occurs shortly after surgery, but peak times differ. Some sources report that patients improved after 6 months after surgery and maintained improvement for up to 4 years, while other studies report that peak improvement was achieved after one year and declined within 7 years [17].

There are concerns about the deterioration of cognitive function and the occurrence of delirium among older patients, making diagnosis with simple screening tests such as MMSE (Mini-Mental State Examination) important. It is known, however, that motion therapy has a beneficial effect on cognitive function and general mental health [17].

Among the adult population, hip fractures are the result of high energy injuries, and the peak occurrence is among older people. As a result of the aging process and widespread osteoporosis in the elderly, fractures of the femoral neck are caused by low-energy injuries [18]. The estimated survival rate after femoral fractures among older people is 23.3% for men and 11.2% for women [19].

Older people are often at risk of falls caused by balance disorders, mental illness, medications, visual disturbance and the inability to adapt to the external environment. Considering disorders of coordination and defense mechanisms in the elderly and the reduction of bone density, the risk of fracture is high [20].

Scientific evidence suggests that hip replacement is the treatment of choice among patients with a high level of fitness, and numerous studies confirm that this procedure allows recovery with improved fitness and quality of life. Post-operative rehabilitation shortens the time of hospitalization, reduces the occurrence of complications, improves functional efficiency and reduces the need for third party assistance [20]. In addition, special attention should be paid to the overall care of the patient, taking into account other conditions that may coexist in older patients such as anemia, chest or urinary tract infections, undiagnosed heart problems or dementia. The complexity of the problem requires a holistic approach and involvement of geriatricians in order to minimize the risk of complications associated with co-morbidities [20].

Research suggests that hip replacement in the case of hip fracture is a procedure that provides faster recovery, better functional improvement and reduces the number of complications compared to the internal anastomosis procedure. However, there are reports of increased initial costs of treatment and greater blood loss during surgery as well as an increased risk of dislocation and infection [20]. Replacement is associated with a greater than 90% 10 year survival with reduced postoperative pain and the need for revision of the surgery due to acetabular pain due to erosion [21].

The group of patients above 80 years of age is particularly prone to postoperative complications and hospital readmission. In this age group, treatment models based on intensive rehabilitation and as short as possible hospitalization time may not be applicable. Due to existing comorbidities, these patients require measures adjusted individually to their condition, which often translates into longer hospital stays or longer rehabilitation after discharge [22].

### **Obesity in the context of replacement procedures**

Obesity is associated with complications due to a higher weight-bearing burden compared to patients with normal body weight. It is also more difficult to restore normal walking patterns due to inadequate muscle strength of the pelvic girdle.

In the era of sedentary lifestyles, we observe a continuous increase in the number of people with obesity, which leads to the acceleration of the development of osteoarthritis, resulting in a reduction in the age of patients undergoing hip replacement [23]. Obesity is also a serious burden on the body during the procedure and subsequent rehabilitation, which often involves the need to extend the time of hospitalization and adapt the rehabilitation plan.

It is estimated that significant weight loss in a year after surgery occurs in 14-49% of patients. It seems logical, therefore, to encourage patients to reduce their weight before surgery. However, they have other conditions such as diabetes or thyroid disease, which hinder the weight reduction process. In addition, vitamin D deficiencies, which increase susceptibility to fractures, are common among postmenopausal women [24].

The preparation of obese people for hip replacement includes not only weight reduction and bone reinforcement but also preparation of the circulatory and respiratory systems for the increased post-operative workload. Therefore, pre-operative rehabilitation should include exercises involving large muscle groups that increase general joint mobility, exercises with moderate resistance to stimulate the skeletal system and conditioning exercises adjusted to the individual patient's capabilities that increase cardiovascular and respiratory efficiency [25].

Research conducted among patients with different BMI (Body Mass Index) values underscores that people suffering from morbid obesity (BMI > 50) are exposed to significantly more serious postoperative complications, including the need for early reoperation, which entails higher costs [26]. According to retrospective studies that assess the presence of twelve increasingly serious complications during the first 90 days following surgery, patients with morbid obesity are much more likely to be exposed to implant infections, need for revision,



wound dehiscence, deep vein thrombosis, pulmonary embolism, implant failure, acute renal failure, myocardial infarction and implant dislocation [27].

### **Personalization of the rehabilitation program**

In the era of global aging and increasing incidence of social morbidities, including obesity, the priority is to develop new rehabilitation guidelines that will optimize the rehabilitation process, reduce treatment costs and ensure that the patient has the best possible function in everyday life. Personalization of the rehabilitation process is essential to achieving the best outcomes. There has been a discussion in the literature for a long time on modifying rehabilitation strategies, but there are no clear guidelines for the management of patients with specific illnesses such as obesity, diabetes or other age related conditions.

It has been shown that, one year after the procedure, 50% of patients who underwent hip and knee hip replacement did not show clinically significant differences in the scale of perceived pain and activities of daily living (ADL). At the same time, it was shown that systematic training in people with osteoarthritis effectively reduced pain and improved ADL scores. Studies of the effectiveness of an 8-week pre-surgery training program showed a tendency to shorter time of hospitalization, and thus the costs of treatment. There was also a slight to moderate improvement in clinical recovery, which, however, translated into a significant improvement in quality of life. Current standards suggest that a training program of 2 to 4 week's duration, which in light of the results obtained seems to be insufficient, supports reflection on the need to extend the rehabilitation period to adequately reflect to the patient's post-operative status [28].

Subsequent studies were conducted on the basis of a two-case study (female and male) using a 6-week rehabilitation program comprising 18 sessions containing two 15-minute elements of aerobic training and a 20-minute strengthening training with 10-minute breaks between exercises. The women's training focused on improving gait function (improving speed, going uphill, and going up stairs). Therefore, a variable-gradient treadmill and an elliptical machine were used, and strengthening training employed based on walking with increasing load, walking on different surfaces and working on improving stabilization. Men were found to improve through running and playing golf. A treadmill was used with increasing speed, supplemented by training based on swinging movements of various ranges and the balls of different heaviness and simulation of the game of golf [29]. At the end of the whole cycle, the adductor's strength increased by 25% and knee extensors by 33%. Compared to men, women obtained better results which were sustained for 12 months. In the second case study, results were not matched with those before the procedure, and, over third consecutive months, there was a weakening of muscle strength. This can be caused by large tissue damage associated with anterolateral lateral surgical access. Therefore, in these men consideration should be given to extending the length of the training plan. Operational access and associated tissue damage and the healing process can have a significant impact on the rehabilitation process after hip arthroplasty, necessitating an individual approach to each patient [30].

Judd et al. showed that the decrease in physical activity one month after the endoprosthesis procedure resulted in loss of muscle strength and functional deficits and decreased physical activity. Interestingly, the loss of strength in the operated limb was not limited to the muscles of the iliac girdle. Although the muscles controlling the iliac rim lost the most on endurance, the deficits were more widespread [31]. This was confirmed by the study of Readon et al., who showed that weakening of the strength of the quadriceps muscle persists within 5 months after replacement [32]. It has also been demonstrated that reduction of muscle strength of flexors, rectifiers and hip abductors lasts from several months to several years after surgery [33, 34].

However, considering that the decrease in muscle strength occurs early after surgery at the time when rehabilitation has the greatest impact, it is reasonable to support early physiotherapeutic intervention to improve long-term rehabilitation results. This will facilitate a more rapid recovery of the lost muscular strength and will facilitate better long-term outcomes of the postoperative rehabilitation [31].

An important component of the rehabilitation plan in the early period following the procedure is active ankle movements used to prevent thromboembolic complications. It has been proven that the optimum frequency of ankle movements for the flow of blood in the deep thigh vein is 60 contractions per minute. Elderly and obese people are particularly at risk of thromboembolism complications, supporting the need to perform this type of exercise with particular care and set a slightly higher intensity than in younger people with normal BMI [30].

Osteoarthritis is associated with a weakening of proprioception, i.e. a deep sensation, through which the body derives information about the position of particular parts of the body. The results of previous studies are contradictory and do not give a definite answer whether the reconstructive procedure results in the improvement or deterioration of deep sensation. In association with balance disorders common in the elderly, proprioception disorders additionally increase the risk of falls, so, in such cases, more attention needs to be paid to proprioception disorders when planning rehabilitation programs [35].

A study investigating changes in proprioceptive responses during a 5-week training program, which included additional exercises to improve proprioception, among patients following hip and knee arthroplasty showed a significant improvement in balance compared to the control group, which underwent only standard training [31]. This suggests that the rehabilitation process for the elderly should include broadly defined balance training, including walking on different surfaces, using devices such as a BOSU balance ball, sensomotor cushion, a ramp and training in safe falling.

In 2016, results were published of research into the impact of pre-operative atrophy of the gluteus muscles on gait disturbances occurring within 6 months after hip replacement surgery. Weakening of the iliac rim muscles leads to the fixation of abnormal gait function patterns. The patient, in order to relieve the aching joint, tilts the torso towards the other limb (with better stabilization) and in this way compensates for the failure of the abductor on the dysfunctional side during gait. The pre-operative strength of muscles stabilizing the pelvis during walking may be a determinant of postoperative improvement of gait function. Analogous studies have demonstrated the impact of pre-operative quadriceps strengthening on results obtained shortly after replacement [36].

Pain associated with the degenerative process, which contributes to a reduction in patients' activity and encourages them to relieve weight on the limb, is the main cause of muscle weakness. Screening performed before the operation to identify people with this problem will allow personalization of the rehabilitation process, taking into account existing muscle dysfunction. This will allow the setting of training goals appropriate to the patient's needs and a more rapid improvement of gait function [36]. Pre-operative training may also strengthen the middle gluteal muscles.

Obesity is one of the most important factors determining the rate of increase in muscle strength after the procedure. Patients with an increased BMI need greater abductor strength compared to patients with a normal BMI. Therefore, regaining muscle strength necessary for proper walking is much more difficult for obese patients. However, weight reduction before the procedure does not guarantee improvement in muscle strength or walking capacity [37].

Ikeda et al. in their study also focused on the importance of psychological factors in post-operative recovery. They report that depression, which often occurs in elderly and chronically ill people, extends the time of rehabilitation, limiting ADL even up to two years after surgery. Depression is also associated with a more frequent early re-operation. It is assumed that the patient's mental state and muscular strength are interrelated, and prolonged muscle weakness translates into worsening of mood due to the impaired everyday living and social life. The psychological state of patients is, therefore, another aspect that requires personalization of the rehabilitation program and, if necessary, appropriate interventions aimed at improving mental and social functioning [37].

## Conclusions

In the research literature, optimizing rehabilitation therapy following hip replacement surgery is widely discussed. Many issues affect patient recovery, especially when their health is burdened by obesity and conditions associated with the aging process. Personalization of rehabilitation therapy will guarantee optimal treatment outcomes and permit satisfactory participation in day-to-day and social life.

Older patients may need an extended period of post-operative rehabilitation, which is influenced by the type of surgical access and muscle weakness due to degenerative disease or cognitive impairment. Proprioception and balance disorders also require functional rehabilitation with training on unstable ground, learning how to avoid falls and how to fall safely. The weakness of the gluteus medius present in older and obese patients suggests that the use of strengthening training in the pre-operative period may improve outcomes. The predisposition of elderly and obese people to thromboembolic complications supports the use of appropriate exercises based on active ankle movement. The importance of personalization and individualization of rehabilitation programs for persons undergoing arthroplasty is the subject of ongoing research, and educational and scientific deliberations, especially in the context of elderly and obese people.

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## IMPACT OF THE SECOND STAGE OF CARDIAC REHABILITATION ON BMI IN PATIENTS AFTER CARDIAC INCIDENTS

### WPŁYW DRUGIEGO ETAPU REHABILITACJI KARDIOLOGICZNEJ NA WSKAŹNIK BMI U PACJENTÓW PO ZAWALE MIĘŚNIA SERCOWEGO

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Wkład autorów:

A. Study design/planning  
zaplanowanie badań  
B. Data collection/entry  
zebranie danych  
C. Data analysis/statistics  
dane – analiza i statystyki  
D. Data interpretation  
interpretacja danych  
E. Preparation of manuscript  
przygotowanie artykułu  
F. Literature analysis/search  
wyszukiwanie i analiza literatury  
G. Funds collection  
zebranie funduszy

#### Summary

**Background.** Cardiovascular disease is currently one of the leading causes of death in the world, and a major contributing factor is the increasing incidence of excessive body mass. On the other hand, reduction of body mass in patients who have experienced a myocardial infarction significantly reduces the risk of a second episode of cardiovascular disease. This in turn increases lifespan, improves quality of life, and reduces the number of premature deaths.

**Material and methods.** The study included 41 people (14 women with an average age of 62.5 years and 27 men with an average age of 61.2 years) who experienced a cardiac incident between January 2015 and February 2016 and who were qualified for the second stage of cardiac rehabilitation conducted in accordance with applicable standards.

**Results.** BMI did not correlate with the results of exercise tests. The training improved the fitness and endurance of the subjects and allowed reduction of body mass.

**Conclusions.** After 8 weeks of the second stage of cardiac rehabilitation, there were significant changes in the BMI in patients undergoing the study. Exercise tolerance and physical capacity in all the groups was improved.

**Keywords:** cardiac rehabilitation, Body Mass Index, excess body weight, obesity

#### Streszczenie

**Wprowadzenie.** Choroba sercowo-naczyniowa jest obecnie jedną z głównych przyczyn zgonów na świecie. Narastającym problemem jest zbyt duża masa ciała, która jest jednym z głównych czynników powodujących stany sercowo-naczyniowe. U pacjentów po zawale mięśnia sercowego zmniejszenie BMI znacznie redukuje ryzyko drugiego zaostrzenia choroby sercowo-naczyniowej, co zwiększa długość i komfort życia oraz zmniejsza liczbę zgonów.

**Materiał i metody.** Badaniem objęto 41 osób - 14 kobiet (62,5 roku) i 27 mężczyzn (61,2 lat), u których doszło do incydentu kardiologicznego między styczniem 2015 r. a lutym 2016 r., i które zakwalifikowano do drugiego etapu rehabilitacji kardiologicznej prowadzonego zgodnie z obowiązującymi standardami.

**Wyniki.** BMI nie koreluje istotnie z wynikami badań wysiłkowych. Ukończony trening poprawił kondycję i wytrzymałość uczestników oraz pozwolił zmniejszyć masę ciała.

**Wnioski.** Po 8 tygodniach drugiego etapu rehabilitacji kardiologicznej wystąpiły istotne zmiany w BMI u pacjentów poddanych badaniu. Poprawiono tolerancję wysiłkową i wydolność fizyczną we wszystkich badanych grupach.

**Słowa kluczowe:** rehabilitacja kardiologiczna, BMI, nadwaga, otyłość

Tables: 5

Figures: 0

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#### Introduction

The main diseases of civilization that currently cause the largest number of deaths are cardiovascular conditions, and in particular, coronary artery disease [1]. According to statistics from the World Health Organization, about 17 million people die every year from cardiovascular illnesses. The highest death rate is due to ischemic heart disease [2].

The main predisposing factor behind the emergence and development of heart disease is the lack of a healthy lifestyle, which leads to excess weight and its complications [3]. On the basis of epidemiological data, the World Health Organization states that obesity is considered an epidemic of our time [4] and has been classified as a chronic non-infectious disease. According to the report by the World Health Organization about 18% of adults in developed countries suffer from obesity [5]. Moreover, the results of the NATPOL 2011 study show an

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unfavorable growing trend regarding the body mass of subjects in Poland. On the basis of the study results, it is forecasted that by 2035 the number of people suffering from obesity will increase from 22% to 33% (from 6.5 million people to over 9 million people) [6].

The aim of comprehensive cardiac rehabilitation is to improve the patients' quality of life, consolidate the effects of their cardiac treatment and improve their overall fitness and efficiency. The additional detailed objectives of cardiac rehabilitation are selected individually for each patient, depending on their needs and physical, economic and social capabilities. They can be related to the regulation and stabilization of blood pressure, weight loss, improvement of blood biochemical components and many other individually selected goals. The increase in the overall fitness and efficiency of the patient's body enables him to return to work and allows him to become independent with everyday activities. In addition, rehabilitation has a positive effect on limiting the progression of disease, counteracting complications and improving the quality and comfort of life [7, 8].

