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

HEALTH-RELATED BEHAVIORS OF SENIORS IN RURAL VERSUS URBAN AREAS:  
A CROSS-SECTIONAL STUDY

ZACHOWANIA PROZDROWOTNE SENIORÓW MIESZKAJĄCYCH NA OBSZARACH  
WIEJSKICH I MIEJSKICH: BADANIE PRZEKROJOWE

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interpretacja danych
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wyszukiwanie i analiza literatury
- G. Funds collection  
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Summary

**Background.** In Polish cities, many organizations help senior citizens (60+), and many targeted programs support their healthcare. Rural areas, in contrast, have been very much neglected. The main goal of this study was to obtain data on selected health-related behaviors of seniors living in urban and rural areas. We compared exercise, eating habits, smoking and alcohol consumption. **Material and methods.** The study was conducted in Poland among people aged 60 and above living in remote rural areas (n=128) and the city (n=146). Interviews were used to conduct surveys and collect lifestyle data. The differences between urban and rural seniors were determined in a significance test of two structure coefficients at a significance level of  $\alpha=0.05$ . **Results.** Some major differences between the two groups were observed: 23.35% of the rural and 15.75% of the city seniors did not exercise ( $p=0.0008$ ); rural seniors smoked more (16.40%) than city seniors (7.53%,  $p=0.0225$ ) and drank more units of alcohol at one time and tended to consume more animal protein. **Conclusions.** The findings suggest that social policies and local programs aimed at improving quality aging should take into account local differences between rural and urban senior communities and tailor actions accordingly. Rural seniors need more interest and support from both government institutions and social organizations.

**Keywords:** diet, alcohol consumption, physical activity, elderly, aging

Streszczenie

**Wprowadzenie.** W Polsce osoby starsze (60+) mieszkające w miastach często mogą liczyć na wsparcie organizacji zajmujących się problemami zdrowotnymi seniorów. Natomiast obszary wiejskie wydają się być pod tym względem zaniedbane. Dlatego za cel badań przyjęto uzyskanie danych na temat wybranych zachowań zdrowotnych seniorów mieszkających na terenach miejskich i wiejskich. Ocenie poddano aktywność fizyczną, zachowania żywieniowe, palenie papierosów oraz spożycie alkoholu. **Materiał i metody.** Badania przeprowadzono w Polsce, wśród osób w wieku powyżej 60. lat mieszkających w mieście (n=146) oraz na wsi (n=128). Posłużono się metodą sondażu diagnostycznego, z wykorzystaniem techniki ankiety. Różnice pomiędzy mieszkańcami miast i wsi oceniono za pomocą testu istotności dla dwóch wskaźników struktury na poziomie istotności  $\alpha=0,05$ . **Wyniki.** Zaobserwowano istotne statystycznie różnice pomiędzy badanymi grupami: liczniejsza grupa seniorów wiejskich 23,35% niż miejskich (15,75%) nie jest aktywna fizycznie ( $p=0,0008$ ); starsi mieszkańcy wsi palą więcej (16,40%) niż miejscy seniorzy (7,53%,  $p=0,0225$ ), wypijają jednorazowo więcej jednostek alkoholu i spożywają większe ilości białka zwierzęcego. **Wnioski.** Wyniki sugerują, że polityka społeczna i lokalne programy mające na celu poprawę jakości starzenia się powinny uwzględniać różnice pomiędzy wiejską i miejską społecznością osób starszych. Seniorzy mieszkający na wsi potrzebują większego zainteresowania i wsparcia zarówno ze strony instytucji rządowych jak i organizacji społecznych.

**Słowa kluczowe:** dieta, spożycie alkoholu, aktywność fizyczna, osoby starsze, starość

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## Introduction

In Poland in 2017, older people constituted over 24% of the general population [1]. In old age it is very important to maintain a low level of disability, high level of independent physical and mental function and active involvement and interest in life in order to achieve so called “successful aging” [2]. A healthy lifestyle is often believed to be the only reasonable strategy for quality aging [3]. Typically, health-oriented behavior includes sensible eating, physical activity (PA), and the avoidance of stimulants, especially alcohol and cigarettes. Research conducted among citizens over 60 show that the risk of loss of health and the aggravation of aging in elderly populations is primarily connected with negligence in the three above-mentioned spheres [4]. The self-rating of successful aging depends also on other factors, like cultural norms and values [5]. In a sense, the urban and rural seniors can be regarded as representing different cultures, with very different lifestyles.

Eastern Poland is the oldest region of the country demographically. Our study focused particularly on the north-eastern region of Poland because it is very much under-researched compared to other Polish regions. Elderly people in this region make up almost 40% of the population [6]. The group analyzed was compared with seniors living in cities in the same region. The aim was to obtain empirical data on exercise, eating habits, smoking and consumption of alcohol among seniors living in urban areas and traditional Polish villages to identify similarities and differences in health-oriented behaviors.

## Material and methods

The study was conducted from January to March 2017 among people over 60 living in the countryside and in the city in the province of Warmia-Masuria in north-eastern Poland. A total of 400 seniors were selected but 76 potential respondents could not be reached and 50 further subjects refused to participate. Eventually 274 seniors from urban and rural areas took part in the study. The rural sample was composed only of those elderly who have spent their entire lives in traditional agricultural villages and have no permanent links with an urban environment. For the urban sample we selected respondents who have lived their entire adult life in the city. A self-reported health data method was employed in the study, using the Pen and Paper Personal Interview (PAPI) approach. The questionnaire was developed using the Questionnaire of Eating Behavior (QEB), Alcohol Use Disorders Identification Test (AUDIT) and the World Health Organization (WHO) recommendations on physical activity for seniors. It consisted of demographics and three thematic parts: physical activity, smoking and alcohol consumption, and eating habits. The information was completed by research assistants in face-to-face interviews with the participants. The results were processed with the aid of STATISTICA v.12 software using a significance test of two structure coefficients at a significance level of  $\alpha=0.05$ .

86.9% of the respondents were between 60 and 74 years old. Women were predominant in the group (74.10%), with a greater gender disparity among seniors living in the city, where there were significantly more women (81.51%) than men. There are two reasons for this overrepresentations of women: first, there are significantly more senior women than senior men in the region [7] and second, men were much more reluctant to participate in the study. More than half of the respondents in rural areas received only basic (primary) or vocational education (33.59% and 26.56% respectively), compared to just over 12% of the city respondents representing a similar education level. Seniors from rural and urban areas have similar financial situations – mostly good or average. More than half of the respondents are married, but there are more older couples in the villages (74.21%) than in the city (50%) (Table 1).