The aim of this article is to assess the impact of the second stage of cardiac rehabilitation on changes in BMI and exercise tolerance of patients after cardiac events.

## Material and methods

### *The study group*

The subjects were in the care of a cardiologist who, in the course of qualifying them for cardiac rehabilitation, ruled out contraindications to participation in this study. Additionally, each of the subjects gave written consent for participation in research, sharing results and processing of personal data collected for scientific purposes. The study was conducted from October 2015 to April 2016.

The study included 41 people—14 women (62.5 years  $\pm$  8.32) and 27 men (61.2 years  $\pm$  10.18)—who experienced a cardiac incident between January 2015 and February 2016 and were qualified for the second stage of cardiac rehabilitation. This rehabilitation was conducted by the Center for Prevention and Rehabilitation (CREATOR) located at Lotnicza 37 Street, the city of Wrocław.

All 41 participants had an intervention for coronary artery disease: 31 had stent placement and 10 had coronary artery bypass surgery. Occurring co-morbidities and medications, in the assessment of the qualifying cardiologist, did not have a significant impact on the results of the study. Patients did not use a specific diet.

### *Criteria for inclusion*

- Exacerbation of cardiac disease between January 2015 and February 2016 requiring hospitalization and cardiac intervention
- Active participation in cardiac rehabilitation
- Expressing written consent for participation in the study

### *Exclusion criteria*

- Nicotinism
- Alcoholism
- Advanced diseases of the musculoskeletal system or amputations
- Cancer

### *Six-Minute Walk Test*

The six-minute walk test is the simplest of many methods for objectively assessing the patient's exercise tolerance, efficiency and functionality. The tests were conducted according to general recommendations and standards of the American Association of Thoracic Diseases. The results, which were obtained using Coonors' formulas, enabled the calculation of the average speed of the walk expressed in kilometers per hour and the energy expenditure expressed in METs.

The average walk speed in the six-minute corridor test:

$$V_{\text{average}} = (\text{distance covered in meters} * 10) / 1000 \text{ [km/h]}$$

Energy expenditure of a six-minute corridor test:

$$W_E = (\text{average speed of walking [km/h]} * 1.667 + 3.5) / 3.5 \text{ [MET]}$$

The six-minute walk test should be performed before and after the rehabilitation stage in order to determine the effectiveness of training and exercise, and also to document progress and changes in exercise tolerance [9, 10].

#### *Exercise test according to the RAMP protocol*

The electrocardiogram exercise test that was performed according to the Ramp protocol took place in the Center for Prevention and Rehabilitation (CREATOR) and was conducted by a physiotherapist who used a stationary cycle ergometer (CRG200 v. 312) and ASPEL Cardio TEST software. Before the beginning of the test, blood pressure and heart rate were measured. From the second stage of the test, power was increased by 25 W every 10 seconds. Exercise heart rate was constantly monitored by an electrocardiogram. Blood pressure was measured at the end of the warm-up, immediately after the end of the trial and then after 3 minutes, and also after a recovery period, the duration of which was individual for each patient.

#### *Exercise test according to the modified Bruce protocol*

The electrocardiographic exercise test that was performed according to the modified Bruce protocol also took place in the Center for Prevention and Rehabilitation (CREATOR) and was conducted by a cardiologist who used a treadmill with an adjustable incline.

Exercise heart rate was constantly monitored by an electrocardiogram. Blood pressure was measured in the third minute of each stage, after the end of the trial and after a recovery period, which was individual for each patient.

#### *The course of cardiac rehabilitation conducted in the Center for Prevention and Rehabilitation (CREATOR)*

Patients with a referral to cardiac rehabilitation performed a series of 21 treatment sessions; these were performed three times a week. On the basis of the performed exercise tests, the patients were assigned to appropriate groups and their individual cycle ergometer endurance training was programmed. The training was conducted three times a week for 45 minutes. The rehabilitation cycle ergometer CRG200 v.312 and Aspel AsTER software were used during the training. It was a modified interval training adapted to the individual needs of the patient. The effort phase was equal to the rest phase. Most often during the training, there were 5 phases of effort with increasing difficulty level to the third phase and then decreasing to the initial state. Depending on the patient's mood on a given day of treatment, the software enables individual changes in the training that was previously programmed on the basis of electrocardiographic strength tests [8, 11].

General-fitness exercises were conducted every day for 30 minutes in two groups divided according to ability level. Based on the exercise test that was carried out according to the modified Bruce protocol, the patients were assigned to the appropriate rehabilitation group. In the case of the A model of cardiac rehabilitation, the gymnastics was conducted dynamically in a standing position with the use of tools and instruments located in the gymnasium. The patients performed endurance, strengthening, stretching, breathing and relaxation exercises. In patients qualified for model B cardiac rehabilitation, the exercises were conducted in a sitting position on an unstable floor. Similar to the A model, endurance, strengthening, stretching, breathing and relaxation exercises were performed. The unstable floor was intended to additionally stimulate deep torso muscles and to strengthen the postural control of patients [11]. During the cardiac rehabilitation program, patients were provided with third-degree prophylaxis in the field of cardiac disease, and each patient also had at least one visit with a psychologist.

#### *Statistical analysis*

The test results were collected and compiled in an Excel 2007 spreadsheet, and then subjected to statistical analysis by STATISTICA version 10 PL (StatSoft, USA). To test the normality of the examined parameters' distribution, the Shapiro-Wilk test was used on all the study groups. The basic descriptive statistics for measurable features were calculated: arithmetic mean, standard deviation and minimum and maximum values

were determined. In order to determine the significance of differences between the examined parameters in the studied groups, the analysis of variance for repeated measurements and Tukey's test were used in the case of statistically significant results of variance. Additionally, Pearson's correlation coefficient was calculated for selected parameters. In the applied statistical tests, the values of coefficients and tests at the level of  $p < 0.05$  were assumed to be statistically significant. The relevant values are marked in the tables.

## Results

Selected results that are statistically significant are presented in the tables below. Table 1 presents the basic characteristics of the group of respondents, including the division into sex. Tables 2 and 3 present basic descriptive statistics. For significant variance analysis results, the post-hoc test was conducted.

The Tukey test results are presented in Table 4. In addition, the Pearson correlation coefficient was calculated for selected parameters. The results are presented in Table 5.

**Table 1.** Characteristics of the subjects based on sex

Data	Women		Men	
Subjects (number %)	14 (34.15%)		27 (65.85%)	
	Before	After	Before	After
Proper body mass	2 (14%)	2 (14%)	3 (11%)	4 (15%)
Excess weight (BMI >25 kg/m <sup>2</sup> )	7 (50%)	6 (42%)	9 (33%)	9 (33%)
Obesity (BMI >30 kg/m <sup>2</sup> )	5 (36%)	6 (42%)	15 (55%)	14 (51%)

**Table 2.** Descriptive statistics for selected parameters – men

Variables	Number of subjects	Average	SD	Minimum	Maximum	Median
AGE	27	61.15	10.18	42.00	72.00	62.00
HEIGHT	27	172.76	6.15	162.00	186.00	170.50
MASS 1	27	91.57	16.34	66.40	127.00	92.00
MASS 2	27	90.25	15.94	66.30	124.50	89.60
BMI 1	27	30.64	5.00	23.10	41.50	30.80
BMI 2	27	30.20	4.85	23.10	40.60	30.30
6MWT 1	27	513.43	87.36	325.00	675.00	500.00
6MWT 1 V	27	5.13	0.80	-	-	-
6MWT 1 MET	27	3.45	0.38	-	-	-
6MWT 2	27	556.94	75.51	375.00	725.00	562.50
6MWT 2 V	27	5.57	0.77	-	-	-
6MWT 2 MET	27	3.65	0.38	-	-	-
RW 1	27	200.19	50.03	110.00	290.00	190.00
RW 2	27	230.45	44.41	145.00	320.00	223.00
BMET 1	27	8.99	3.51	2.30	17.20	10.10
BMET 2	27	9.92	4.03	2.30	17.20	10.10

**HEIGHT** – body height of the subjects, **MASS 1** – body weight before rehabilitation, **MASS 2** – body weight after rehabilitation, **BMI 1** – Body Mass Index before rehabilitation, **BMI 2** – Body Mass Index after rehabilitation, **6MWT 1** – distance in meters covered in 6MWT before rehabilitation, **6MWT 2** – distance in meters covered in 6MWT after rehabilitation, **6MWT1 V** – average speed of walking [km/h] in 6MWT before rehabilitation, **6MWT 2 V** – average speed of walking [km/h] in 6MWT after rehabilitation, **6MWT 1 MET** – average energy expenditure [MET] in 6MWT before rehabilitation, **6MTK 2 MET** – average energy expenditure [MET] in 6MWT after rehabilitation, **RW 1** – RAMP protocol result (W) before rehabilitation, **RW 2** – RAMP protocol result (W) after rehabilitation, **BMET 1** – the Modified Bruce Protocol result (MET) before rehabilitation, **BMET 2** – the Modified Bruce Protocol result (MET) after rehabilitation



**Table 3.** Descriptive statistics for selected parameters – women

Variables	Number of subjects	Average	SD	Minimum	Maximum	Median
AGE	14	62.5	8.32	43.00	79.00	63.00
HEIGHT	14	160.86	5.07	150.50	170.00	160.75
MASS 1	14	78.26	12.42	62.60	105.50	75.10
MASS 2	14	77.59	12.17	61.90	103.00	75.75
BMI 1	14	30.40	5.70	24.20	46.60	29.05
BMI 2	14	30.10	5.56	23.90	45.50	28.65
6MWT 1	14	443.75	80.67	250.00	550.00	437.50
6MWT 1 V	14	4.44	0.81	-	-	-
6MWT 1 MET	14	3.11	0.38	-	-	-
6MWT 2	14	477.68	96.35	275.00	625.00	481.25
6MWT 2 V	14	4.78	0.96	-	-	-
6MWT 2 MET	14	3.27	0.46	-	-	-
RW 1	14	132.79	27.66	83.00	178.00	139.00
RW 2	14	152.07	24.46	98.00	190.00	152.50
BMET 1	14	5.15	3.18	2.30	10.10	4.30
BMET 2	14	6.46	3.42	2.30	13.40	7.00

**HEIGHT** – body height of the subjects, **MASS 1** – body weight before rehabilitation, **MASS 2** – body weight after rehabilitation, **BMI 1** – Body Mass Index before rehabilitation, **BMI 2** – Body Mass Index after rehabilitation, **6MWT 1** – distance in meters covered in 6MWT before rehabilitation, **6MWT 2** – distance in meters covered in 6MWT after rehabilitation, **6MWT1 V** – average speed of walking [km/h] in 6MWT before rehabilitation, **6MWT 2 V** – average speed of walking [km/h] in 6MWT after rehabilitation, **6MWT 1 MET** – average energy expenditure [MET] in 6MWT before rehabilitation, **6MWT 2 MET** – average energy expenditure [MET] in 6MWT after rehabilitation, **RW 1** – RAMP protocol result (W) before rehabilitation, **RW 2** – RAMP protocol result (W) after rehabilitation, **BMET 1** – the Modified Bruce Protocol result (MET) before rehabilitation, **BMET 2** – the Modified Bruce Protocol result (MET) after rehabilitation

**Table 4.** Impact assessment of rehabilitation on the values of selected parameters (Tukey test)

	1 W <sub>1</sub>	2 M <sub>1</sub>	3 W <sub>2</sub>	4 M <sub>2</sub>	1-2	1-3	1-4	2-3	2-4	3-4
<b>BMI</b>	30.393	30.641	30.100	30.200	<b>0.000165</b>	0.999328	0.992561	0.999690	0.999957	<b>0.014570</b>
<b>6MWT</b>	443.75	513.43	477.68	556.94	<b>0.001059</b>	0.140344	0.676558	<b>0.004668</b>	0.073910	0.107517
<b>RW</b>	132.79	200.19	152.07	230.44	<b>0.000180</b>	<b>0.000584</b>	<b>0.017696</b>	<b>0.00016</b>	<b>0.000200</b>	0.081115
<b>BMET</b>	4.7615	8.9926	6.4615	9.9222	0.323740	<b>0.021529</b>	0.289803	<b>0.003459</b>	0.080951	0.143705

**W<sub>1</sub>** – women before rehabilitation, **W<sub>2</sub>** – women after rehabilitation, **M<sub>1</sub>** – men before rehabilitation, **M<sub>2</sub>** – men after rehabilitation, **BMI** – Body Mass Index, **6MWT** – 6 Minutes Walk Test, **RW** – RAMP protocol result (W), **BMET** – the Modified Bruce Protocol result (MET)

**Table 5.** Pearson correlations for selected variables

Variable	Pearson correlations p < ,05000									
	MASS 1	MASS 2	BMI 1	BMI 2	6MWT 1	6MWT 2	RW 1	RW 2	BMET 1	BMET 2
<b>SEX</b>	<b>-0.376999</b>	<b>-0.369475</b>	-0.010658	0.001433	<b>-0.340208</b>	<b>-0.375447</b>	<b>-0.604579</b>	<b>-0.700520</b>	<b>-0.519594</b>	<b>-0.396745</b>
<b>AGE</b>	-0.193187	-0.184491	-0.127293	-0.116967	<b>-0.365681</b>	<b>-0.563051</b>	-0.242294	<b>-0.318895</b>	<b>-0.490853</b>	<b>-0.462448</b>
<b>HEIGHT</b>	<b>0.455756</b>	<b>0.458308</b>	-0.104651	-0.107143	0.244154	0.270983	<b>0.607275</b>	<b>0.631999</b>	<b>0.379055</b>	<b>0.465116</b>
<b>MASS 1</b>	1.000000	<b>0.998637</b>	<b>0.832476</b>	<b>0.829411</b>	-0.129076	-0.050935	<b>0.448569</b>	<b>0.354229</b>	0.094145	0.109766
<b>MASS 2</b>	<b>0.998637</b>	1.000000	<b>0.829428</b>	<b>0.829527</b>	-0.153430	-0.072371	<b>0.448447</b>	<b>0.351238</b>	0.081441	0.095719
<b>BMI 1</b>	<b>0.832476</b>	<b>0.829428</b>	1.000000	<b>0.998109</b>	-0.306209	-0.232086	0.126003	0.019469	-0.141396	-0.178410
<b>BMI 2</b>	<b>0.829411</b>	<b>0.829527</b>	<b>0.998109</b>	1.000000	<b>-0.337740</b>	-0.258713	0.122501	0.013332	-0.158016	-0.196258
<b>6MWT 1</b>	-0.129076	-0.153430	-0.306209	<b>-0.337740</b>	1.000000	<b>0.820922</b>	0.284398	<b>0.367111</b>	<b>0.602303</b>	<b>0.528036</b>
<b>6MWT 2</b>	-0.050935	-0.072371	-0.232086	-0.258713	<b>0.820922</b>	1.000000	0.262929	<b>0.423142</b>	<b>0.743388</b>	<b>0.638447</b>
<b>RW 1</b>	<b>0.448569</b>	<b>0.448447</b>	0.126003	0.122501	0.284398	0.262929	1.000000	<b>0.852217</b>	<b>0.584440</b>	<b>0.481459</b>
<b>RW 2</b>	<b>0.354229</b>	<b>0.351238</b>	0.019469	0.013332	<b>0.367111</b>	<b>0.423142</b>	<b>0.852217</b>	1.000000	<b>0.684330</b>	<b>0.663922</b>
<b>BMET 1</b>	0.094145	0.081441	-0.141396	-0.158016	<b>0.602303</b>	<b>0.743388</b>	<b>0.584440</b>	<b>0.684330</b>	1.000000	<b>0.759999</b>
<b>BMET 2</b>	0.109766	0.095719	-0.178410	-0.196258	<b>0.528036</b>	<b>0.638447</b>	<b>0.481459</b>	<b>0.663922</b>	<b>0.759999</b>	1.000000

**HEIGHT** – body height of the subjects, **MASS 1** – body weight before rehabilitation, **MASS 2** – body weight after rehabilitation, **BMI 1** – Body Mass Index before rehabilitation, **BMI 2** – Body Mass Index after rehabilitation, **6MWT 1** – distance in meters covered in 6MWT before rehabilitation, **6MWT 2** – distance in meters covered in 6MWT after rehabilitation, **RW 1** – RAMP protocol result (W) before rehabilitation, **RW 2** – RAMP protocol result (W) after rehabilitation, **BMET 1** – the Modified Bruce Protocol result (MET) before rehabilitation, **BMET 2** – the Modified Bruce Protocol result (MET) after rehabilitation

## Discussion

The results of our study show that the use of standard cardiac rehabilitation has a significant impact on improvement of the examined parameters.

The process of treating cardiac patients has recently been refined by the development of better technologies, techniques and methods. Szmit et al. in their studies confirm that, due to the application of new specialized techniques and technologies, contemporary comprehensive cardiac care positively affects the human body. It reduces the number of premature deaths, improves quality of life and reduces recuperation time [12]. These studies also confirm that, despite the use of all available therapies, it is not possible to completely heal ischemic heart disease, but only to slow its progression. Available literature turns particular attention to the fact that regular physical effort is a very important element of the therapy for patients who have had cardiac incidents or who have other cardiovascular diseases [13, 14, 15, 16]. According to the authors, the treatment of ischemic heart disease may involve pharmacological therapy or surgical treatment; however, it is always necessary to perform comprehensive cardiac rehabilitation. Cardiac rehabilitation reduces the mortality caused by cardiovascular diseases by 30% per annum. It aims to improve exercise tolerance, increase functional fitness and return the patient to their everyday life from before the diagnosis. Benefits of comprehensive cardiac rehabilitation have been confirmed and documented by many studies and cardiac rehabilitation is recommended as part of a complete treatment plan for cardiovascular diseases by the American Heart Association and the American College of Cardiology.

Storch-Uczciwek et al. in their meta-analysis also present many studies that confirm the positive effect of adequate and regular physical activity on the treatment and prevention of heart disease [17].

Skrypnik et al. showed that appropriate physical training improves exercise tolerance, enhancing the quality of mental and physical life and, as a consequence, reducing the number of exacerbations and deaths [18]. The study indicates that the best effects of physical training have been induced in patients with chronic heart failure who were assessed as NYHA class II and III. The authors emphasize that the positive effects of using physical training are possible only with an appropriate and systematic form, such as general exercises and endurance training on a cycle ergometer [18].

Our study indicates a statistically significant difference in endurance parameters as measured in exercise tests, and confirmed the effectiveness of cardiac rehabilitation in the form of regular and monitored physical exercise.

According to studies by many authors, the physical capacity of the body and exercise tolerance are important prognostic factors in patients with cardiovascular conditions. In his research, Paduch demonstrated that coronary artery bypass grafting surgery and the second stage of comprehensive cardiac rehabilitation, conducted in an outpatient mode according to the current standards and guidelines of the Polish Cardiac Society, brings a lot

of benefit to the patient. It was particularly important to increase exercise tolerance and the duration of the exercise test [19, 20].

In the study by Podsiadły et al, a significant increase in the duration of exercise tests was demonstrated both in the group of patients that had coronary artery bypass grafting and in the group that had stent implantation [21].

The results of our own study confirm the positive correlation between improving exercise tolerance and increasing the duration of exercise tests. The exercise time was extended both during the RAMP test and the modified Bruce protocol. The majority of the subjects in our study were overweight or obese. Already in 1997 the relationship between obesity and the risk developing of cardiovascular disease had been shown. It was also shown that the progressive remodeling of the heart muscle associated with excessive body weight significantly increases the risk of arrhythmias and sudden cardiac death [22].

Kotseva et al. in their studies showed that an increasing part of the studied population has a problem with abnormal body mass. Estimates by the World Health Organization indicate that globally, the problems of overweight and obesity may affect up to 30% of women and 24% of men. Over the last decade, there has been a nearly 15% increase in the number of obese women with diagnosed ischemic heart disease. Analyzing the results of numerous Polish and other scientists who deal with the problem of abnormal body weight shows that overweight is more frequently observed in men, while obesity is noted more frequently in women [6, 23].

The majority of patients that took part in our study, both women and men, were characterized by an abnormal, elevated body mass. This confirms the presented thesis that there is a relationship between cardiovascular diseases and abnormal body mass – excessive body mass or obesity. However, it has not been confirmed that men more often struggle with overweight, and women with obesity. The results of our study indicate the opposite situation. Most of the examined men suffered from obesity, while the BMI in half of the surveyed women was in the “overweight” category.

The applied model of cardiac rehabilitation results from the recommendations described by Piotrowicz et al. In 2004, individual models of cardiac rehabilitation were developed, which were adopted as a standard. Their effectiveness has been confirmed by various tests carried out on many levels. This work also demonstrates the effectiveness of the described and adopted standard [11].

The results of our study, as well as a number of analyzed research outcomes of many authors, show the effectiveness of complex cardiac rehabilitation as the main element of treatment and prophylaxis in patients who have experienced cardiac incidents or who are at risk for cardiovascular disease. As has already been mentioned, the education of patients and people at risk is just as important as individual training and exercises. Obesity and excess body mass influence the development of cardiovascular disease as well as other serious conditions. Analysis of the results of our study and others indicate similar tendencies, confirming the improvement of exercise tolerance and reduction of energy expenditure after the completion of the second stage of cardiac rehabilitation. A reduction in the BMI was also noted in the subjects.

## Conclusions

Analyzing the results of this study provides answers to the research questions:

1. The second stage of comprehensive cardiac rehabilitation, conducted according to applicable principles and guidelines, significantly reduced the value of BMI regardless of the sex of the examined patients.
2. On the basis of statistical analysis using Pearson's correlation, no significant connection was found between increased BMI and the effectiveness of the second stage of cardiac rehabilitation measured by the Watt and MET load during the exercise test.
3. The value of BMI of the examined patients calculated after completion of cardiac rehabilitation indicates a statistically significant connection with exercise tolerance.
4. The analysis of results after completion of the second stage of cardiac rehabilitation showed a decrease in the body mass of the subjects and a reduction in the BMI. In addition, the length of the distance covered in the six-minute corridor test and the value of electrocardiographic stress test results, conducted according to the RAMP protocol and the modified Bruce protocol, were increased. The above-mentioned parameters have changed statistically significantly.

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PART III. OTHER  
DZIAŁ III. RÓŻNE

THE EFFECT OF HIGH-HEELED FOOTWEAR ON THE INDUCTION OF SELECTED  
MUSCULOSKELETAL CONDITIONS AND POTENTIAL BENEFICIAL USES IN  
PROPHYLAXIS AND MANAGEMENT

WPŁYW OBUWIA NA OBCASIE NA INDUKCJĘ WYBRANYCH ZMIAN MIĘŚNIOWO-  
SZKIELETOWYCH ORAZ JAKO FORMA PROFILAKTYKI I UZUPEŁNIENIE LECZENIA  
ZACHOWAWCZEGO

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Authors' contribution

Wkład autorów:

- A. Study design/planning  
zaplanowanie badań
- B. Data collection/entry  
zebranie danych
- C. Data analysis/statistics  
dane – analiza i statystyki
- D. Data interpretation  
interpretacja danych
- E. Preparation of manuscript  
przygotowanie artykułu
- F. Literature analysis/search  
wyszukiwanie i analiza literatury
- G. Funds collection  
zebranie funduszy

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Summary

Footwear is, first and foremost, an essential wardrobe component, without which it is difficult to imagine an ordinary working day. High-heeled shoes are mainly worn for aesthetic reasons, and to enhance the slenderness of the female body. Badly fitting footwear can lead to the development of several medical conditions affecting function of the foot as well as the wider musculoskeletal system. Foot deformations correlate highly with the type of footwear being worn. The most commonly occurring foot disorders caused by wearing high heels are: bunions, hammer toe, mallet toe, claw toe, and flat feet. These types of shoes can also cause injuries such as sprains, dislocations and fractures around the ankle joint and in the foot itself. High-heeled footwear may have an effect not only on the foot, but also on the whole limb, including the spine and pelvis, as destructive changes around the foot affect the entire biokinematic chain, and being the first component of this chain they impede movement and negatively impact the function of other joints. Over time, inappropriate function of the foot joints results in dysfunction of other joints located higher, disrupting correct body posture. The aim of this work is to draw the readers' attention to the effects of wearing high-heeled footwear, both the negative and positive, though the latter are extremely rare.

**Keywords:** high-heeled shoes, bunion, hammer toe, mallet toe, claw toe, flat feet, metatarsalgia, impaired body posture

Streszczenie

Obuwie to przede wszystkim część ubioru współczesnego człowieka, bez którego trudno wyobrazić sobie zwykły dzień pracy. Buty na wysokim obcasie mają stanowić głównie o walorach estetycznych, podkreślając smukłość kobiecego ciała. Nieodpowiednio dobrane obuwie może stać się przyczyną wielu stanów chorobowych bezpośrednio przekładających się na funkcję stóp jak i szerzej pojętego układu mięśniowo-szkieletowego. Deformacje stóp mają silny związek z rodzajem noszonego obuwia. Najczęściej spotykane zniekształcenia stóp wygenerowane przy pomocy butów na wysokim obcasie to: paluch koślawy, palce młotkowate, palce młoteczkowate, palce szponiaste i stopa płasko-koślawą. Buty takie mogą stać się też przyczyną urazów, do których zaliczyć należy skręcenia, zwichnięcia czy złamania w obrębie stawu skokowego jak i samej stopy. Obuwie na obcasie może mieć wpływ nie tylko na samą stopę lecz na całą kończynę dolną z kręgosłupem i miednicą włącznie, gdyż rozpoczynając zmiany destrukcyjne stawów na obwodzie stopy oddziałują na cały łańcuch biokinematyczny, a będąc pierwszymi z tego łańcucha utrudniają poruszanie się i wpływają na funkcjonowanie pozostałych stawów. Ich niewłaściwa praca z biegiem czasu skutkuje dysfunkcją stawów położonych powyżej i zaburza prawidłową postawę ciała. Celem pracy jest zwrócenie uwagi czytelników na skutki noszenia obuwia na obcasie, zarówno te negatywne jak i te pozytywne, choć te drugie, występują dużo rzadziej.

**Słowa kluczowe:** buty na obcasie, paluch koślawy, palce młotkowate, palce młoteczkowate, palce szponiaste, stopa płasko-koślawą, metatarsalgia, zaburzenia postawy ciała

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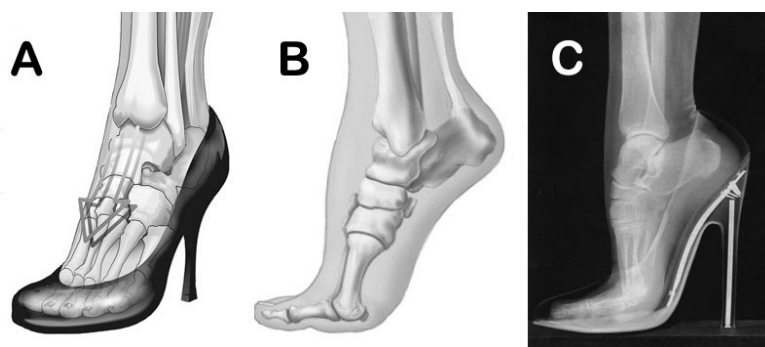
## Introduction

Primitive humans moved around barefoot, but they were acutely aware that their chances of survival were highly dependent on environmental factors, including healthy and functional feet. Diseased and injured limbs caused individuals to become dependent on the help of others. Moving around barefoot through rough terrain often caused foot injuries, and efforts were made to try to protect them – leading to the creation of the first shoes. Neolithic shoes found on the remains of the “Tyrolean Iceman”, who was discovered in the Alps, were made out of bear skin filled with straw and tied together with string – these shoes already provided some protection and allowed the man to cover large distances [1].

In ancient and medieval times, shoes were already being created using completely different technologies, which allowed for the joining of a sole with an upper fragment of the shoe, providing protection for the foot and the lower calf. For centuries, wearing shoes was a sign of prestige, a privilege of free and rich individuals. Slaves and the poor continued to walk barefoot. Until the end of the 16<sup>th</sup> century, the left shoe was practically indistinguishable from the right, and they could be worn interchangeably. In addition, these kinds of shoes were longer than the foot itself, which is a form of universalism, as they fit both long and short feet. Their only distinguishing factor was in their coloration, as the prevailing fashion dictated that they should contrast with the trouser legs being worn [2]. In the 17<sup>th</sup> century, heels began to be added to flat shoes, causing the left shoe to become different from the right. This arose from the fact that shoes were becoming more fitted, and elevating the back of the foot affected the shape of the front half of the shoe, directing its point towards the inner edge of the foot. The addition of heels was necessary at the time to keep the foot away from dirty streets. It is worth adding that at the time, men’s shoes were more decorative and refined [2, 3]. It was only in the 20<sup>th</sup> century, with the rise of industrialisation, that shoes became relatively cheap and easily accessible to everyone. In many cases, the shoes whose primary role was to protect the feet began to have negative effects, causing deformities in the lower limbs, pelvis and in the musculoskeletal system.

Most deformations around the foot begin with an initial inflammation of the synovial bursa, which is caused by maintaining a joint in an unnatural, forced position. Bursitis causes significant pain and discomfort, especially during walking. When the synovial bursa are exposed to excessive pressure, they begin to secrete synovial fluid in inappropriate amounts, leading to their inflammation and enlargement [4]. The newly formed structures disrupt correct anatomical relationships, initiating the changes leading to deformation. Inflammation of the synovial bursa impedes the movement of ligaments and muscles, and consequently leads to motor dysfunction. Individuals particularly at risk of developing bursitis are those who force their body to function in an unnatural position [5]. A perfect example of this are high-heeled shoes. Despite their undeniable aesthetic appeal, this type of footwear unfortunately also has a high probability of causing injury, however from the perspective of time, an injury may become a constructive experience that may change wardrobe preferences.

Many modern women cannot imagine a life without high-heeled shoes which, despite the aesthetic values, have a relatively strong effect on the feet, giving rise to deformities. The higher the heel, the easier it is for the foot to slip down in it, and the toes put pressure on the tip of the shoe, leaving little space for themselves, and leading to their unnatural positioning. Long-term, forced positioning of the foot in a high-heeled shoe impacts on all the structures of the locomotor system surrounding the foot, including: ligaments, joint capsules, muscles, and tendons, positioning the joints incorrectly (Figure 1). Tight shoes not only cause deformities, but also constrict various tissues, disrupting vascular flow, which in some cases may lead to atrophy. Unfortunately, un-ergonomic footwear causes not only degeneration, but also adaptive changes in the entire peripheral and axial musculoskeletal system, which is often a contributing factor to many diseases and syndromes.



**Figure 1.** The effects of high-heeled footwear on skeletal and joint structures of the foot. A – slipping of the foot restricts space for the toes. B – vertical positioning of the foot reduces the supporting surface area and disrupts the mechanics of the MTP joints. C – X-ray image of a foot in a high-heeled shoe depicts the tarsal and metatarsal bones as an elongation of the axis of the lower leg  
Source: the author

## Aim of the work

The aim of this work is to present selected foot deformities caused by wearing high-heeled footwear, which is important from the point of view of basic healthcare providers, orthopaedists, neurologists, physiotherapists and other medical specialisations, including within public health. An aim of this work is to additionally draw attention to the fact that in some cases, high-heeled footwear can also be used to help manage certain medical conditions.

## Bunions

A further foot deformity resulting from the use of high-heeled shoes with narrow points are bunions. A high heel (over 6 cm) causes the forefoot to be subjected to greater strain, while the narrow point aligns the toes, and especially the big toe, in an incorrect position [6]. These factors cause a worsening of the deformity, which constitutes not only a cosmetic problem, but a much more serious partial lateral dislocation of the big toe and its associated MTP joint, moving it towards the second toe. This condition is associated with a limited range of motion and increased pain, especially during attempted movement, as this is associated with an unfavourable change in the biomechanics of walking [7]. At the medial side of the foot, at the MTP 1 joint, a painful enlargement is formed, deforming the outline of the foot (Figure 2). It is formed by a protruding first metatarsal bone and an enlarged synovial bursa of the big toe, which normally protect the MTP 1 joint from chronic compression.