**Table 1.** Demographic characteristics of the respondents

	City (n=146)		Village (n=128)		Total (n=274)	
	N	%	N	%	N	%
<b>Gender</b>						
<b>Women</b>	119	81.51	84	65.62	203	74.10
<b>Men</b>	27	18.49	44	34.38	71	25.90
<b>Age</b>						
<b>60-74 yrs</b>	119	81.51	119	92.97	238	86.90
<b>75-89 yrs</b>	27	18.49	9	7.03	36	13.10
<b>Education</b>						
<b>Higher</b>	46	31.50	26	20.31	72	26.28
<b>Secondary</b>	82	56.16	25	19.54	107	39.06

<b>Vocational</b>	11	7.55	34	26.56	45	16.43
<b>Primary</b>	7	4.79	43	33.59	50	18.23
<b>Economic status</b>						
<b>Very good</b>	12	8.23	3	2.35	15	5.50
<b>Good</b>	70	47.94	52	40.62	122	44.50
<b>Average</b>	61	41.78	67	52.35	128	46.70
<b>Bad</b>	3	2.05	6	4.68	9	3.30
<b>Marital status</b>						
<b>Married</b>	73	50.00	95	74.21	168	61.30
<b>Single</b>	73	50.00	33	25.79	106	38.70
<b>Occupational status</b>						
<b>Working</b>	17	11.64	14	10.94	31	11.30
<b>Not working</b>	129	88.36	114	89.06	243	88.70

## Results

More seniors in rural areas than in urban areas did not exercise ( $p=0.0005$ ). 26.56% of the senior rural population, and 16.44% of the senior urban population exercise every day; 24.22% of the country seniors exercise a few times a week. The number is lower by more than half in comparison to urban seniors (54.79%). Significant differences were observed between the groups ( $p=0.008$ ,  $p=0.01960$  and  $p<0.0001$ , respectively). The largest group, regardless of the place of living, spends 1-2 hours per week on exercising. Significantly more seniors from the cities ( $p=0.0005$ ) exercise 2-4 hours per week. In both groups the most commonly chosen form of exercising is walking. Gymnastics and aerobic, on the other hand, are the least popular activities. A large number of rural seniors (38.57%) dance, compared to only just over 5% of city seniors ( $p=0.0001$ ). Urban seniors are significantly more likely to cycle (13.45%) than the rural ones (1.43%;  $p=0.0001$ ) (Table 2).

**Table 2.** Exercising\*

	Respondents						p
	City (n=146)		Village (n=128)		Total (n=274)		
	N	%	N	%	N	%	
<b>Frequency</b>							
<b>None</b>	23	15.75	41	32.03	64	23.35	0.0008
<b>&lt; Once a month</b>	6	4.12	10	7.81	16	5.84	0.0961
<b>Once a week</b>	13	8.90	12	9.38	25	9.12	0.4430
<b>A few times a week</b>	80	54.79	31	24.22	111	40.51	$p<0.0001$
<b>Everyday</b>	24	16.44	34	26.56	58	21.18	0.01960
<b>Time/per week</b>							
<b>0 h</b>	23	15.75	41	32.03	64	23.35	0.0016
<b>&lt; 1 h</b>	19	13.01	22	17.19	41	14.97	0.3558
<b>1-2 h</b>	60	41.10	50	39.06	110	40.15	0.7361
<b>2.1-4 h</b>	39	26.71	13	10.16	52	18.98	0.0005
<b>4.1-6 h</b>	5	3.43	2	1.56	7	2.55	0.3465
<b>Most popular forms of exercising**</b>							
<b>Walking/ Nordic walking</b>	75	63.03	40	57.14	115	60.85	0.1573
<b>Dancing</b>	6	5.03	27	38.57	33	17.46	0.0001
<b>Cycling</b>	16	13.45	1	1.43	17	8.99	0.0001
<b>Gymnastics/aerobic</b>	4	3.36	2	2.86	6	3.17	0.4047-
<b>Jogging</b>	18	15.13	0	-	18	9.52	-

Notes:

\*The data presented in this section was partially discussed in another article on the physical activity of seniors.

\*\*n=189; the question was answered only by those respondents who admitted to exercising.

There were no statistically significant differences between the groups in frequency of alcohol consumption. Rural seniors often have one unit of alcohol at a time (44.0%;  $p=0.0482$ ), while urban dwellers have two to three units (58.33%,  $p=0.0008$ ). People living in the countryside drink more than five units of alcohol at one time (10.0% compared to 0.92%,  $p=0.0007$ ). There are almost twice as many cigarette smokers among rural respondents than the urban ones (16.40% vs 7.53%;  $p=0.0225$ ) (Table 3).

**Table 3.** Smoking and alcohol consumption

	Respondents						p
	City (n=146)		Village (n=128)		Total (n=274)		
	N	%	N	%	N	%	
<b>Frequency of alcohol consumption</b>							
Once a day	1	0.68	4	3.12	5	1.82	-
1-3 times a week	10	6.84	6	4.68	16	5.83	0.4465
> 1 once a month	54	36.99	59	46.09	113	41.24	0.0128
1-3 times a month	43	29.46	31	24.21	74	27.00	0.3288
Abstinent	38	26.03	28	21.87	66	24.08	0.4217
<b>Units of alcohol consumed at one time*</b>							
1	35	32.40	44	44.00	79	37.99	0.0482
2-3	63	58.33	38	38.00	101	48.55	0.0008
4-5	9	8.33	8	8.00	17	8.17	0.9208
More than 5	1	0.92	10	10.00	11	5.29	0.0007
<b>Smoking</b>							
Smokers	11	7.53	21	16.40	32	11.68	0.0225
Non-smokers	127	86.9	100	78.12	227	82.84	0.0520
Social smokers	8	5.48	7	5.46	15	5.48	-

\*n=208; the question was answered only by those respondents who admitted to drinking alcohol.

72.66% of respondents have three to four meals a day. Most respondents have regular meals (81.39%) and at least one portion of fruits or vegetables a day. There are, however, statistically significant differences between the rural and urban group in dairy consumption ( $p=0.0468$  and  $p<0.0001$  respectively). Significantly more senior villagers admit to having meat daily (14.06%) compared to only 0.68% of city seniors ( $<0.0001$ ) and 82.82% of them eat animal products several times a week (Table 4).