Predisposing factors for bunions include flat feet (due to increased strain on the forefoot), contraction of the Achilles tendon (forced by plantar flexion of the foot), and instability of the ankle joint.

Bunions are the most common foot deformity, which is present in about 30% of adults [8]. The incidence of this deformity increases with age. Prusinowska et al. [9] found that the incidence is 3% in individuals aged 15-30, 9% in those aged 31-60, and 16% in individuals above 60 years of age.



**Figure 2.** Bunions. A – X-ray image of feet in the AP view. B – clinical image of deformed feet  
Source: the author

## Hammer toe

Hammer toe is a common foot deformity caused by the wearing of high-heeled shoes (>6 cm), meaning that they are caused by the transfer of body weight onto the front part of the foot. The high heel pushes the foot downwards, pressing the toes against the tip of the toe, increasing pressure and causing dorsal flexion of the 2<sup>nd</sup> to 5<sup>th</sup> toes (most commonly the second toe, as it is the longest). Because of this, these deformities occur in the sagittal plane (Figures 3 and 4). Footwear that narrows in the direction of the toes causes the forefoot to become narrower, and the lack of space causes the smaller toes to be pushed into a dorsal flexion at the MTP joints. These deformities are very common and can take the form of small, asymptomatic changes all the way to large ones, which significantly limit the capabilities of the patient. Initial deformation occurs in the PIP joints of the foot, while a secondary element of the deformity is a slight hyperextension in the MTP joint [6]. The development of hammer toes is also promoted by bunions, which cause the remaining toes to be improperly aligned. The lateral movement of the big toe into the space of the neighbouring toe causes it to flex dorsally. Initially hammer toes may have limited mobility, but with disease progression they become rigid. In this condition, disproportions are formed between the muscles responsible for bending and straightening the toes, and their impaired length means that a toe that is bent in one position cannot be straightened even when its extensor muscle is tensed,

leading to flexion contracture. Ultimately, the muscles of the toes lose the ability to straighten the toe, even when this movement is not limited by the footwear being worn [10].

Hammer toes frequently co-occur with bunions and are found in about 30% of the adult population aged over 65 years [11].



**Figure 3.** Hammer toes. A – clinical picture of hammer-like positioning of the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> toes. B – Hammer toes in an X-ray (side view)

Source: the author

### Mallet toe

Mallet toe can be a result of wearing tight footwear or high-heeled shoes, which causes a sliding of the foot in the shoe towards the toes, which is associated with a deformation of the forefoot and excessive plantar flexion of the 2<sup>nd</sup> to 5<sup>th</sup> toes in the DIP joints, while preserving the longitudinal axis in the MTP and PIP joints (Figure 4) [12].

Mallet toes should not be confused with hammer toes, which are a deformity consisting of bending in the PIP joint and hyperextension in the MTP joint.

### Claw toe

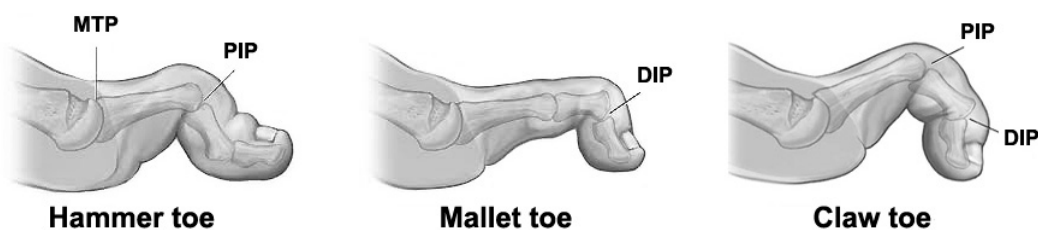
Claw toe resembles mallet toe, and in both cases the deformity affects the 2<sup>nd</sup> to 5<sup>th</sup> toes. In claw toe, hyperextension of the MTP joint always occurs, with additional flexion in the PIP and DIP joints (Figure 4). Claw toe is the kind of toe alignment that usually gives rise to blisters, causing pain and discomfort. Due to the bending, the dorsal side of the toe is prone to rubbing and blistering, similarly to the tip of the toes, which is being pressed against the sole of the shoe. Claw toes are classified based on the mobility of the toe joints. Two types exist – elastic and rigid. Elastic claw toes are able to move. This type of deformity can be manually straightened. Rigid claw toes cannot move. Movement of the toes is very limited and can be very painful [12].

Every fifth deformity of the forefoot (20%) is a result of developing claw toe [13]. These deformities occur very commonly and can take the form of small, asymptomatic changes all the way to large deformities significantly limiting the abilities of the patient. With time, claw toes lose their normal range of motion and become a permanent deformity.

**Table 1.** Types of forefoot deformity

Type of deformity	Location of deformities
Hammer toe	Plantar flexion in the proximal interphalangeal joint which may be accompanied by hyperextension in the metatarsophalangeal joint
Mallet toe	Plantar flexion in the distal interphalangeal joint without changes in the metatarsophalangeal joints.
Claw toe	Plantar flexion in both interphalangeal joints with a simultaneous dorsal flexion in the metatarsophalangeal joints.





**Figure 4.** Types of forefoot deformities classified by the location of the deformity

### Flat feet

Flat feet are the most common foot deformity in humans. This deformity is caused by long-term loading of the foot with simultaneous weakening of ligaments and muscles, leading to their extension. Improperly fitted and uncomfortable footwear, as well as overweight and its associated excessive pressure on the feet can also cause the weakening of the physiological arches of the foot [14].

The correctly arched foot has three physiological points of support, which are: the sole, the head of the first metatarsal bone and the head of the fifth metatarsal bone. This support of the foot is possible when the physiological arches, or the longitudinal and transverse arches, are preserved. In flat feet, at least one of these arches is lowered or completely absent. The foot in a high-heeled shoe has a limited support area, which is practically confined to the forefoot. Excessive loading of this region causes the metatarsal bones to become spread apart and the arch to become flattened, leading to the body weight to be transferred to the second, third and fourth metatarsal bones. This mechanism allows for the formation of transverse flat feet [15].

As mentioned previously, wearing high-heeled footwear causes a reduction in the area of the supporting surface, leading to an increase in the loading on the longitudinal arch, causing it to be lowered and increasing the shared area between the sole of the foot and the surface.

When flat feet develop, they often lead to other deformities, such as hammer toes and bunions [16].

In children, flat feet occur quite frequently and are described as physiological, since with reaching adulthood the problem often subsides by itself. Within the young adult population, the incidence of flat feet is estimated to be around 17% [14].

When flat feet are diagnosed, the use of high-heeled shoes should be stopped (recommended heel height <3 cm), and footwear should contain insoles that support the normal curvature of the arches. Shoes with wide points predispose towards the development of flat feet.

### Injuries of the ankle joint

The ankle joint is a complex mechanism which is capable of a wide range of motion: flexion, extension, inversion, eversion and a combination of these movements, and it is therefore prone to injury. Ankle injuries are fairly common in women using high-heeled shoes. The higher the heel, the greater the risk of injury. A range of predisposing factors contribute to ankle injuries, including a reduction in the supporting base area, moving of the centre of gravity upwards and forwards, weakening of the muscle-joint-ligament apparatus, as well as defects caused by varus or valgus gait. The most common ankle injuries are sprains, resulting from excessive supination. The foot is rotated too far outward, which affects the destabilisation of the step and incorrect mechanics of the entire lower limb. A sprain is the mildest forms of injury, which in principle is limited to a twisting of the joint capsule and a stretching of ligaments without the loss of contact between the joint surfaces. Ankle sprains most commonly occur in women above the age of 30. Following ankle sprains, the fibula may become inappropriately displaced distally and remain in this position. This leads to an excessive stretch of the biceps femoris muscle, which reflexively leads to an increase in its muscle tone. The result of this is increased pulling of the ischium in the direction of backwards rotation of the pelvis, which can lead to irritation of the sacroiliac joint [17].

Other, equally serious consequences can result from dislocation, leading to the bursting of the joint capsule and the ligaments stabilising the joint. Dislocation most commonly happens during inversion, when damage occurs to the lateral ligaments of the ankle joint: the anterior and posterior talofibular ligaments and the calcaneofibular ligaments [18]. During eversion, damage occurs to the deltoid ligaments. Dislocation leads to bloody haematomas, indicating damage to blood vessels. Individuals who have had previous dislocations have an increased risk of suffering another sprain or dislocation, which relates to the instability formed earlier. Individuals with weakened muscles in the lower leg, especially the peroneus muscles are also at higher risk of lateral dislocations [19].

High ankle sprains refer to the tearing of the ankle syndesmosis, connecting the tibia and fibula to the ligaments connecting the lower leg to the foot. These injuries are significantly less common than the typical lateral ankle sprains, however they are often accompanied by fractures in the bones of the ankle.

Ankle instability in individuals using high-heeled shoes can have even more serious consequences in the form of single- or double-ankle fractures, which are also related to damage to the joint-ligament apparatus.

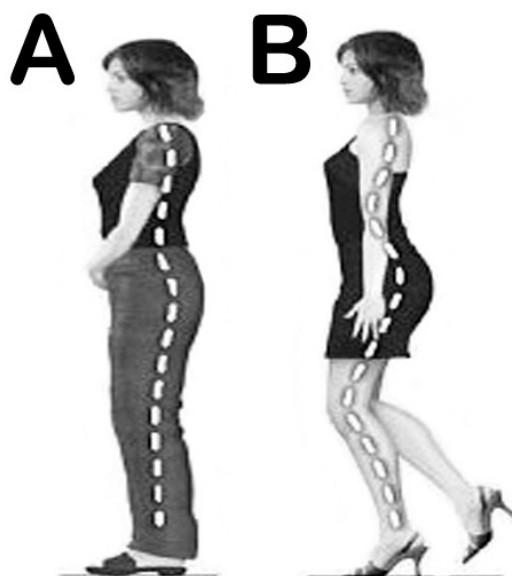
The rate of occurrence of fractures in the region of the ankle joint in the general population can reach even 15%, of which the vast majority related to the use of high-heeled footwear. The frequency of these injuries increases with higher walking speed and elongated step length [20].

### **Disorders of posture and effects on the nervous system**

In unhindered conditions during free standing, the hip knee joints are extended, and the angle formed by the plane of the foot with the axis of the lower leg is around 90°. This angle changes during different phases of gait, especially in the stance phase – it is the smallest when the heel contacts the walking surface, and the largest when the toes are lifted off the surface. Wearing high-heeled footwear causes an increase in the angle between the longitudinal axes of the foot and the lower leg both during free standing as well as during all phases of gait. This has a strong effect in moving the centre of gravity forward, which imposes certain compensatory mechanisms on the musculoskeletal system, allowing for the maintenance of a stable posture [6, 21]. Higher tension is placed on the posterior structures of the calf, which are responsible for bending the ankle and anterior thighs, which in turn bend the hip joints. Changes in muscle tension play their own role in forward tilting of the pelvis and a worsening of lumbar hyperlordosis, which causes overloading of the spine and accelerates degenerative changes in the posterior spinal column (Figure 5).

High-heeled shoes can be used as a form of medical management in patients suffering from ankylosing spondylitis (AS). During the development of AS, patients adopt a characteristic “skier position”, which is highly detrimental to both body posture and gait [22]. Using high-heeled shoes has a corrective effect on spinal extension, but it should be remembered that the high heels cannot cause a compensatory bending in the knee joints. Use of this kind of footwear (heel height 2-4 cm) should take place in the early stages of the disease, where degenerative changes in the axial musculoskeletal system have not yet been consolidated. Consistent wearing of high-heeled footwear will not protect the patient from joint stiffening, but will allow this ossification to happen when the spine is in an extended position, leading to increased quality of life, owing for example to higher lung capacity and greater range of visibility [23].

During clinical examination of patients with suspected sciatica, attention is paid to the way the patient moves as well as the footwear that the patient is wearing at the appointment. In female patients wearing high-heeled shoes on a daily basis, the problem of sciatica seems obvious. But can we be sure? Indeed, high-heeled footwear causes the user to experience heightened tension in the muscles of the spine, allowing the patient to close the vicious circle of the chain of pain, but this mechanism occurs most often in individuals who rarely use this type of footwear [24]. In individuals who use it often, these muscles are well trained and stabilise the spine with less effort. In the question of provoking pain, high heeled shoes cause the peroneal nerve, one of the branches of the sciatic nerve, to have an unhindered course, where it is not irritated by tension. In a patient who always walks in high-heeled footwear, wearing flat shoes will cause dorsal flexion of the foot, causing a tensing of the peroneal nerve, leading to pain. Therefore when assessing neuropathic pain in patients who move around on high-heeled footwear, the frequency of their use should always be taken into account, as it is key to a reliable diagnosis and appropriate therapeutic proceedings.



**Figure 5.** Changes to the curvature of the spine and tilting of the pelvis while wearing shoes with varying heel height. A – flat shoes cause a neutral positioning of the pelvis and correct lumbar lordosis. B – high-heeled shoes cause a forward tilt of the pelvis and lumbar hyperlordosis, which can be the cause for degenerative changes in the spine. A lowering of the center of gravity also disrupts the muscle synergy of flexor and extensor muscles around the lower limbs

Source: the author

### Thromboembolism

High-heeled shoes cause the muscle tension in the lower limb to be much higher than during the use of flat shoes, which significantly slows down peripheral blood flow and promotes the development of chronic venous insufficiency. High-heeled shoes are mostly worn by young women of reproductive age, who may be increasing their risk of thromboembolism through the use of hormonal contraceptives [25]. This risk is significantly increased in women whose work involves long-term standing, for example hostesses and check-out clerks. A decidedly positive effect is achieved by women who move dynamically in stilettos, alternately tensing and flexing the calf muscle, therefore preventing blood congestion in the lower limbs and promoting circulatory mechanisms. It is also worth highlighting that women who move around in high-heeled shoes on a daily basis have slimmer calves, which is a result of high energy requirements of these muscles, and burning of fat found in their vicinity.

### Conclusions

Shoes with heels of variable height are a widespread element of daily wardrobes of modern women. A high proportion of ladies wearing high-heeled shoes experience pain and discomfort around the joints of the lower limb, which become worsened around the feet. High-heeled footwear is in large part responsible for pain in the lumbar section of the spine and changes in the axial positioning of the pelvis, which can result in impaired gait. Individuals using high-heeled shoes are more prone to ankle injury than those who wear flat shoes. High-heeled shoes can also be linked to circulatory disorders which manifest as distal swelling in the lower limb. This does not mean that high-heeled shoes only have negative effects on women's health. In some cases, they can be used as a form of medical management, e.g. over the course of AS.

### Selected abbreviations

**MTP** – metatarsophalangeal  
**PIP** – proximal interphalangeal  
**DIP** – distal interphalangeal  
**RTG** – Radiography

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## KNOWLEDGE AND USE OF ERGONOMIC PRINCIPLES IN PHYSICIANS AND NURSES WITH LOW BACK PAIN

### WIEDZA ORAZ ZASTOSOWANIE ZASAD ERGONOMII PRZEZ LEKARZY I PIEŁĘGNIARKI Z DOŁĘGLIWOŚCIAMI BÓLOWYMI KRĘGOSŁUPA

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#### Authors' contribution

##### Wkład autorów:

- A. Study design/planning  
zaplanowanie badań
- B. Data collection/entry  
zebranie danych
- C. Data analysis/statistics  
dane – analiza i statystyki
- D. Data interpretation  
interpretacja danych
- E. Preparation of manuscript  
przygotowanie artykułu
- F. Literature analysis/search  
wyszukiwanie i analiza literatury
- G. Funds collection  
zebranie funduszy

#### Summary

**Background.** Medical professionals frequently experience low back pain as a result of mechanical overload caused by prolonged standing, performing activities in a position of trunk flexion, extended work hours and physically stressful duties. The above-mentioned stresses, when they exceed the adaptive capacity of the tissues, can lead to pain, degenerative changes and even disability. **Material and methods.** 114 employees, including 48 (42%) physicians and 66 (58%) nurses, were examined. Their average age was  $42.08 \pm 9.43$  years, and the average years of work experience was  $17.16 \pm 10.36$  years. To assess the occurrence of low back pain, a standardized Oswestry Questionnaire was used, while for assessments of ergonomics an original questionnaire was used. **Results.** 95 respondents (83.33%), including 31 physicians (64.58%) and 64 nurses (96.96%), did not apply the principles of ergonomics in the work environment. The most common reasons were that working conditions were not conducive to ergonomic approaches to their duties and that there were not enough medical personnel to make ergonomic choices possible. All subjects experienced back pain. The Oswestry Questionnaire was used to determine the degree of disability caused by back pain. Among the physicians, the majority of respondents ( $n=35$ , 73%) experienced a small degree of disability, while the nurses experienced a moderate amount of disability ( $n=35$ , 53%). **Conclusions.** Most of the examined personnel did not apply principles of ergonomics and had incomplete knowledge in this area. All subjects were burdened with low back pain, one of every ten of them were seriously affected. The results indicate the need to provide ergonomics education to medical personnel.

**Keywords:** ergonomics, low back pain, Oswestry Questionnaire

#### Streszczenie

**Wprowadzenie.** Pracownicy personelu medycznego narażeni są na występowanie dolegliwości bólowych kręgosłupa w wyniku przeciążeń mechanicznych układu ruchu spowodowanych długotrwałym przebywaniem w pozycji stojącej, wykonywaniem czynności zawodowych w pozycji zgięcia tułowia oraz długimi godzinami pracy i dyżurami. Wymienione przeciążenia przekraczające zdolności adaptacyjne tkanek, prowadzą do występowania dolegliwości bólowych, zmian zwyrodnieniowych, a nawet do niepełnosprawności. **Materiał i metody.** Zbadano 114 pracowników personelu medycznego w tym: 48 (42%) lekarzy oraz 66 (58%) pielęgniarek. Średnia wieku badanych wynosiła  $x=42,08 \pm 9,43$  lat, a średni staż pracy  $x=17,16 \pm 10,36$  lat. Do badań wykorzystano autorski kwestionariusz ankiety dotyczący stosowania zasad ergonomii pracy, a do oceny występowania dolegliwości bólowych dolnego odcinka kręgosłupa standaryzowany Kwestionariusz Oswestry. **Wyniki.** W badanej grupie 95 osób (83,33%), w tym 31 lekarzy (64,58%) oraz 64 pielęgniarki (96,96%) nie stosowało zasad ergonomii w środowisku pracy, a najczęstszym powodem był brak warunków do ich przestrzegania oraz niewystarczająca ilość personelu medycznego. Wszyscy badani doświadczali występowania dolegliwości bólowych kręgosłupa. Według Kwestionariusza Oswestry określono stopień niepełnosprawności wywołany bólem kręgosłupa. Wśród lekarzy największa część badanych ( $n=35$ ; 73%) osiągnęła niewielki stopień niepełnosprawności spowodowany występowaniem dolegliwości bólowych kręgosłupa natomiast wśród pielęgniarek - mierny ( $n=35$ ; 53%). **Wnioski.** Zdecydowana większość badanych lekarzy i pielęgniarek nie przestrzegała zasad ergonomii pracy i posiadała niepełną wiedzę w tym zakresie. Wszyscy badani obarczeni byli występowaniem dolegliwości bólowych kręgosłupa, a co 10 z nich w stopniu poważnym. Wyniki badań wskazują na potrzebę prowadzenia edukacji w zakresie ergonomii wśród pracowników personelu medycznego.

**Słowa kluczowe:** ergonomia pracy, ból dolnego odcinka kręgosłupa, kwestionariusz Oswestry

Tables: 5

Figures: 2

References: 18

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## Introduction

Medical professionals have a high risk for low back pain syndrome as a result of mechanical overload caused by prolonged standing, performing professional activities in a position of trunk flexion, extended time of working during surgery, and other duties.

Incorrect adjustment of a workstation and incorrect positioning for physical duties can lead to back pain and eventually even to disability.

Improper spinal movement can lead to back pain and a decrease the quality of life. This is a major social problem and a disease of civilization. Improper movement of the spine can even lead to degenerative lesions in the spine.

Incorrect posture during work (i.e. during diagnostic examination or taking care of patients) leads to overuse injuries of the spine, causing lumbosacral back pain and often referred pain due to a herniated nucleus pulposus putting pressure on neural roots [1].

This functional spinal disorder occurs when static and dynamic weight is more than the ability of the body to adapt bone and surrounding tissues. According to epidemiological data in well-developed countries, 40 to 60 percent of the population suffers back pain and about 30 percent of them have chronic back pain syndrome [2].

In medical professions it is typical to spend most of the time at work standing or moving dynamically. According to the estimated data, nurses and physicians spend an average of 16-24 percent of their working hours in standing or crouching positions with loaded and / or raised arms. During the 8-hour workday, they also walk about 4 to 7 kilometers. It is also common for these professionals to bend forward; this forward flexion is often accompanied by rotation of the spine in the transverse plane and lateral flexion in the frontal plane. This happens during nursing duties such as: getting patients up and putting them in the right posture, feeding, administering medications, and toilet needs. Each task can take from 30 seconds up to 15 minutes time [3-4]. There are also other risks for back pain such as: genetics, weakness of the joints, low levels of physical activity, trauma, other illness and lack of ergonomic movement patterns and incorrect adjustment of workstations [5-6].

Well-organized work conditions are the essential factor in providing a good quality of life for employees [7]. The field that takes care of these conditions and guides adjustments to workstations (keeping in mind both the goals of the work and the needs of the employee) is called work ergonomics. Ergonomics is the study of the interactions between people and objects, with the goal of making these interactions safer and more efficient [8].

Each workstation should be individually adjusted for the requirements and risk factors of the job associated with it. Working with good ergonomics helps to maintain or even improve the health of the employee and protects them from many illnesses such as: overload lesions, spine and joint arthritis, vision problems, headache and exhaustion [9].

## Aim of the study

The main aim of the study was to assess the usage of ergonomics and the state of knowledge about ergonomics, as well as the incidence of back pain syndrome in the study group of nurses and physicians.

In addition, the study assessed the following questions:

1. Do the studied nurses and physicians adhere to principles of ergonomics?
2. When ergonomic principles were not used, what was the reason?
3. What level of disability due to low back pain were the nurses and physicians experiencing, according to the Oswestry Disability Index?
4. Are there differences between the examined physicians and nurses?

## Material and methods

114 employed medical staff were examined, including 48 (42%) physicians and 66 (58%) nurses. There were 20 (17.54%) people working on the surgical ward and 94 (82.46%) on the non-surgical ward. Of the 114 respondents, 90 (78.94%) were on duty, some of whom were in the ICU (27 respondents - 30%). Average work experience was estimated to be  $17.16 \pm 10.36$  years.

Inclusion criteria was: performing medical staff work as a physician or a nurse and work experience no less than 5 years. Exclusion criteria was lack of consent. Examination was carried out with an original questionnaire about ergonomics and the Oswestry Disability Index in Polish version for assessment of low back pain in the study group.

The original questionnaire consisted of two parts. The first was about general characteristics of the examined group including age, gender, Body Mass Index, height and detailed characteristics of their specific work. The

second part consisted of questions about their knowledge of ergonomics and the practical usage of ergonomics principles. To assess the level of low back pain, the modified Oswestra Disability Index in Polish version was used. It contains questions about the influence of lower back pain on the functional state of living in categories such as: pain level, nursing, getting up, walking, sitting, standing, sleeping, social life, traveling and changing of pain intensity. Each criterion examined was assessed with questions that score between 0 and 5.

Examinees were grouped by level of disability based on the number of points they scored: inconsiderable (0-4 points), small (5-14 points), moderate (15-24 points), high (25-34) and total (>35 points) [10-12].

Data was collected in a database and analyzed statistically with Statistica v.12.0. Descriptive statistics were gathered for the general characteristics of the examined group. To compare the data between the examined groups, the Student's t test and the Mann-Whitney U test were used, with the level of statistical significance at  $p \leq 0.05$ .

## Results

### *General characteristics of the studied group of physicians and nurses*

General characteristics of the examined medical staff group, including age, weight, height and BMI are presented in Table 1.

**Table 1.** General characteristic of the studied group of medical personnel, including age, weight, height and BMI

General characteristics of the studied group				
Variable	General	Physicians	Nurses	p
Number of group n; % of group	n=114; 100%	n=48; 42%	n=66; 58%	
Gender	Women	27; 23.68%	64; 56.14%	
	Men	21; 18.42%	2; 1.75%	
Age [years]	$x=42.08 \pm 9.43$	$x=41.09 \pm 9.66$	$x=43.56 \pm 9.21$	0.451
Body weight [kg]	$x=68.45 \pm 13.37$	$x=70.09 \pm 13.34$	$x=68.41 \pm 12.65$	0.267
Body height [m]	$x=1.68 \pm 0.08$	$x=1.66 \pm 0.07$	$x=1.72 \pm 1.12$	0.567
BMI [kg/m <sup>2</sup> ]	$x=24.12 \pm 3.69$	$x=24.16 \pm 3.57$	$x=25.11 \pm 3.42$	0.148
Length of service	$x=17.16 \pm 10.36$	$x=15.67 \pm 10.11$	$x=18.78 \pm 14.89$	0.000*

Abbreviations: n – number of group, kg – kilogram, m – meter, p – statistical significance (\* $p \leq 0.05$ )

Average physician work experience was  $15.67 \pm 10.11$  years; this was statistically different from the nurses, whose average work experience was  $18.78 \pm 14.89$  years.

Characteristics of the examined group, including specifics of their profession, are presented in Table 2.

**Table 2.** Characteristics of the studied group of medical personnel regarding profession and type of work

Characteristics of the studied group of medical personnel regarding profession and type of work			
Variable	General	Physicians	Nurses
Number of whole group n; % of group	n=114 (100%)	n=48 (42%)	n=66 (58%)
Number of group n; % of group	n=114 (100%)	n=48 (100%)	n=66 (100%)
Work on the surgical ward			
Non-Surgical ward	94 (82.46%)	39 (81.25%)	55 (83.33%)
Surgical ward	20 (17.54%)	9 (18.75%)	11 (16.67%)
Duty			
Yes	90 (78.94%)	38 (79.16%)	52 (78.78%)
Acute duty	27 (30.00%)	12 (31.57%)	15 (28.85%)
Non-acute duty	63 (70.00%)	26 (68.42%)	37 (71.15%)
No	24 (21.06%)	10 (20.84%)	14 (21.22%)
Is work a cause of high-stress?			
Yes	106 (92.98%)	44 (91.66%)	62 (93.93%)
No	8 (7.02%)	4 (8.34%)	4 (6.07%)

Abbreviation: n – number of group

Out of the 114 examined medical staff members, most of them (n=94; 82.46%) were doing their duty on the non-surgical ward and 106 (92.98%) agreed that their job is high-stress.

On a 10 point scale, the average level of stress among examined persons was  $6.08 \pm 2.40$ ; for physicians it was  $5.71 \pm 2.36$  and for nurses it was  $6.54 \pm 2.81$ .

*Characteristics of examined group of physicians and nurses, including usage of ergonomics principals and knowledge of ergonomics*

Characteristics of the examined medical staff, including usage of ergonomics principals and knowledge about ergonomics are in Table 3. For this question, respondents could provide more than one answer.

**Table 3.** Characteristics of the studied group of medical personnel regarding knowledge of the definition of ergonomics

Characteristics of the studied group regarding knowledge of ergonomics definition			
Variable	General	Physicians	Nurses
Number of whole group n; % of group	n=114 (100%)	n=48 (42%)	n=66 (58%)
Number of group n; % of group	n=114 (100%)	n=48 (100%)	n=66 (100%)
Appropriate workplace organization	77 (67.54%)	34 (70.83%)	43 (65.15%)
Taking proper body position during work activities	67 (58.77%)	32 (66.67%)	35 (53.03%)
Use of short breaks and exercises to regenerate the body	49 (42.98%)	26 (54.17%)	23 (34.84%)
Appropriate workplace equipment	38 (33.33%)	24 (50%)	14 (21.21%)

Abbreviation: n – number of group

This question gave different possible definitions of ergonomics, all of which were correct. Only 77 (67.54%) of the 114 examined thought that work ergonomics is about the right organization of the workstation, and an even smaller proportion (n=38; 33.33%) thought that it is about good equipment. Unfortunately, no one picked the whole correct answer for this question.

Characteristics of the examined group, including usage of the work environment, are in Table 4.

**Table 4.** Characteristics of the studied group of medical personnel regarding usage of ergonomics principles in the work environment

Do the respondents respect the principles of ergonomics in the work environment?			
Variable	General	Physicians	Nurses
Number of whole group n; % of group	n=114 (100%)	n=48 (42%)	n=66 (58%)
Number of group n; % of group	n=114 (100%)	n=48 (100%)	n=66 (100%)
Yes	19 (16.67%)	17 (35.41%)	2 (3.03%)
No	95 (83.33%)	31 (64.58%)	64 (96.96%)
Why do the respondents not respect the principles of ergonomics in the work environment?			
Variable	General	Physicians	Nurses
Number of whole group n; % of group	n=114 (100%)	n=48 (42%)	n=66 (58%)
Number of group n; % of group	n=114 (100%)	n=48 (100%)	n= 66 (100%)
Lack of conditions in the work environment to comply with the principles of ergonomics	81 (71.05%)	21 (43.75%)	60 (90.90%)
Insufficient number of medical personnel	54 (47.36%)	16 (33.33%)	38 (57.57%)
Lack of proper adaptation of premises	33 (28.94%)	8 (16.67%)	25 (37.87%)
Excess of duties	42 (36.84%)	7 (14.58%)	35 (53.03%)
Habits	18 (15.78%)	8 (16.67%)	10 (15.15%)

Abbreviation: n – number of group

The majority of those examined (n=95; 83.33%) admitted that they do not use ergonomics principals at their workstation. The main reasons they reported were no ability to use ergonomics in their work (n=81; 71.05%) and not enough medical staff to make ergonomic activity possible (n=54; 47.36%).



*Characteristics of the examined group of physicians and nurses, including the occurrence of low back pain in daily life according to the Oswestry Disability Index*

Characteristics of the examined group of physicians and nurses, including the occurrence of back pain and its interference with daily life, are presented in Table 5.

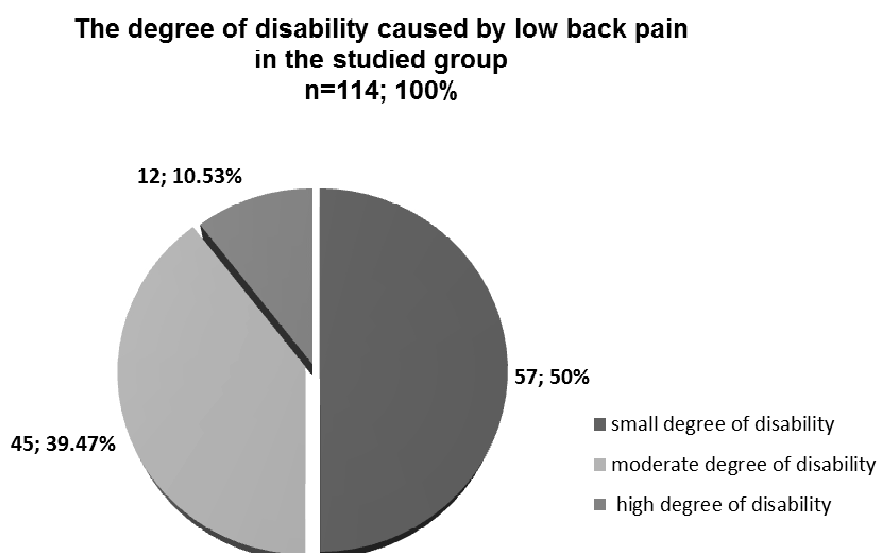
**Table 5.** Characteristics of the studied group regarding occurrence of low back pain syndrome based on the Oswestry Questionnaire

Intensity of low back pain according to the Oswestry Questionnaire				
Variable	General	Physicians	Nurses	p
Number of whole group n; % of group	n= 114 (100%)	n=48 (42%)	n=66 (58%)	
Intensity of pain	x=2.32±1.43	x=2.09±1.40	x=2.45±1.62	0.000*
Lifting	x=2.28±1.53	x=1.31±1.53	x=2.96±1.65	0.000*
Sitting	x=1.95±1.00	x=1.76±0.95	x=2.08±1.17	0.000*
Sleeping	x=1.58±0.78	x=1.42±0.74	x=1.78±0.56	0.542
Traveling	x=1.85±0.92	x=1.67±0.86	x=1.99±0.98	0.232
Care	x=1.37±0.77	x=1.22±0.59	x=1.47±0.62	0.564
Walking	x=1.29±0.65	x=1.21±0.54	x=1.33±0.71	0.321
Standing	x=2.04±1.06	x=1.89±1.06	x=2.12±1.09	0.000*
Social life	x=1.37±0.75	x=1.27±0.62	x=1.46±0.88	0.552
Changes of pain intensity	x=1.69±0.85	x=1.51±0.74	x=1.89±0.91	0.535
SUM	x=15.56±6.08	x=14.04±5.29	x=17.29±7.01	0.000*

Abbreviation: n-number of group, p-statistical significance (\*p≤0.05)

On the Oswestry Disability Index, the average number of points (on a scale from 0 to 50), was 15.56, with results of 14.04 for physicians and 17.29 for nurses. There were observed statistically significant differences in categories such as: pain level, getting up, sitting, standing, and the total amount of points between examined physicians and nurses.