**Table 4.** Eating habits

	Respondents						p
	City (n=146)		Village (n=128)		Total (n=274)		
	N	%	N	%	N	%	
<b>Number of meals per day</b>							
Three	113	77.40	85	67.46	198	72.66	0.0326
Four-five	33	22.60	43	33.59	76	27.34	0.0213
<b>Regularity of meals</b>							
Yes	119	81.50	104	81.25	223	81.39	0.9577
No	27	18.50	24	18.75	51	18.61	0.9577
<b>Fruit consumption</b>							
At least once a day	109	74.66	95	74.22	204	74.46	0.4668
A few times a week	29	19.86	27	21.09	56	20.44	0.4006
Occasionally	8	5.48	6	4.69	14	5.10	-
<b>Vegetables consumption</b>							
At least once a day	104	71.24	84	65.63	188	68.62	0.1590
A few times a week	38	26.02	42	32.81	80	29.2	0.1087
Occasionally	4	2.74	2	1.56	6	2.18	-
<b>Dairy consumption</b>							
At least once a day	81	55.48	58	45.33	139	50.73	0.0468
A few times a week	51	34.94	52	40.62	103	37.60	0.1664



<b>Occasionally</b>	14	9.58	18	14.05	32	11.67	p<0.0001
<b>Fish consumption</b>							
<b>3-4 times a week</b>	15	10.28	7	5.47	22	8.03	0.0719
<b>Once a week</b>	63	43.16	52	40.62	115	41.97	0.3354
<b>A few times a month</b>	46	31.5	49	38.28	95	34.67	0.1044
<b>Occasionally</b>	22	15.06	20	15.63	42	15.3	0.4480
<b>Animal protein in meals</b>							
<b>Once a week</b>	5	3.43	4	3.12	9	3.28	0.3182
<b>A few times a week</b>	140	95.89	106	82.82	246	89.78	0.0002
<b>Everyday</b>	1	0.68	18	14.06	19	6.94	<0.0001

## Discussion

Physical activity has a positive influence on physical and mental health and improves quality of life, allowing seniors to enjoy their independence [8]. In the group studied, 23.35% of all the participants never exercise. A significant difference was recorded between the two groups of seniors: 15.75% of the urban dwellers do not exercise, with twice that percentage in rural areas. Rural seniors seem to be less likely to undertake physical activities in a strict sense, that is, as a form of reflexive, health-enhancing activity. The WHO recommends the elderly engage in at least 150 minutes of moderate exercise, or 75 minutes of vigorous exercise, a week [8]. In the group studied only a few met these standards. In total, 61.69% of the respondents said they exercise daily or several times a week, but regret not spending enough time on these activities. This means that only one-fifth of all the respondents comply with WHO recommendations.

Similar to other findings on seniors' health [10], walking was the dominant form of exercising (Table 2). Polish seniors are particularly keen on Nordic walking [11], a gentle form of physical activity suitable for people over 60. None of the surveyed villagers jog. In the city however, this form of exercise is preferred by 14.29% of the respondents. As many as 38.57% of the rural seniors pointed to dancing as their most common form of keeping fit, while in the city just over 5% seniors dance. The reason for these differences may lie in the fact that dancing in rural areas has always played central social functions and folk festivals are often an important event in the agricultural cycle [12]. Cycling seems to be much more popular in the city, with a statistically significant difference noted. However, it is assumed through observations made in the countryside during the interviews, that the use of a bike was very widespread there. In rural areas, though, a bicycle is utilized more as a means of transport than as a form of activity undertaken in one's free time, and thus perhaps resulted in a much lower response rate in this regard.

Our findings indicate that place of residence may affect the amount and type of physical activities performed by seniors. In the city, more seniors exercise. Many factors, such as lifestyle and education play a role, but the shortage of sports facilities in the countryside as well as targeted activities organized by institutions may also be an important reason for lower exercise levels, not only among older people but also younger ones. Moreover, the countryside lacks general awareness-raising activities and programs enabling persons over 60 to participate in various forms of physical activity adapted to their psychophysical abilities.

In 2017, 24% of Polish citizens smoked cigarettes, and in the over 60 population, 30% of men and 19% of women smoke cigarettes [13]. In our study, 16.40% of rural seniors admitted to smoking, more than double the number in the urban group. The number of social smokers in both groups was the same. In total 11.68% of the respondents smoked. In comparison, in the US, 8.2% of people over 65 reported cigarette use every day [14]. In the north-eastern region of Poland the rural seniors in general are more likely to reach for a cigarette than their urban peers. Smoking remains a strong risk factor for premature mortality in older age and increases the risk of cardiovascular disease [15]. Seniors living in the city might be more aware of the benefits of a healthy lifestyle, potentially partially explaining the difference in the results. In addition, as discussed earlier, they are more likely to undertake physical activity, thus impacting their decision to limit or quit smoking.

Another stimulant we looked at in the study was alcohol, because aging has changed attitudes towards alcohol consumption by older people [16]. Alcohol abuse by an elderly person can lead to serious health consequences, and mixing alcohol with drugs can produce particularly serious side-effects [17]. The general amount and frequency of alcohol consumption decreases in older age groups, but problems related to alcohol consumption still occur in about 2-5% of people over 60 years of age. To compare, in the United States, about 5% of seniors are estimated to suffer from alcohol-related problems [17].

In the group of rural seniors analyzed, 21.87% abstained from alcohol. The result obtained in the north-eastern region of Poland is similar to nationwide data. The report *Alcohol Consumption in Poland in 2013* shows

that among those over 60 years of age, 27% abstain, and the inhabitants of rural areas are less likely to drink alcohol than the urban population [18]. The State Agency for the Prevention of Alcohol-Related Problems defines "irresponsible consumption" as four units of alcohol consumed by men, and two by women [18]. The villagers most often drink one unit of alcohol, and the inhabitants of the city two to three. But in the countryside, 10% of respondents drink more than five units of alcohol at one time, whereas in the city less than 1% of the seniors do so. It is suggested that the reason for the difference lies in lifestyle, which also affects the so-called drinking culture [19]. Nevertheless, these findings contradict the general belief that frequent and excessive consumption of alcohol is mainly a problem among inhabitants of Polish rural areas.

Aging results in severe changes in the digestive system, which can significantly affect nutrition [20]. Chronic energy deficiency among the elderly often leads to increased hospital admissions and even mortality [21]. Healthy eating directly affects overall body function. Due to the increased incidences of chronic diseases in older age, appropriate dietary restrictions are often recommended. Nutrition guidelines for the elderly indicate that they should have four to five meals a day, and should include a variety of foods in their diet [22]. Among the villagers surveyed, 33.59% try to meet these recommendations, compared to 22.60% of urban seniors. Both groups do not differ much, though, in terms of the regularity of food intake – almost 82% of the seniors have regular meals. This result is similar to other studies conducted among Polish rural seniors [23].

The medical guidelines for the elderly emphasize the importance of fruit and vegetables as healthy foods that help maintain a proper weight and slow the process of aging and reduced likelihood of chronic disease [24]. According to the European Code Against Cancer, as many as 62% of Poles do not eat fruits and vegetables on a daily basis. Only 2% consume the recommended minimum of 400 g per day [25]. Both groups are alike in fruit and vegetable consumption. In general, the largest group of respondents said they eat fruit or vegetables at least once a day, which is a testimony to the dietary habits of the respondents. In the group surveyed 79.6% of the respondents eat vegetables and fruit six times a week. The quality of these products is a separate issue. From the interviews and from observations during the study it appears that in the countryside most of the respondents have orchards and vegetable gardens, so they have access to their own fresh produce.

Dairy products are very popular in both groups but more city seniors have them on a daily basis. Half of all the respondents admit to having dairy products several times a week. In this case as well, the quality of the products makes a difference. In the traditional villages where the research was conducted, milk, eggs and dairy products can be bought directly from farmers. The products are usually fresh and made according to local recipes, without artificial additives. In cities however, access to such high quality products is rather limited.

Fish consumption is on a similar level in the countryside and in the city: seniors most often have fish once a week. This is probably connected with the Catholic tradition of fasting on Fridays, which is deeply rooted in Poland. All the respondents eat meat, but older villagers consume animal protein more often, i.e., every day or several times a week. Meat dishes are popular with the elderly, regardless of their place of residence. The preference seems to be associated with traditional eating habits. Therefore, it might be more difficult for older people than for younger generations to change their lifelong habits and replace meat with other products.

Our research focused on those elements that are widely believed to comprise a so-called healthy lifestyle. Urban and rural environments are surely very different locations, with community norms, outlooks and social ties attached to them that all influence the health-related behaviors of seniors in those environments. The results indicate that the elements of a healthy lifestyle differ between older rural and urban dwellers. The specific lifestyles of rural seniors, and their physical activities in particular, should not be considered merely in terms of will and choice but also in relation to the possibilities and limitations faced by rural inhabitants. Anthony Giddens, a sociologist, rightly points out that class divisions, inequality, and social exclusions can be defined in terms of differential access to forms of self-actualization and empowerment [26]. From this point of view, the concept of life chances can be useful in explaining differences between rural and urban seniors' lifestyles. Life chances determine the realization of life choices and are connected to a particular life situation, not only to the economic aspect but also to values and norms, patterns and social relationships which enable or disable the realization of life choices [27]. Life choices and needs, and life chances seem to be interdependent. Allowing greater access and support is particularly important in rural areas, where almost 32% of all Polish citizens over 65 live [28]. Therefore, targeted programs that account for differences between seniors' environments and their lifestyles, are needed to improve the life quality of this group and support the practice of successful aging.

## Conclusions

The differences in health-related behaviors of rural and urban seniors indicate that programs promoting quality aging need to be tailored to different environments and lifestyles of the elderly. However, the features of

lifestyle chosen for this very study influence successful aging only to a certain extent. There are other significant factors that could be studied in future research, such as sexual activity, access to facilities or social engagement on the quality of seniors' lives. Urban seniors might have much better access to community centers, seniors' associations, and shopping malls, but in villages the parishes that are central for community life in Polish rural areas might prevent social isolation and create closer ties between locals, thus affecting satisfaction and successful aging. It would be interesting to explore these and other elements further across Poland as well as other countries to inform details of actions and policies aimed at older citizens.

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## VALUE ORIENTATIONS AND RISKY SEXUAL BEHAVIOUR AMONG FIRST YEAR UNIVERSITY STUDENTS

### ORIENTACJA WARTOŚCI I RYZYKOWNE ZACHOWANIA SEKSUALNE U STUDENTÓW PIERWSZEGO ROKU

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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.** There is strong evidence that values play an important role in basic patterns of human behaviour, but there is a lack of support for this with respect to sexual behaviour. This study examines the relationship between the value orientations of young adults and their sexual behaviour.

**Material and methods.** The Rokeach Value Survey (18 terminal values – desirable end-states; 18 instrumental values – desirable modes of conduct) and a questionnaire on sexual behaviour (number of sexual partners in one's lifetime, condom use, and sex with an unknown person) were administered to 832 students (355 males; mean age = 20.5 years). Six factors were extracted from the Rokeach Value Survey. Logistic regression was performed on students who had had sexual experience (n = 455) using the measures pertaining to risky sexual behaviour as outcomes and each of the value factors as separate predictors.

**Results.** The students with high scores on the value factors relating to Social Orientation (Capable, Clean, Obedient, Polite, Responsible, Honest) and Sense of Fellowship (Broad-Minded, Helpful, Forgiving) were less likely to report risky sexual behaviour than the students with low scores on these value factors.

**Conclusions.** Individuals who consider socially oriented values to be more important are less likely to engage in risky sexual behaviour. The promotion of safe sex should take health values into account.

**Keywords:** value orientation, students, risky sexual behaviour

#### Streszczenie

**Wprowadzenie.** Istnieją mocne dowody potwierdzające koncepcję, że wartości odgrywają ważną rolę w formowaniu podstawowych schematów ludzkiego zachowania, choć wciąż brak wniosków związanych z zachowaniem seksualnym. To badanie przygląda się związkowi między orientacją wartości i zachowaniami seksualnymi u młodych osób dorosłych.

**Materiał i metody.** Ankieta Rokeacha dotycząca wartości (18 wartości ostatecznych – pożądanych stanów końcowych, 18 wartości instrumentalnych – pożądanych rodzajów postępowania) oraz kwestionariusz zachowań seksualnych (ilość partnerów seksualnych w ciągu życia, stosowanie prezerwatyw, stosunki z osobami nieznanymi) zostały przedstawione grupie 832 studentów (355 mężczyzn; wiek: 20,5). Sześć czynników wyszczególniono z ankiety Rokeacha. Zastosowano regresję logistyczną na grupie studentów z doświadczeniem seksualnym (n = 455), przyjmując miarę ryzykownych zachowań seksualnych jako rezultat, a każdą z wartości jako osobny wskaźnik.

**Wyniki.** Studenci z wysokimi wynikami związanymi z wartościami: Orientacja Społeczna (Pomysłowość, Czystość, Posłuszeństwo, Grzeczność, Odpowiedzialność, Szczerłość) oraz Poczucie Wspólnoty (Otwartość, Bycie pomocnym, Wybaczanie) w mniejszym stopniu raportowali ryzykowne zachowania seksualne niż studenci z niskimi wynikami dla tych wartości.

**Wnioski.** Można przyjąć, że przypisanie większego znaczenia wartościom prospołecznym jest związane z rzadszymi ryzykownymi zachowaniami seksualnymi. Promocja bezpiecznych zachowań seksualnych powinna obejmować kwestie zdrowotne.