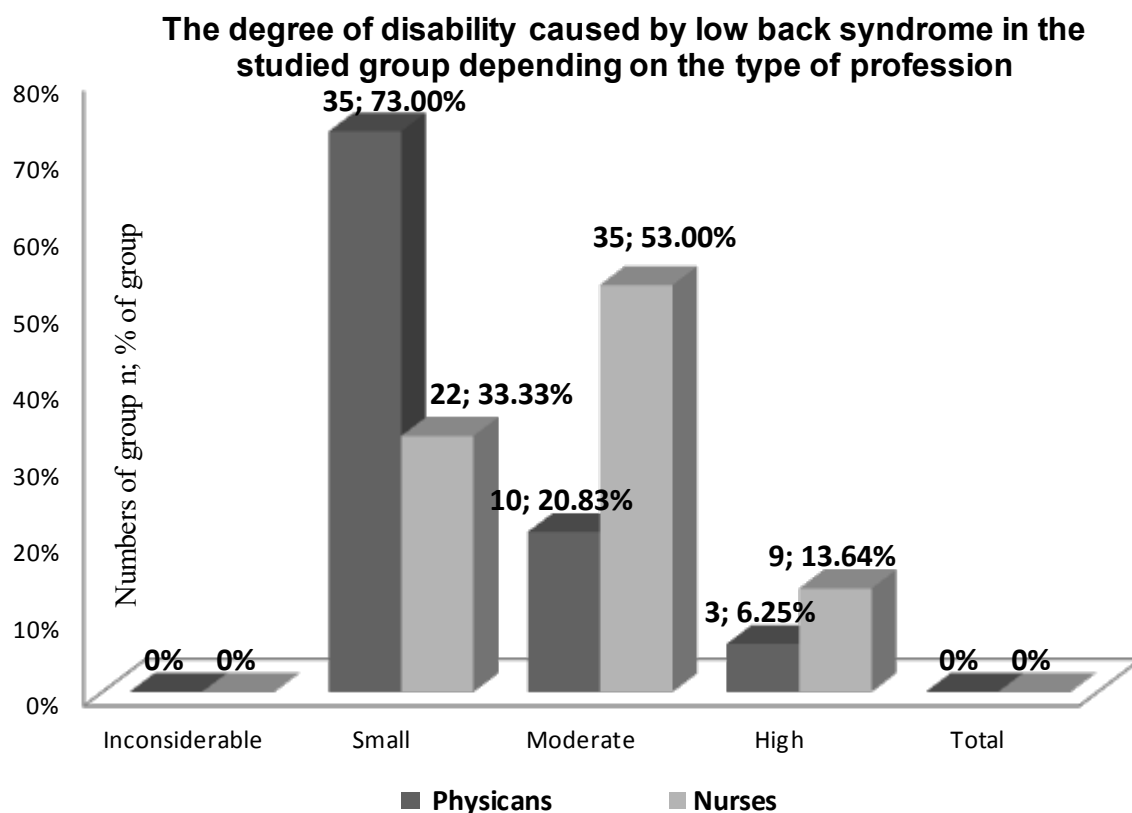
Figure 1. shows characteristics of the examined medical staff, including the state of disability caused by the low back pain according to the Oswestry Disability Index.



**Figure 1.** Characteristic of the studied group of medical personnel regarding the degree of disability caused by low back pain

According to the point score on the Oswestry Disability Index, there were different levels of disability caused by low back pain. Minimal disability was seen in 57 of those examined (50%), medium disability in 45 of those examined (39.47%), and serious disability in 12 (10.53%) of examined persons.

Figure 2. shows the characteristics of the examined group including the state of disability (ODI), depending on the type of profession.



**Figure 2.** Characteristic of the studied group of medical personnel regarding the degree of disability caused by low back pain depending of the type of profession

Most of the examined physicians (n=35; 73%) had minimal disability caused by back pain; most nurses had a medium level of disability (n=35; 53%).

## Discussion

Specifics of medical staff work may predispose to higher risk of back pain. According to Maciuk and co-workers, the frequency of lumbosacral spine pain among nurses is about 75%, and for cervical spine pain it is 60% and increasing [3]. The most common reason for back pain is mechanical factors. Improper positioning and movement of the torso (dynamic and static) leads to overuse of the spine structures which leads to overload syndrome or degenerative lesions or even disability.

Kułagowska et al. stated that 97% of nurses working on long-term care units suffer from back pain, of which 82% is in the lumbosacral spine [1]. Those results are similar to this study, in which every person asked admitted that they had a problem with back pain.

In the Kułagowska et al. study, the examined nurses proposed changes that could decrease the pain and injuries caused by their jobs such as: more employees (82%), using helpful medical equipment (53%), architectural changes (36%) and changes in work organization (26%).

Similar results were observed in this study in which the examined professionals described the problem as: not enough staff (47.36%), no opportunity to use principals of ergonomics during their work (71.05%) and improper adjustment of their workstation (28.94%). The data suggests that increasing the amount of medical staff on the ward and better adjustment of the workstations could improve work conditions by making it possible to use ergonomics, which leads to decreasing the overuse of the body and decreasing the back pain.

Burdorf et al. and Koppelaar et al. checked PubMed and Embase or Web of Science and showed that moving patients causes back pain. They proved that elimination of this movement decreases back pain. This suggests that correct adjustment of the workstation and equipping the wards with helpful medical equipment, such as lifts, will improve the working conditions for the medical staff [13-14].

Pop and co-workers assessed the severity of back pain with the Oswestry Disability Index among medical staff, including doctors, nurses and physiotherapists. 90% of the examined group suffered from lumbosacral spine pain back pain, and 19% of them had no disability (n=32) but 1% (n=2) had total disability caused by back pain.

They also assessed the level of disability according their jobs. 12% (n=13) of nurses and 29% (n=9) of doctors had no disability. 45% (n=49) of nurses and 55% (n=17) of doctors had minimal disability, 34% (n=37) of nurses and 13% (n=4) of doctors had medium disability and 7% (n=8) of nurses and 3% (n=1) of doctors had serious disability, and 1% (n=1) of nurses had total disability caused by back pain. They also proved that the level of characteristics of ward "hard" or "soft" does not make a difference for a level of illness caused by back pain [15].

Similar results were found in our current study; therefore we have to consider that there is a difference between the level of disability due to back pain between examined doctors and nurses as measured by the ODI. Most of the doctors had a low level of disability, but most of the nurses had a medium level of disability. This suggests that nurses are more likely to be injured or develop back pain by doing their duty than are doctors.

Radziwińska et al. also analyzed back pain among the nurses; they had very similar results to this study. The average score on the ODI was 16.33. In that study 65% (n=39) of persons had 5-14 points, which indicates a low level of disability caused by the back pain. Only 7 people (11.66%) had no disability (0-4 points) but 5 of them (8.33%) had serious disability (25-34 points). This is similar to this current study, in which most examinees (50%) had minimal disability and 10.53% had severe disability caused by back pain according to the ODI [16].

In analyzing the results of the ODI, we observed that the examined medical staff had statistically important differences in categories such as: intensity of pain, lifting, sitting, standing, and the total amount of points. The average of each of these categories was higher for nurses than for doctors. According to this data we can assume that nurses are at the higher risk for back pain than doctors.

Data about back pain in medical staff has been gathered for a long time and we can observe the increased tendency to develop back pain when we look at this data. Therefore, studies about the prevention of back pain among medical staff may prove that ergonomics education will improve their health quality and decrease the incidence of back pain [17-18].

## Conclusions

1. The majority of examined doctors and nurses did not use ergonomics and their knowledge about ergonomics was not adequate.
2. All the examined persons were having back pain and one of every ten of them had a serious problem with it.
3. It was observed that most of the physicians have had a low disability score but nurses had mainly medium levels of disability, which suggests that they have more taxing work.
4. The results we got suggest education of medical staff about ergonomics and enforcement of rules for using ergonomics.

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## ARE THE 100 BEST SPA HOTELS IN POLAND REALLY SPA CENTERS?

### CZY 100 NAJLEPSZYCH HOTELI SPA W POLSCE TO RZECZYWIŚCIE OŚRODKI SPA?

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#### Authors' contribution

Wkład autorów:

A. Study design/planning

zaplanowanie badań

B. Data collection/entry

zebranie danych

C. Data analysis/statistics

dane – analiza i statystyki

D. Data interpretation

interpretacja danych

E. Preparation of manuscript

przygotowanie artykułu

F. Literature analysis/search

wyszukiwanie i analiza literatury

G. Funds collection

zebranie funduszy

#### Summary

**Background.** In the face of unrelenting civilization threats and social challenges, the dynamic development of wellness & spa centers is observed. The aim of this work is an analysis to determine whether the 100 best Polish spa hotels satisfy the requirements of this type of company in light of terminology put forward by the International Spa Association (ISPA) and the European Spas Association (ESPA).

**Material and methods.** Definitions put forward by ISPA and ESPA form the basis of assessment in this study. A method of diagnostic survey was applied.

**Results.** According to the ESPA, only 41% of spas can actually be classified as such, compared to 61% according to ISPA. As many as 22% of the hotels surveyed do not meet the requirements of such enterprises for either ESPA or ISPA. Inconsistent definitions of ESPA and ISPA lead to chaos in the wellness & spa market.

**Conclusions.** It is necessary to develop a Polish definition which clearly defines the criteria for the classification of spa facilities and the possibility of their verification from the point of view of quality and compliance with planned standards.

**Keywords:** Poland, spa centers, definitions, International Spa Association, European Spas Association

#### Streszczenie

**Wprowadzenie.** W obliczu niesłabnących zagrożeń cywilizacyjnych i wyzwań społecznych obserwuje się dynamiczny rozwój ośrodków wellness & spa. Celem pracy jest analiza, czy w świetle terminologii International Spa Association (ISPA) i The European Spas Association (ESPA), 100 najlepszych polskich hoteli spa rzeczywiście spełnia wymogi tego typu przedsiębiorstwa.

**Materiał i metody.** Podstawą oceny są przyjęte przez ISPA i ESPA definicje spa. Zastosowano metodę sondażu diagnostycznego.

**Wyniki.** Według kryteriów ESPA tylko 41% hoteli może być określonych mianem spa, według ISPA – tylko 61%. Aż 22% ze wszystkich badanych hoteli nie spełnia kryteriów ESPA i ISPA. Niespójne definicje ESPA i ISPA prowadzą do chaosu na rynku wellness & spa.

**Wnioski.** Konieczne jest opracowanie ustawowej polskiej definicji, która określi normy/kryteria klasyfikacji obiektów spa i umożliwi ich weryfikację pod względem jakości i zgodności z wyznaczonymi standardami.

**Słowa kluczowe:** Polska, ośrodki spa, definicje, International Spa Association, European Spas Association

Tables: 3

Figures: 0

References: 30

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#### Introduction

The etymology of the word spa is not entirely explained. Some place its origins in Latin, saying it means "health through water" (sanitas per aquas) or "healthy by water" (sanus per aquam) [1]. Others say it comes from the Walloon "espa" (fountain), the Latin for "spagare" (moisture, spray) or from Belgium (from the town of Spa in the foothills of the Ardennes) where curative thermal springs were discovered in the 16<sup>th</sup> century. Just understanding the concept also poses many difficulties [2]. The International Spa Association defines a spa as a place of business through which the customer feels a general sense of personal well-being, with a range of different services aimed at renewal of the mind, body, and spirit [3]. The European Spas Association defines a spa as a mineral water source, place or locality *where this type of source has been discovered and is used to improve health* [4]. The first definition indicates the diversity of services that lead to physical, mental, and spiritual well-being (renewal, relaxation, unwinding, stress relief, stimulation or calmness, harmony of body and soul, good

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fun, etc.) [5]. Essentially, this is convergent with the concept of wellness, which can be misleading due to the broader meaning of the term wellness [6]. It is not a product or service that you can buy or sell, but a state of mind [7]. From wellness a client will expect education, consulting, and coaching (which do not need a spa element at all) [8]. The spa is an integral part of the concept of wellness, situated in the area of services and body treatments (health, physiotherapy, therapeutic, cosmetic and beauty) [9].

The second definition which defines a spa as a place where natural medicinal raw materials exist (implicitly a spa) and also as a company/group of companies which provide health services and specific treatments and activities based on natural resources [4]. At the same time, while in the European sense, the spa activity is based on natural medicinal raw materials, in the American sense (ISPA), this is not a requirement. Due to these inconsistencies, the term 'spa' in Poland includes both facilities which base their activities on the idea of a spa (based on a clear concept, not a collection of individual, often randomly-selected treatments) and other entities, such as fitness clubs, wellness centers, beauty salons, and training and conference centers (offering simple beauty treatments as hotel services) [2]. Currently, there is no lack of pseudo-spa facilities which use a variety of words in their name to underline their uniqueness or interdisciplinary nature, like car spa, drinks spa, or 'agrotourism' spa. This linguistic misuse is the result of the lack of a statutory definition in Polish law. Therefore, very often this word is treated as a hypnotic marketing message with which to guarantee market success.

Resultantly, what can customers expect and which kind of center should they choose? This is a difficult question in the context of the terminological chaos described above and the lack of Polish standards or criteria available for the clear classification of spa facilities. Rather, the choice is based on general impressions, associations, emotions, and opinions of the customer. Increasingly, customers acutely feel the lack of verification which might support the accuracy of a selection and the desired levels of service and quality (meaning, on the one hand, meeting the requirements of the purchaser and his stated or implied needs and, on the other hand, compliance with established standards) [10].

Obviously, observing standards (*International Organization for Standardization standards* - ISO 9000 series) in Polish hotel facilities with a specific category is mandatory [11]. However, one should be aware that in service units providing intangible services, such as, for example, spa (where the essence of the system is the customer's attitude and their expectations of a special character), the ISO management system itself is insufficient. Tools and procedures related to the examination of the client's needs and expectations, as well as his/her satisfaction, are of a very general nature.

Unfortunately – so far – there are no developed quality management systems in Poland in this segment. It is true that efforts have been made for several years in the Polish market to address the problems with terminology and standards, but there is still a long way to go. An important and necessary basis for these activities is to improve services and ensure the possibility of verifying such services, through a system of certification for example. In Poland, the criteria and standards for the operation of spa enterprises are set (and is introducing a system of certification) by a consortium of two companies: Comforum and the Polish subsidiary of Germanischer Lloyd Sp. z o.o. [12]. Quantitative and qualitative factors are assessed, including water, treatments, equipment, hotel services, gastronomy, and care for harmony of body and mind.