**Słowa kluczowe:** orientacja wartości, studenci, ryzykowne zachowania seksualne

Tables: 4

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## Introduction

Values are strong, cognitive, emotionally significant guiding and organising principles in an individual's life; they substantially shape both their current and future patterns of health-related behaviour [1, 2], and they might also influence sexual behaviour. Rokeach sees a value system as an enduring organisation of beliefs comprising preferable modes of conduct or end-states of existence along a continuum of relative importance [3]. On the basis of Rokeach's value system theory it was assumed [4] that people's underlying core values would be relatively (1) stable and enduring, (2) limited in number, and (3) capable of being measured in terms of personal importance.

Several studies [4-11] have shown that specific value orientations are associated with risky health-related patterns of behaviour and that two of these are specifically associated with sexual behaviour. However, the labels for the values concerned are varied (e.g., *Sense of Accomplishment*, *Broad-Minded*, *Independent* or *Freedom*). Nagel [12] found that those who did not use tobacco were more concerned with the values associated with *World at Peace* and having a *Sense of Accomplishment*. Such non-smokers were also less interested in material comforts, pleasure, and having an exciting life. Foreyt [13] found that individuals who use tobacco seem to have different value characteristics than non-smokers. On the other hand, a study conducted by Young and West [2] did not confirm that certain values were more likely associated with risky patterns of behaviour. Kristiansen [14] showed that smokers placed more emphasis on being *Broad-Minded* than non-smokers. Smokers were also more concerned with *Freedom*, being *Independent* and not being *Obedient*, which suggests that smokers' behaviour can be described as flexible or unconstrained. These results highlight the possibility that smokers and non-smokers might have different value priorities. Chang [10] observed that smokers and non-smokers differ in personal values: *Hedonic Gratification* values predicted more favourable attitudes towards smoking, and *Idealism* predicted more negative attitudes towards this activity.

Chernoff & Davison [4] demonstrated that the respondents in their study who took higher risks reported significantly different value priorities than those who took lower risks with the former prioritising the value *Exciting Life* and deeming the values *Self-Controlled*, *Helpful*, *Honest*, *Loving*, *Equality*, and a *World at Peace* as less important. It was therefore suggested that health-endangering behaviour may be positively associated with the values *Risk-Taking*, *Impulsivity*, and *Sensation Seeking*, and negatively associated with other-oriented values (i.e., *Concern for Others*) [4].

There are several reasons why this topic is important among young adults, especially those who are in the university environment. Firstly, there is significant public concern regarding risky health-related behaviour in late adolescence and early adulthood as such people are focused on establishing their own attitudes towards life, often without parental supervision [15]. Compared with other stages of life, this 'emerging adulthood' period is characterised by a very sharp increase in risky patterns of behaviour such as alcohol and drug use or risky sexual behaviour (RSB) [16]. As far as RSB is concerned, rates of inconsistent condom use, sex with unknown partners or the use of drugs or alcohol during this life stage are likely to be twice as much as any other period in life [17].

The aim of this study is to examine the relationship between value orientations and sexual behaviour of young adults. It is expected that the participants with more socially oriented values will engage in less risky sexual behaviour than those with less socially oriented values.

## Material and methods

### *Sample and procedure*

The sample consisted of 882 first-year students at P.J. Šafárik University (7,000 students) and the Technical University (12,000 students) in Košice (230,000 inhabitants) who, under the guidance of field workers, completed a questionnaire concerning health behaviour during a compulsory lecture. The students were randomly selected from a list of study groups provided by the faculties concerned and their participation was voluntary. All the procedures concerning data collection were explained to respondents before data collection. The Ethics Committee of the Medical Faculty of P.J. Šafárik University approved this study.

50 of the 882 participants were excluded from the study – 7 left the room before the beginning and 43 were excluded afterwards because they did not complete major parts of the questionnaire. A total of 832 respondents therefore completed the study (94.3%): 355 males and 477 females, aged 19-28 years with 90% of the students aged 19-23 years (mean = 20.5; SD = 1.4). Out of these, 45.1% studied at the science faculty, 34.8% at the technical faculty and 20.1% at the medical faculty. More than half of the respondents had completed grammar school and the majority of the students lived in student halls (38.0%) or with their parents (37.1%).

## Measures

Sexual behaviour – The respondents were first asked whether they had ever had sex (penetration of the vagina by the penis) (yes / no). Further questions on sexual behaviour included (1) how many sexual partners they had had in their life (3 and less / 4 or more); (2) how often they used condoms (always / almost always, occasionally, never); (3) whether they had ever had sex with an unknown person (yes / no). Those who reported more than 4 sexual partners, inconsistent condom use, and the experience of sex with an unknown partner were reported as engaging in risky sexual behaviour (RSB).

By combining these three types of sexual behaviour another four variables were constructed: (1) multiple sexual partners and sex with an unknown person; (2) multiple sexual partners and inconsistent condom use; (3) sex with an unknown partner and inconsistent condom use; (4) multiple sexual partners, sex with an unknown person and inconsistent condom use. All four types of combined variables were dichotomised as apply / none. All other combinations were recorded as missing for that variable.

Values – Values were measured by the Rokeach Personal Value Survey [18]. The Personal Value Survey includes terminal values, that is desired end-states, and instrumental values. The questionnaire includes the following terminal values: *Comfortable Life, Exciting Life, Sense of Accomplishment, World at Peace, World of Beauty, Equality, Family Security, National Security, Freedom, Happiness, Inner Harmony, Pleasure, Self-Respect, Social Recognition, Mature Love, Health, True Friendship, and Wisdom*. The instrumental values comprised *Being Ambitious, Broad-Minded, Capable, Cheerful, Clean, Courageous, Forgiving, Helpful, Honest, Imaginative, Independent, Intellectual, Obedient, Polite, Logical, Loving, Responsible, and Self-Controlled*.

The Rokeach Survey can be applied in two ways, namely *ipsative*, in which values are rank-ordered, and *non-ipsative*, in which all values are measured independently from one another. In this study the *non-ipsative* method was used. The participants were asked to rate the importance of each value from the terminal and instrumental scales on a 5-point Likert scale, ranging from Not at all important (1) to Maximum importance (5).

## Statistical analyses

As we were interested in the importance of values regarding risky vs. safe sexual behaviour rather than in the importance of values regarding the initiation of sexual behaviour, the analyses were limited to the 455 respondents who reported having ever had sexual intercourse. We first assessed their current sexual behaviour and sexual history by gender. Gender differences were tested using the Chi-Square Test. Next, we performed a factor analysis on the Rokeach Survey to reduce the number of variables. We omitted variables with Kaiser-Meyer-Olkin (KMO) values lower than 0.6 or with communalities lower than 0.4 [19], which resulted in the elimination of nine items. The resulting KMO measure of sampling adequacy was 0.908, which is higher than the recommended value of 0.6. Moreover, the diagonals of the anti-image correlation matrix were all over 0.84, supporting the inclusion of each item in the factor analysis. We then extracted six factors with loadings from 0.366 to 0.787. Finally, we performed logistic regression analyses using the measures of RSB as outcomes and each of the factors as separate predictors. All of the statistical analyses were performed using SPSS 15.