Globally, and in Europe, the spa industry has been developing over the last 30 years or so [13, 14], however, Poland has considerably less experience in this regard. Unfortunately, at present, domestic spa companies rarely belong to global or European associations which guarantee reliability, authenticity, efficiency, and safety. The exceptions are two Dr. Irena Eris hotels (*Wzgórza Dylewskie, Krynica Zdrój*), which are members of ISPA and certified for quality by Deutscher Wellness Verband, the Premium Quality and Spa Clinic *Pod Tężniemi* in Ciechocinek, which has been certified by ESPA signed EUROPESPA med. Symbols of quality from Deutscher Wellness Verband can also be used by *Hotel Król Kazimierz* in Kazimierz Dolny, *Spa Nałęczów, Palace Thermal Springs* and the *English Pavilion* in Nałęczów-Zdrój, *Hotel Malinowy Zdrój* in Solec-Zdrój and *Hotel Villa Park* in Ciechocinek [15]. Obviously, it is pleasing that there is more competition appearing in Poland to find the best holiday accommodation and day spa which stand out in terms of design, interesting architecture, and functionality (e.g. Spa Prestige Awards), or indicative of spa hotels where the cuisine is as important as the luxury accommodation or effective treatment (e.g. the best restaurants in Polish spa hotels). Distinctions of this type are helping the Polish customer by providing knowledge which enables choice of the facility, and in the end a guarantee of customer satisfaction.

However, the important question is whether the quality of the service is repeatable? The lack of its explicit definition means that the client creates his/her own – usually subjective – assessment criteria, and if they are not fulfilled, they simply stop using the given service provider. The more precisely the spa service process is described, the greater the ability to ensure high quality is. The lack of Polish standards/criteria for the classification of objects, coupled with the terminological incoherence already described, may cause a problem

in the selection of quality assessment criteria. Therefore, the purpose of this work is to fill the gaps created in this area. We analyze whether the 100 best Polish spa hotels (recognized in 2016 by Eden magazine as the best hotels in this industry) actually meet the requirements of this type of enterprise in light of the terminology put forward by the International Spa Association and the European Spas Association. In the era of competition and globalization (including international health tourism), it is also quite important to know whether a foreign tourist considers our center a spa or not. In Poland, there has been no research so far on this subject. Specialists generally pay attention to the fact that as spa services have not been the object of investigation for a long period, there is a lack of empirical research on spa services [16]. Therefore, the aim of this work is to analyze whether the 100 best Polish spa hotels (recognized in 2016 by "Eden Magazine" as the best hotels in this industry) actually meet the requirements of this type of enterprise in light of the terminology put forward by the International Spa Association and the European Spas Association. This kind of study may, from a legislative perspective, provide certain pointers for drawing up the Polish definition of spa, and from a practical point of view, help acquire customers from other geographical areas and build up competitiveness.

## Material and methods

The 100 best spa hotels in Poland were selected for analysis by businessmen and experts from the wellness & spa industry, journalists promoting the philosophy of wellness and journalists from "SPAeden.pl" and "Eden Magazine" [17]. The data were collected using a telephone interview, which was carried out with the reception of the hotel (in all 26 cases contact was established by email, and in two through a website chat). In addition, the websites of all facilities were analyzed (in nine cases, due to the lack of information, it was only the website of the facility).

The research, conducted from February to April 2017, used an original questionnaire in which interviewees were asked about the characteristics of the hotel: the location (health resort, beyond), the number of stairs, the number of rooms and beds, and the number of treatment rooms. They were also asked about the type of services provided (full-body massages, facial treatments, hydrotherapy treatments), including their nature (included in the price of stay or not). Physical health programs (physical activities, healthy eating, massages, manual treatments, and body renewal rituals) and those concerning mental/spiritual health (learning/practice of philosophy of the East and/or West, health education, personal counseling, special therapies). The infrastructure of the hotel (saunas, cooling zone and consultative-advisory points) was also analyzed. The collected information was supposed to enable an evaluation of whether the inspected hotels are spa centers in the understanding of ESPA and ISPA definitions. According to ISPA, to be qualified as a spa, it is necessary to provide at least 2 of the 3 following services: whole-body massage, dermatological treatments (at least the face), and body treatments (such as hydrotherapy) [3]. The definition also shows that the resort has to provide services for the renewal of mind, body, and spirit. ISPA does not specify whether they must offer all of them or just one. It is also not specified which programs they should implement. Due to the fact that the boundary between activities within individual services is very fluid and difficult to grasp, in the present paper – modeled on Georgiev and Trifonova Vasileva [18] – it was decided to separate two categories of programs implementing the above ISPA guidelines:

1. Physical health – including:
  - a. physical activities that improve motor skills,
  - b. healthy eating programs,
  - c. massages, manual treatments, and rituals of body renewal.
2. Health mental/spiritual – including:
  - a. learning/practice of philosophy of the East and/or the West (e.g. meditation, yoga, Ayurveda),
  - b. health education, personal consulting (e.g. psychological, medical, cosmetological),
  - c. special spiritual renewal therapies (e.g. aromatherapy, chromotherapy).

Due to the fact that customer demand for well-being in the comprehensive approach will grow [19], in this research hotels which firstly provide 2 out of 3 services (full body massages, facial treatments, hydrotherapy treatments), and the second offer a combination of a minimum of three programs selected from two categories (physical and mental/spiritual health) considered to be hotels meeting the ISPA recommendations.

According to ISPA, using natural resources is not an essential condition, whereas it is important for ESPA. Therefore, when comparing the best Polish hotels with the requirements of the ESPA, it was also taken into account whether the hotels were located on the grounds of the spa and whether and how they use the natural resources of the soil, sea, climate, and traditional methods of treatment (e.g. Doctor Kneipp) which, according to ESPA, are fundamental elements in the functioning of a spa facility [4]. Analysis of the results is presented in the upcoming tables.

## Results

The characteristics of the studied spa hotels are presented in Table 1. All hotels are categorized as hotels with at least 3 stars. Although only 30% of them are located on the territory of resorts (10% in mountain health resorts, 4% in mountain foothills, 8% in lowland areas, and 8% in coastal areas), 41% base their services on natural resources of the soil, sea, climate or traditional methods of treatment.

**Table 1.** Characteristics of spa hotels (n=100)

	Characteristics of spa hotels	%
Hotel category	*****	11
	****	86
	***	3
Number of rooms	≤50	26
	51-100	47
	101-200	20
	201-300	4
	>300	3
Number of beds	≤50	2
	51-100	23
	101-200	41
	201-300	17
	301-400	7
	401-500	6
Location of hotel	>500	4
	on territory of resort	30
Number of treatment rooms	outside of territory of resort	70
	3-10	70
	11-20	22
	>20	8

In most of the analyzed facilities (79%), the spa service is included in the stay (see Table 2). The offers include facial treatments, full-body massages (declared in both cases by hotels), and hydrotherapy treatments (58% of hotels). Analysis of implemented programs showed that physical health programs are most commonly provided, such as massage, manual treatments, and rituals of renewal of the body (pampering and pleasure – 100%, and cosmetic spa – 92%). Programs of mental/spiritual health are rarely offered. At the same time, the most popular services are learning/practice of philosophy of the East and/or West (especially Ayurveda and yoga) – 38%, and special therapies for spiritual renewal (especially aromatherapy, in a few cases chromotherapy, in one a floatation tank) – 51%. Programs such as *peace of mind* are offered by 9% of the hotels, and *stress management* – 4%. All resorts offer packages, usually targeted to different groups of people (e.g. Spa for Friends, Ladies' Privilege, Male Thing, Gift for Parents, Spa for Children, Condition of Seniors, Prescription for the Businessman), long-stay (e.g. Relaxing SPA Weekend for Two, 'SPAntastic') and special occasions (e.g. Romantic Weekend, For Two, Christmas with Spa).

**Table 2.** Services offered in spa hotels

	Spa services	%
The price of the services	included in the price	79
	extra charge	21
Type of service	full-body massages	100
	facial treatments	100
	hydrotherapy treatments	58



<b>Programs</b>	<b>Physical health</b>	physical activities	56
		healthy eating programs	46
		massages, manual treatments, and rituals of body renewal	100
	<b>Mental health/ spiritual</b>	learning/practice of Eastern philosophy and/or the West (e.g. meditation, yoga, Ayurveda)	38
		health education; personal consulting (e.g. psychological, medical, cosmetological)	17
		special spiritual renewal therapies (e.g. aromatherapy, chromotherapy)	51

Among the 100 best Polish spa hotels, about 94% have a sauna (see Table 3). The most common is a dry sauna (93%), steam bath (60%), and infrared (35%). Less frequent are salt sauna (21%), herbal (16%), aromatherapy (16%), mud (6%), bio-sauna (4%), ice, Roman, bread, and stone sauna (2%). A cooling zone is integrated with the sauna area. 92% of hotels have recreational swimming pools. They are usually filled with chlorinated water (82%), but there is also salt water (7%), spring (4%), thermal and ozonized (3%), and sea (1%) water. Half of swimming pools are equipped with hydro-massages, 34% counter-currents, 21% paddling pools, 17% geysers, 14% cascades, 13% slides, 10% massaging benches, 7% water slides, 7% waterfalls, 7% cannons and water fountains, 4% massage jets, 2% showers, and 5% stream-oriented massages. 83% of hotels have a hot tub (including, 78% with chlorinated water, 3% with thermal and 2% with chlorine-free water).

Only 5 hotels do not have advisory points. In the others, there is the possibility to consult a cosmetologist (86%), a physiotherapist (47%), a trainer (38%), a doctor (20%), a dietician (15%), a psychologist (in one case), and other specialists (a massage therapist – 9%, chef – 1%, podologist – 1%).

**Table 3.** Spa zone infrastructure in the hotels surveyed

<b>Spa zone infrastructure (%)</b>	
Sauna (42-90 °C)	94
Laconium (55 °C)	6
Caldarium (20-40 °C)	15
Tepidarium (~36 °C)	18
Sanarium	12
Recreational swimming pool	92
Hot tub	83
Shower/shower of impressions	20
Igloo/ice bowl	16
Dr. Kneipp paddling pools	24

Analysis of the 100 best Polish spa hotels in terms of ESPA requirements showed that only 41% of them can be classified as a spa resort (including those which base their services on the natural resources, sea, and climate, or traditional methods of treatment – 41%, or those located in the area of health resorts – 30%). ISPA requirements – providing at least 2 out of 3 services and offering at least three programs selected from two categories: physical and mental/spiritual health – were met by 61% of hotels in total. As many as 22% of the hotels surveyed do not meet the requirements of such enterprises for either ESPA or ISPA.

## Discussion

This work underlines the fact that the lack of similar notions or understanding and uniform criteria (including the lack of a statutory definition of the word ‘spa’ in Polish law [Journal of Laws No. 31, pos. 272 [20]]) means that 22 of 100 of the top graded spa hotels in Poland (marked out by businessmen and experts from the wellness & spa industry and journalists who promote philosophy wellness and columnists of the portal “SPAeden.pl” and “Eden Magazine”) should not be recognized as spas. Only 41% satisfy the requirements for this type of resort

outlined by ESPA, and 61% those of ISPA. As such, there is an urgent need to develop a Polish statutory definition. Many European countries (like Germany, Austria, Greece, Italy, Lithuania) already have one [10].

The analysis confirms earlier findings by Dryglas [2] that there are currently spa hotels of both the European and American models in Poland. American clients expect more pampering services as value added, which is represented by optional services not intended for medical purposes [21]. Canadians value not only pampering but also healthy food [22]. Europeans seek services which deliver recovery after illness, sanatorium services, medical consultations, etc. [10]. As previous research on spas was more concerned with physical value for a customer, the recent spiritual value provided is increasingly emphasized [23]. People are beginning to appreciate a holistic pattern of spa treatment [10] as an opportunity to improve health (body), escape from emotional pain and stress (spirit) [24], and develop a concept of well-being that encompasses their whole life (mind) [25].

The 21<sup>st</sup> century is a time of enterprises which understand that today's customers expect maximum use of their time for rest, health, pleasure, integration with family and friends, and getting to know new things, to all matters for which in everyday life he/she is pressed for time [26]. It is time for hotels to realize that the provision of only cosmetological, health and beauty-care services is not enough. Today's customers no longer want to just relax; they want to change. They expect comprehensive programs which lead to bio-psycho-social welfare which, in addition, (due to lack of time) are realized during one stay. Therefore, the (usually) self-service wellness area [27] becomes as important to customers as the spa treatment zone [28]. This is confirmed by observation of the spa market around the globe [24, 29] and in Poland [27]. It shows the common areas of these services, which are closely associated with beauty care, health care and physical and psychological condition [29]. Discovering that many bodily problems are the result of a lack of harmony and a disturbed mental balance is bearing fruit with the need to implement programs for maintaining mental and spiritual health (e.g. inner calm, coping with stress, or eliminating its effects) [29]. This is important in our modern reality, in which building human capital is very significant and in which health is treated as a condition of basic professional and social competence which is used to achieve a better quality of life [30]. Observation of these changes in human lifestyle in the 21<sup>st</sup> century shows that it is not possible to separate the spa and wellness area, and it is necessary to introduce holistic health-oriented programs which care about health [29]. We are talking here, of course, about the activities of specialized residential hotels whose functions are based on the philosophy of wellness & spa. Sallmann [27] describes them as those that provide guests with basic services characteristic of each type of hotel (accommodation and meals) and provide the opportunity to use the services and programs characteristic of the wellness & spa profile (such as healthy eating, physical activities, and the program body and spirit care). On the one hand, they provide information on the protection and maintenance of health; on the other, they offer professional care in the field of healthy eating, physical activity, external appearance, relaxation techniques, and mental education. Unfortunately, Polish research shows that in this type of hotel an important principle, which is the appropriate connection of the spa area with the wellness area, is not always consistently implemented [15].

It is obvious that hotels can specialize, may have a different location and nature (urban, permit, business conference, focused on spiritual development, etc.) and may have a limited or specialized nature of their services. However, it seems that every modern spa hotel (although in different proportions) should implement a basic set of comprehensive spa and wellness services.

In summary, the common goal of wellness & spa hotels should be to achieve a balance between physical, mental, social and spiritual elements through the application of different procedures and therapeutic methods. The implementation of this goal should be based on both spa (natural healing resources or traditional methods of treatment) and wellness (programs maintaining/improving physical and mental/spiritual health). The proportion in which they are used will allow for the classification of hotels as:

- standard spa and wellness hotels that offer services based on natural medicinal resources and combinations of wellness programs (improving both physical and mental/spiritual health);
- specialized spa and wellness hotels, which will depend on the choice of the combination of elements from each of these concepts.

For example, sea spa and mind wellness will mean a hotel that specializes in caring for mental/spiritual health (by running special programs of spiritual renewal, education, and health counseling or the learning/practices of the philosophy of the East and/or the West) and which assumes that a large part of treatments and procedures will be based on climate/sea water. Mineral spa and body wellness will mean a hotel which aims to improve physical health (through physical activities, specially designed diet, massage, etc.), and the treatments and procedures will be based largely on spring water.

It seems that such an approach to the problem may, from a legislative perspective, provide some tips on how to develop the Polish definition of spa and develop a quality management system; secondly, it may practically help in attracting clients from different geographical areas and building competitiveness.

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## BIOAEROSOL AND SMOG AS DETERMINANTS OF HUMAN POPULATION HEALTH

### BIOAEROZOL I SMOG JAKO DETERMINANTY ZDROWIA POPULACJI LUDZKIEJ

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A. Study design/planning

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B. Data collection/entry

zebranie danych

C. Data analysis/statistics

dane – analiza i statystyki

D. Data interpretation

interpretacja danych

E. Preparation of manuscript

przygotowanie artykułu

F. Literature analysis/search

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#### Summary

When asked to describe air pollution, the average person will invariably mention the word “smog”. Although the term is often poorly understood, social awareness of it is much higher than just a few years ago. In the era of globalization, it has become clear that smog goes beyond dust and gas pollution and encompasses the microbiological purity of the air. This is due, among other things, to the fact that the human body may not only be a reservoir but also an emitter of microbiological particles dangerous to health and life. According to Górny, SCMB (Harmful Microbiological Factors) are easier to aerosolize compared to other air pollutants [1]. It highlights the risk of infectious diseases from abroad, including allergic disease entities. It also emphasizes the close relationship between various types of air pollution.