## Results

### Sexual behaviour

Table 1 presents information on sexual behaviour separately for males and females. 43% of males versus 31% of females reported that they had had 4 or more sexual partners in their life; 72% of males versus 81% of females reported inconsistent condom use; and 17% of males versus 10% of females had had sex with an unknown person.

**Table 1.** Self-reported sexual behaviour

	Total % (N)	Male % (N)	Female % (N)	Gender Difference (p)
<b>Sexual experience</b>				<b>ns</b>
Yes	62.5 (455)	61.3 (184)	63.3 (271)	
<b>Number of sexual partners</b>				<b>*</b>
lower risk (3 or less)	63.7 (269)	57.1 (97)	68.3 (172)	
higher risk (4 or more)	36.0 (152)	42.9 (73)	31.3 (79)	

<b>Condom use</b>				<b>ns</b>
lower risk (always)	22.7 (100)	24.6 (50)	19.3 (50)	
higher risk (often, sometimes, never)	77.3 (340)	72.4 (131)	80.7 (209)	
<b>Sex with an unknown person</b>				<b>*</b>
lower risk (no)	87.4 (341)	83.5 (132)	90.1 (209)	
higher risk (yes)	12.6 (49)	16.5 (26)	9.9 (23)	
<b>Cumulative risk indicators</b>				
<b>Number of partners and an unknown partner</b>				<b>ns</b>
lower risk	90.1 (314)	87.5 (119)	91.9 (192)	
higher risk	9.9 (34)	12.5 (17)	8.1 (17)	
<b>Number of partners and condom use</b>				<b>ns</b>
lower risk	69.5 (290)	66.3 (112)	71.8 (178)	
higher risk	30.5 (127)	33.7 (57)	28.2 (70)	
<b>Sex with an unknown partner and condom use</b>				<b>ns</b>
lower risk	89.7 (323)	86.3 (126)	92.1 (197)	
higher risk	10.3 (37)	13.6 (20)	7.9 (17)	
<b>Number of sexual partners, condom use and age of first intercourse</b>				<b>ns</b>
lower risk	89.1 (368)	88.6 (148)	89.4 (220)	
higher risk	10.9 (45)	11.4 (19)	10.6 (26)	

\*  $p < .05$ ; ns = not statistically significant

### Values

Table 2 presents the mean ratings for the 18 terminal and 18 instrumental values. In comparison with *Family Security*, *Mature Love*, *Health* and *Wisdom*, which were the highest rated terminal values, *World of Beauty* and *Comfortable Life* were rated the lowest in this respect. Among the instrumental values, *Loving*, *Honest* and *Responsible* were rated the highest, whereas *Helpful*, *Ambitious* and *Forgiving* were among the lowest rated.

**Table 2.** Means and standard deviations (SD) for terminal and Instrumental values

<b>Terminal values</b>	<b>Mean</b>	<b>SD</b>
Comfortable Life	3.7	0.9
Exciting Life	3.8	0.9
Sense of Accomplishment	3.9	0.8
World at Peace	4.4	0.9
Equality	3.8	0.9
World of Beauty	4.2	1.0
Family Security	4.6	0.7
Freedom	4.4	0.9
Happiness	4.5	0.7
Inner Harmony	4.4	1.0
Mature Love	4.6	0.7
National Security	4.1	1.0
Pleasure	4.1	0.8
Self-Respect	4.1	0.8
Social Recognition	3.8	0.9
True Friendship	4.6	0.7
Wisdom	4.3	0.7
Health	4.4	0.8
<b>Instrumental values</b>		
Ambitious	3.4	0.9
Broad-Minded	3.6	0.9
Capable	3.7	0.8
Cheerful	4.0	1.0



Clean	4.1	0.9
Courageous	3.8	0.8
Forgiving	3.4	0.9
Helpful	3.2	0.9
Honest	4.2	0.9
Imaginative	3.6	0.9
Independent	3.8	1.0
Intellectual	3.9	0.9
Logical	3.7	0.9
Loving	4.4	0.8
Obedient	3.6	0.9
Polite	4.0	0.8
Responsible	4.2	0.8
Self-Controlled	3.6	0.9

SD = standard deviation; Participants rated the importance of each value on a 5-point scale, from “not at all important” (1) to “extremely important” (5). Higher scores indicate higher importance.

Table 3 presents the following six factors that were extracted from the items: Self-Contentment, Social Orientation, Concern for Society, Self-Confidence, Self-Actualisation, Sense of Fellowship. Factor loadings varied from 0.366 to 0.787.

**Table 3.** The 6 extracted factors and value loadings

Values	Factors					
	F1 Self- Contentment	F2 Social Orientation	F3 Concern for Society	F4 Self- Confidence	F5 Self- Actualisation	F6 Sense of Fellowship
Independent					.744	
Intellectual					.784	
Logical					.780	
Freedom					.324	
World at Peace			.759			
World of Beauty			.758			
Equality			.692			
National Security			.539			
Freedom			.366			
Clean		.508				
Capable		.594				
Obedient		.787				
Polite		.655				
Responsible		.554				
Honest		.389				
Broad-Minded						.634
Helpful						.717
Forgiving						.701
Loving				.573		
Happiness				.555		
Family Security				.591		
True Friendship				.571		
Mature Love				.645		
Freedom				.309		
Self-Respect	.658					
Pleasure	.608					
Social Recognition	.732					
Health	.563					

Wisdom	.471					
Freedom	.311					
Eigen value	7.59	2.19	1.89	1.52	1.14	1.04
Explained variance	28%	8%	7%	6%	4%	4%

### Values and risky sexual behaviour

Table 4 presents the correlations of the six value factors with RSB. It shows that the factors Social Orientation (*Clean, Capable, Obedient, Polite, Responsible, and Honest*) and Sense of Fellowship (*Broad-Minded, Helpful, and Forgiving*) have statistically significant correlations with RSB. With the exception of condom use, there was a significant negative correlation between Social Orientation and RSB as well as a significant negative correlation between Sense of Fellowship and RSB in all its aspects apart from condom use and the number of sexual partners. The factor Concern for Society (*World at Peace, World of Beauty, Equality, National Security, and Freedom*) was only correlated with fewer sexual partners. The correlation analyses showed that all of the factors were associated with lower ratings of RSB. Condom use, represented as a single variable, was not significantly associated with any of the factors. However, when it was combined with other RSB it correlated significantly with several value factors.