**Keywords:** bioaerosol, allergic diseases, air pollution, smog

#### Streszczenie

Nie sposób nie odnieść wrażenia, iż po zapytaniu przechodnia o zanieczyszczenia powietrza, odpowie „smog”. Poprzez działanie szeroko rozumianego mainstreamu, świadomość społeczna w dziedzinie smogu jest zdecydowanie wyższa, aniżeli jeszcze kilka lat temu. Jednak tym, co budzi obawy w dobie globalizacji, jest zagrożenie nie tyle smogu (zanieczyszczenia głównie pyłowe i gazowe), co czystości mikrobiologicznej powietrza. Wynika to między innymi z faktu, iż organizm ludzki może być nie tylko rezerwuarem, lecz także źródłem emisji niebezpiecznych dla zdrowia i życia cząstek mikrobiologicznych. Według Górnego, SCMB (Szkodliwe Czynniki Mikrobiologiczne) w porównaniu do innych zanieczyszczeń powietrza są łatwiej transportowane drogą aerozolu [1]. Otwiera to temat tzw. chorób zawleczonych z zagranicy, włączając w to alergiczne jednostki chorobowe. Jednocześnie ukazuje ścisły związek między różnego typu zanieczyszczeniami powietrza.

**Słowa kluczowe:** bioaerozol, choroby alergiczne, zanieczyszczenia powietrza, smog

#### Introduction

When asked to describe air pollution, the average person will invariably mention the word “smog”. Although the term is often poorly understood, social awareness of it is much higher than just a few years ago. In the era of globalization, it has become clear that smog goes beyond dust and gas pollution and encompasses the microbiological purity of the air. This is due, among other things, to the fact that the human body may not only be a reservoir but also an emitter of microbiological particles dangerous to health and life. According to Górny, SCMB (Harmful Microbiological Factors) are easier to aerosolize compared to other air pollutants [1]. It highlights the risk of infectious diseases from abroad, including allergic disease entities. It also emphasizes the close relationship between various types of air pollution.

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## Aim of the work

This work aims to examine the subject of air pollution and allergic inhalation diseases that can be induced by smog and microbiological pollution of the air. In addition, we wish to draw attention to the insufficient consideration given to both topics, particularly the interaction between them, in public discussions.

## Source and emission mechanism of atmospheric air biological pollutions

The air carrying pollutants, known as the dissipative phase, and the colloidal mixture of materials in the air, known as the dispersed phase, form the bioaerosol world. Gołofit-Szymczak and Skowron highlight that dust suspended in the air forms a kind of smog in Poland and London [2].

House dust can be of plant, animal and mineral origin as well as dust P10 and P2.5 [2]. Zawisza and others have discussed house dust as a mixture of allergens specific to each household and work environment: metabolites *Dermatophagoides pteronyssinus* – European house dust mite (especially three storage species: *Tyrophagus putrescentiae*, *Acarus siro* and *Lepidoglyphus destructor*), fungal spores, even mold [3, 4], hair and epidermis. This is relevant because, as emphasized by Yang's research, society increasingly spends time in closed rooms [5]. Metabolites of microorganisms in the air are another major biological allergen. Of these, mite metabolites are most often mentioned in Poland, while in the US and Germany metabolites are often identified from cockroaches (*Periplaneta americana* and also *Blattella germanica*) [6, 7].

About 8-11 million Poles are exposed to micro-toxins of mold fungi (strong allergens) that have settled on finishing building materials [8, 9]. Biologically active components of bioaerosols include pathogenic enzymes and entero- and endotoxins including mycotoxins. In addition, the scaly epidermis in the form of dandruff, flower pollen and the remains of plant organisms are frequently found in the air [7].

According to Ann and colleagues, the most common determinants of immunological diseases of the respiratory system are mycelium fragments as well as fungal spores, protozoa and viruses as well as cell fragments and whole bacterial cells [10].

## Easiness of the spread of biological allergens

Particles deposit in the airways depending on the age-related vital capacity of the lungs [1]. The smallness of mold spores permits them to deposit extensively [11, 12]. This is true for mold spores most commonly found in rooms such as *Aspergillus*, *Alternaria*, *Candida*, *Cladosporium* and *Penicillium* [13]. Another easy-to-spread allergen is the cat-derived Fel d1. Its high concentration, of course, occurs in rooms that cats live. However, its effect is so strong that only a small amount is sufficient to induce an immune response [14]. As people can be a major source of emissions of biological pollutants and also their incubator [15], cat allergens can also be found in buildings like cinemas, hospitals and homes without cats.

Dog allergens such as Can f1 and Can f2 are less clinically significant, although their occurrence is just as common as Fel d1 allergens. All of these animal allergens, as well as those from rodents and pests, should be considered as part of internal air pollution [14]. Pałczyński also discussed volatiles as being divided into animal and vegetable proteins, organic and inorganic chemicals. As airing of rooms does not have a positive effect on their microbiological purity [15], we discuss the range of factors involving air quality when mixing outdoor and indoor air. Sulfur oxides, nitrogen and carbon are also important components of smog [16].

## Acts of legislation of air pollution level normalization

The first Polish standard specifying acceptable levels of biological pollution was established at the end of the 19<sup>th</sup> century by Odo Bujwid, the Polish bacteriologist and pioneer of therapeutic prophylaxis. On the basis of his own research, he calculated the maximum amount of bacteria that could be present in the air. His calculation of "50 bacteria in a liter" became the accepted upper limit [15]. Krzysztofik in the 1970s measured the number of hemolytic microorganisms and the total number of fungi in the air and created the scientific foundation for the writing of the first acts of legislation. They addressed the following:

- "guidelines and general provisions regarding the sampling of atmospheric air"
- "methods of microbiological testing of air" [17],
- "determination of the number of bacteria and microscopic fungi in the atmosphere when sampling by aspiration and sedimentation" [18, 19].

More recently, after Poland acceded to the EU Community, through the amendment of the Labor Code and the Regulation of the Minister for Health Protection from 2005, Directive 2000/54/EC also became applicable. This legislation's main aims are:

- introduction of rules of conduct “on the protection of workers from the risks related to exposure to biological agents at work”,
- in the matter of health prevention and elimination of health determinants, the obligation to ensure proper protection of employees by the employer,
- and recommendation for conducting auxiliary tests of indicator microorganisms [20].

### **SCMB definition**

The Regulation of the Minister of Health of 2005 on “harmful biological factors for health in the work environment and health protection for workers professionally exposed to these factors” defines bioaerosol as “microorganisms (including genetically modified), cell cultures, including those carried out in laboratory conditions and cell cultures derived from multicellular organisms, internal human parasites, capable of causing infection, allergy or a toxic reaction either directly or through the structures and substances they produce, as well as cellular and cell-free organisms capable of replication or transfer of genetic material” [21]. The definition is quite wide and useful, as it takes into account many health determinants of the population.

### **Influence of SCMB and smog on human health**

Adult humans consume up to 20,000 cubic meters of air every day and therefore have a high risk of airborne pathogens entering the respiratory tract. This is particularly true for diseases like atopic asthma, which makes one vulnerable to a whole range of allergy-mediated diseases [22].

Respiratory mixtures contain the etiological factors of numerous immunological diseases [23]. It is also likely that the number of SCMB will continue to increase as our knowledge grows [24].

Among the viral factors, pathogens for the following diseases are common in the air: influenza, chickenpox, meningitis (which may be a complication of the mumps, when an adult suffers), mononucleosis, rubella and shingles.

Diseases from *Streptococcus* and *Staphylococci* species are also common [15]: inflammation of the bronchial tubes and lungs, rhinitis, alveolitis, pulmonary tuberculosis and pertussis.

Fungal diseases also have pathogens frequently found in the air: lungs and their fungal inflammation, bronchus mycosis, mucormycosis, cryptococcosis and aspergillosis [9].

According to the European air quality monitoring company Airly, diseases such as cancer, allergic asthma, respiratory failure, and immunodeficiency can be the result of a long exposure to smog. For the immediately occurring symptoms, netography measures difficult gas exchange, a consequence of breathing made difficult by thick air smog [25]. The Global Initiative for Asthma reports that exposure to the above-mentioned factors leads to the development of the atopic form of bronchial asthma [26]. In the report of the Department of Analysis and Strategy of the National Health Fund, we find: that “the potential cause of the increase in deaths in January 2017 is abrupt deterioration in air quality, which can cause violent health consequences in particularly vulnerable people, including the cardiovascular system” [25, 26, 27, 28].

### **Conclusions**

1. The environment has a real impact on the bioaerosol hygiene.
2. The qualitative and quantitative composition of bioaerosol may affect the occurrence of disease symptoms in hypersensitive people.
3. The public is unaware of the dangers of environmental bio-aerosol pollution.
4. The human population should be made aware of the health risks resulting from exposure to toxic bioaerosol issues.

### **Summary**

Currently, two types of smog are distinguished, a dominance of gases in the case of California smog (Los Angeles smog type) and dust in the case of the London type [25]. To these should be added smog associated with microbiological factors. Biological pathogens may be the most dangerous element of internal and external air.

Due to the modern age's ease in crossing borders for work or tourism, the threat to human health from transport of microbial pathogens from other continents has never been greater. This emphasizes the importance of paying global attention to the role of SCMB (Microbial Factors) in the dispersed phase of air. Therefore, air pollution or smog must be understood in a wider sense [25, 26, 27, 28].

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- w studiach przypadków, 1000 słów, łącznie z tabelami i bibliografią – ok. 7 stron, napisanych komputerowo, z podwójnym odstępem, z czcionką 11 pkt i z 10 pozycjami literatury;
- w artykułach od redakcji, 1500 słów wyłączając spis literatury – ok. 10 stron, z podwójnym odstępem, z czcionką 11 punktów, 15 pozycjami literatury, bez streszczenia i słów kluczowych; tabele i ryciny mogą być dołączone, artykuł może zawierać podział na sekcje;
- w recenzjach książek – 750 słów, bez podziału na sekcje, bez słów kluczowych i streszczenia.

Artykuły przekraczające wymaganą długość lub liczbę pozycji literatury będą przedstawiane do indywidualnej decyzji Redaktora Naczelnego.

Oryginalne artykuły naukowe powinny zawierać następujące elementy:

- tytuł (w j. polskim i j. angielskim),
- słowa kluczowe (z Medical Subject Headings [MeSH], katalog Index Medicus; w j. polskim i j. angielskim),
- streszczenie (150-250 słów, w j. polskim i j. angielskim, podzielone na części: Wstęp, Materiał i metody, Wyniki, Wnioski),
- wprowadzenie,
- materiał i metody,
- wyniki,
- dyskusja,
- wnioski,
- ujawnienia i uznanie,
- bibliografia.



Studia przypadków powinny zawierać następujące elementy:

- tytuł (w j. polskim i j. angielskim),
- słowa kluczowe (z Medical Subject Headings [MeSH], katalog Index Medicus; w j. polskim i j. angielskim),
- streszczenie (150-200 słów, w j. polskim i w j. angielskim, podzielone na części: Wstęp, Materiał i metody, Wyniki, Wnioski),
- wstęp,
- opis przypadku,
- wnioski,
- bibliografia.

Artykuły przeglądowe powinny zawierać następujące elementy:

- tytuł (w j. polskim i j. angielskim)
- słowa kluczowe (z Medical Subject Headings [MeSH], katalog Index Medicus; w j. polskim i j. angielskim)
- streszczenie (150-250 słów, w j. polskim i j. angielskim)
- wstęp
- cel pracy
- krótki opis stanu wiedzy
- wnioski
- bibliografia

#### Tabele

Tabele powinny być ponumerowane zgodnie z ich kolejnością w tekście. Tekst powinien zawierać odniesienia do tabel.

Każda tabela powinna być przesłana w osobnym pliku.

#### Ilustracje

Każda rycina powinna być wysłana w osobnym pliku. Ryciny najlepiej przesłać w formacie TIF lub EPS. Format JPG jest także dozwolony.

Wszystkie ryciny, zarówno fotografie, wykresy, jak i diagramy, powinny być ponumerowane kolejno, zgodnie z pojawieniem się w tekście. Autor/autorzy powinni wskazać w tekście głównym, w którym miejscu należy umieścić daną tabelę czy rycinę.

#### Cytaty i bibliografia

Pozycje literatury powinny być cytowane w nawiasach kwadratowych w kolejności cytowania.

Bibliografia powinna być ułożona w kolejności cytowania w tekście. Jeżeli liczba autorów przekracza 6, po 6 nazwisku należy dopisać „et al.”. Jeżeli praca posiada numer DOI, należy podać go w formie pełnego linku na końcu opisu bibliograficznego, np.:

Adamowicz K. Association between Body Mass Index and gastric cancer in Pomeranian men and women. *Health Prob Civil.* 2018; 12(4): 231-237. <https://doi.org/10.5114/hpc.2018.76517>

#### Cytowanie czasopisma:

Tomao P, Ciceroni L, D'Ovidio MC, De Rosa M, Vonesch N, Iavicoli S, et al. Prevalence and incidence of antibodies to *Borrelia burgdorferi* and to tick-borne encephalitis virus in agricultural and forestry workers from Tuscany, Italy. *Eur J Clin Microbiol Infect Dis.* 2005; 24(7): 457-463. <https://doi.org/10.1007/s10096-005-1348-0>

#### Czasopismo – suplement:

Kalman M, Inchley J, Sigmundova D, Iannotti RJ, Tynjälä JA, Hamrik Z, et al. Secular trends in moderate-to-vigorous physical activity in 32 countries from 2002 to 2010: a cross-national perspective. *The European Journal of Public Health.* 2015; 25(Suppl. 2): 37-40.

#### Tom czasopisma z numerem części:

Abend SM, Kulish N. The psychoanalytic method from an epistemological viewpoint. *Int J Psychoanal.* 2002; 83(Pt 2): 491-5.

#### Cytat z czasopisma online:

Zhang M, Holman CD, Price SD, Sanfilippo FM, Preen DB, Bulsara MK. Comorbidity and repeat admission to hospital for adverse drug reactions in older adults: retrospective cohort study. *BMJ.* 2009 Jan 7; 338: a2752. <https://doi.org/10.1136/bmj.a2752>

#### Publikacja elektroniczna przed drukowaną:

Yu WM, Hawley TS, Hawley RG, Qu CK. Immortalization of yolk sac-derived precursor cells. *Blood.* 2002 Nov 15; 100(10): 3828-31. Epub 2002 Jul 5.

#### Książka:

Biddle SJ, Mutrie N. Psychology of physical activity: determinants, well-being, and interventions. 2th edition. London: Routledge; 2008.

#### Rozdział z książki:

Hung Chih Yu A. Exploring motivation for leisure-based physical activity: a case study of college students. In: Burns R, Robinson K, editors. *Proceedings of the 2006 Northeastern Recreation Research Symposium.* Newtown Square: Department of Agriculture, Forest Service, Northern Research Station; 2006. p. 342-349.

#### Zapowiedzi/w druku:

Tian D, Araki H, Stahl E, Bergelson J, Kreitman M. Signature of balancing selection in *Arabidopsis*. *Proc Natl Acad Sci U S A.* Forthcoming 2002.

#### Materiały opublikowane online nieposiadające numeru DOI:

Abood S. Quality improvement initiative in nursing homes: the ANA acts in an advisory role. *Am J Nurs [Internet].* 2002 Jun [cited 2002 Aug 12]; 102(6): [about 1 p.]. Available from: <http://www.nursingworld.org/AJN/2002/june/Wawatch.htmArticle>

#### Materiały opublikowane w języku innym niż angielski:

Wielkoszyński T. [Modified, spectrophotometric method of silicon determination in biological material]. *Diagn Lab.* 2000; 36(3): 377-385 (in Polish).

Wydawca otrzymuje wszelkie prawa autorskie na zasadach wyłączności w odniesieniu do manuskryptów publikowanych, a także prawo do publikacji w formie drukowanej, z wykorzystaniem nośników elektronicznych lub innych oraz publikacji online. Streszczenia mogą być publikowane bez zezwolenia Wydawcy.

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Zarejestrowane manuskrypty są przesyłane do 2-3 niezależnych ekspertów do oceny naukowej. Przesłane artykuły są akceptowane do publikacji po otrzymaniu pozytywnej opinii niezależnych recenzentów. „Health Problems of Civilization” prowadzi proces recenzji „double-blind”, w którym autorzy nie znają tożsamości recenzentów, a recenzenci – tożsamości autorów. Proces oceny zajmuje zazwyczaj 2-4 miesiące.

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