**Table 4.** Correlations between value factors and indicators of risky sexual behaviour

Factors	Indicators of more risky patterns of sexual behaviour						
	More than 4 sexual partners	Inconsistent condom use	Sex with an unknown person	More than 4 partners and an unknown person	More than 4 partners and inconsistent condom use	Inconsistent condom use and sex with an unknown person	More than 4 partners, inconsistent condom use and sex with an unknown person
	OR (CI)	OR (CI)	OR (CI)	OR (CI)	OR (CI)	OR (CI)	OR (CI)
F1 – Self-Contentment	ns	ns	ns	ns	ns	ns	ns
F2 – Social Orientation	0.60 (0.50-0.82)***	ns	0.54 (0.38-0.76)***	0.57 (0.38-0.85)**	0.66 (0.50-0.85)**	0.41 (0.24-0.69)***	0.55 (0.35-0.84)**
F3 – Concern for Society	0.75 (0.60-0.94)***	ns	ns	ns	ns	ns	ns
F4 – Self-Confidence	ns	ns	ns	ns	ns	ns	ns
F5 – Self-Actualisation	ns	ns	ns	ns	ns	ns	ns
F6 – Sense of Fellowship	ns	ns	0.71 (0.51-0.79)*	0.63 (0.43-0.91)**	0.71 (0.57-0.91)*	0.49 (0.29-0.82)**	0.55 (0.37-0.82)**

\*  $p < .05$  \*\*  $p < .01$  \*\*\* $p < .001$ ; OR = odds ratio; CI = confidence interval; ns = not statistically significant

## Discussion

The aim of this study was to examine the relationship between value orientations and sexual behaviour of young adults. We expected that participants with more socially oriented values would show less risky sexual behaviour compared with those with less socially oriented values. Our results support such differences but not for all of the measured values. The most robust associations were found in the Social Orientation factor (*Clean, Capable, Obedient, Polite, Responsible, and Honest*) and the Sense of Fellowship factor (*Broad-Minded, Helpful, and Forgiving*). In all of the correlations that were significant, the higher the importance of the values in the particular factors the less risky the sexual behaviour.

We found that RSB was inversely related to the factors Social Orientation and Sense of Fellowship, which reflect values focused on the well-being of others. Participants taking a higher risk (higher number of partners, sex with an unknown person, and all cumulative indicators) consistently rated such well-being values lower, both those reflecting social orientation on a personal level, for example *Responsible, Loving* and *Honest*, and

social orientation on a societal level, for example *Equality*, *Justice* and *World at Peace*. This is consistent with Chernoff & Davison's [4] finding that the values *Honest*, *Loving* and *Helpful* were less important for those who engage in risky sexual behaviour. The reason for the consistently lower preferences for these values might be that such people seem to be less concerned with the well-being of others. This confirms assumptions originally advanced by Morash [20]. Moreover, socially-oriented values and beliefs have been associated with higher levels of empathy, moral reasoning and pro-social behaviour [21].

We found no differences in sexual behaviour with respect to some of the values that Chernoff and Davison had identified as differences in their research. Chernoff and Davison [4] showed that college students with high risk levels of RSB reported significantly different value priorities than their lower-risk peers. Specifically, the high-risk students gave less priority to caution, restrain, self-discipline, and concern for the well-being of others. The authors found that risky sexual behaviour was associated with higher levels of importance concerning *Exciting Life* and lower levels of importance with respect to *Self-Controlled*, *Loving* and *Equality*. We did not find these associations. In comparison with Chernoff and Davison [4], who claimed that the importance of the value of *Exciting Life* might lead to a high probability of risky sexual behaviour, this value in our study had such weak correlations that it was eliminated from the factor analyses. Similarly, a study by Liu [22] indicates that boys with a higher level of self-enhancement and girls with a higher level of openness to change and a lower level of conservativeness are more likely to report engagement in problem behaviours [6]. An explanation for this difference might be that we reduced the number of values by factor analysis, which may have yielded more stable findings.

Other studies on the associations between values and health-related behaviour have also shown the importance of social values. Piko [6] found that a higher health and social value orientation is related to a lower level of smoking as well as alcohol and drug use, which might be explained in terms of social values protecting young people from risk behaviour. Chang [9] observed that socially oriented values such as *Equality*, *National Security* and *World at Peace* were associated with unfavourable attitudes towards smoking behaviour. These findings are consistent with the study of Joireman et al. which demonstrated that young adults with a pro-social value orientation were less likely to report health endangering behaviour [23]. However, a recent study by Young and West [2] found no significant associations between social values and substance use.

Interestingly, the self-oriented factors such as Self-Contentment, Self-Confidence and Self-Actualisation were not significantly related to any risky or safe sexual behaviour in our sample. This contrasts with a previous study showing that young adults with intrinsic life goals (e.g., self-acceptance, internal development, friendship and the development of good social relationships) tend to report lower frequencies of risky health-related behaviour [8, 24]. However, in the Chernoff & Davison [4] study students who gave a high priority to the self-oriented value *Health* reported a similar level of risky and safe sexual behaviour. We may assume that young people who perform risky sexual behaviour did not see their own behaviour as inconsistent with the idea that *Health* is an important value.

### *Strengths and limitations*

This study has several strengths and limitations. We obtained a very high response rate (94%), limiting the likelihood of selection bias, and we included students from a range of university courses. Although we cannot exclude information bias, we did use specific measures to guarantee confidentiality. These measures have been shown to yield valid outcomes. Another limitation of this study apart from the self-report nature of the data is the cross-sectional design itself, which limits the potential for causal inferences. It should also be noted that our sample included only young adults from cities in one region; our findings therefore may not fully apply to students living in rural areas and should be confirmed by an assessment of other groups of young adults.

### *Implications*

Our results support the hypothesis that a stronger orientation towards social values is associated with less risky sexual behaviour. This may support interventions aiming to promote safe sex among adolescents. An example of such an intervention might be the value of self-confrontation, which has been shown to promote smoking-cessation and weight-reduction [25].

Our study shows an association between higher social values and less risky sexual behaviour. More research is needed to explore how types of value models (extrinsic vs. intrinsic values or instrumental vs. terminal values) are associated with other health-related patterns of behaviour. Moreover, the stability of this association over time is unclear as is the causal pathway by which values are associated with health-related patterns of behaviour. It would seem that longitudinal studies are the most suitable to study this.

## Conclusions

In conclusion, value orientations are associated with RSB. The higher one's values, the lower one's RSB. This may provide new pathways for prevention.

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## ALCOHOL CONSUMPTION AMONG STUDENTS IN THE LUBLIN REGION OF POLAND

### POZIOM SPOŻYCIA ALKOHOLU PRZEZ STUDIUJĄCYCH W WOJEWÓDZTWIE LUBELSKIM

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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.** Alcohol is a psychoactive addictive substance that is a frequent part of student life, where consumption levels can be high. This study aimed to determine the level of alcohol consumption among students in the Lublin province.

**Material and methods.** The study was carried out in 2018, using 700 freshmen from the Lublin province (456 women – 65.14% and 244 men – 34.86%) who completed the Alcohol Use Disorders Identification Test (AUDIT) on the Internet.

**Results.** The vast majority of the respondents drink alcohol (80% – 560 people), every fifth respondent declared abstinence (20% – 140 respondents). The gender of the respondents significantly differentiated the level of alcohol consumption ( $\chi^2=42.262$ ;  $p<0.0001$ ). More women than men consumed alcohol at a low risk of developing alcohol-related disorders (89.04%, i.e. 406 women – 71.72%, i.e. 175 men). The value of BMI significantly differentiated the level of alcohol consumption ( $\chi^2=17.513$ ;  $p=0.008$ ).

**Conclusions.** Most respondents consume alcohol at low-risk. Gender and BMI value significantly determine alcohol consumption. It is therefore extremely important to organize at universities cyclical preventive lectures on the harmful effects of alcohol consumption, highlighting its different impact on men and women. Physical activity plays a positive role in promoting health, even when at the same time unhealthy habits such as excessive alcohol consumption occur. Therefore, the possibility of participation in the university in the afternoon sports and recreation classes should be particularly promoted among students.

**Keywords:** alcohol consumption, students, AUDIT

#### Streszczenie

**Wprowadzenie.** Alkohol jest jednym z psychoaktywnych środków uzależniających obecnych w życiu studenta, a jego spożycie odnotowuje się na wysokim poziomie. Celem badań było określenie poziomu spożycia alkoholu przez studium w województwie lubelskim.

**Materiał i metody.** Badania przeprowadzono w 2018 roku wśród 700 studentów studiów I-go stopnia z województwa Lubelskiego (456 kobiet – 65,14% i 244 mężczyzn – 34,86%), którzy wypełnili przez Internet test Rozpoznawania Zaburzeń Związanych ze Spożywaniem Alkoholu (AUDIT).

**Wyniki.** Zdecydowana większość badanych pije alkohol (80% – 560 osób), co piąty badany deklaruje abstynencję (20% – 140). Płeć ankietowanych istotnie różnicowała poziom spożycia alkoholu ( $\chi^2= 42,262$ ;  $p<0,0001$ ). Więcej kobiet niż mężczyzn spożywało alkohol na niskim poziomie ryzyka wystąpienia zaburzeń związanych ze spożywaniem alkoholu (89,04%, tj. 406 kobiet – 71,72%, tj. 175 mężczyzn). Wartość wskaźnika BMI różnicowała istotnie poziom spożycia alkoholu ( $\chi^2=17,513$ ;  $p=0,008$ ).

**Wnioski.** Większość respondentów spożywa alkohol na niskim poziomie ryzyka. Płeć i wartość wskaźnika BMI istotnie determinują spożywanie alkoholu. Jest zatem niezmiernie ważne, aby organizować na uczelniach wyższych cykliczne wykłady profilaktyczne na temat szkodliwych skutków spożywania alkoholu, podkreślając jego różny wpływ na organizmy kobiet i mężczyzn. Aktywność fizyczna odgrywa pozytywną rolę w promowaniu zdrowia, nawet wtedy, gdy jednocześnie pojawiają się niezdrowe nawyki, takie jak na przykład nadmierna konsumpcja alkoholu. Należy zatem szczególnie promować wśród studentów możliwość uczestnictwa na uczelni w popołudniowych zajęciach sportowo-rekreacyjnych.

**Słowa kluczowe:** spożycie alkoholu, studenci, AUDIT

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## Introduction

Going to college is a time of many changes in the lives of young people. During this time the values and habits shaped during upbringing are tested. New social contacts, a different – irregular – lifestyle, moving away from home and associated stress lead to risky behavior in young people. The risky behaviors most commonly described in the literature for this age group include, first of all, the use of psychoactive substances (tobacco, alcohol, drugs), anti-social behavior, premature and risky sexual conduct [1, 2, 3, 4]. Early alcohol initiation and regular alcohol consumption increase the risk of becoming addicted or suffering from non-communicable diseases due to alcohol abuse. Factors that encourage alcohol consumption among young people are various. Social considerations (positive external motivation) dominate among the reasons for drinking alcohol as indicated by Cooper's motivation scale abbreviated by Kuntsche et al. [5]. Negative external motivation, i.e. the desire to fit into a group, was definitely the least selected choice. The subquestions show that young people turn to alcohol most frequently to have fun at parties, and least frequently not to feel rejected or disliked. The main motivator in the ranking is internal/personal reasons, i.e. the desire to get drunk or experience novel pleasant sensations. The most negative effects of alcohol consumption among young people include driving under the influence of alcohol, undertaking risky and/or unwanted sexual behavior, participating in fights, committing acts of vandalism. Since heavy drinking during early adulthood is widespread, many people see nothing wrong with these behaviors [6]. Easy access to alcoholic beverages, cultural behaviors, widespread advertising of alcoholic beverages cause the prevalence of its consumption not only among students but also more frequently among junior high school and high school students [7, 8, 9]. Some reports indicate an increasing number of young people who suffer from the symptoms of heavy drinking whilst attending college [10, 11, 12]. The aim of the study was to determine the level of alcohol consumption in students from the Lublin province.

## Material and methods

As part of the "EurEcas – European assessment of behavior toward health and addiction among students" project (EurEcas – Europejska ocena zachowań wobec zdrowia oraz uzależnień wśród studentów)<sup>1</sup>, students from Hungary, Ukraine and Poland were surveyed in spring 2018. The "EurEcas" project was implemented utilizing funds for statutory activities as part of activities to maintain research potential during the period from 2017 to 2019 in Pope John Paul II State School of Higher Education in Biała Podlaska. 2,130 students took part in the project in total, however, after a preliminary analysis, incomplete answers were found in 165 of the responses. Finally, correctly completed questionnaires were obtained from 1965 students (542 from Hungary, 723 from Ukraine and 700 from Poland). Students agreed to participate in the study and completed a survey via the Internet. The survey consisted of the following questionnaires SCOFF, IFIS, DASS-21, LOT-R, AUDIT and additional questions. The questions concerned the place of residence during the time spent in college, the received scholarships, health and marital status of the students as well as their height and weight. It took the respondents about 30 minutes to complete the survey.

The results collected in this article used data from AUDIT regarding students from eastern Poland, the Lublin province (456 women – 65.14% and 244 men – 34.86%). The respondents were freshmen between the ages of 19 and 23. The Alcohol Use Disorder Identification Test (AUDIT) developed by WHO is used to determine the harmful effects of alcohol consumption [1]. Alcohol consumption can be described in grams as the quantity of consumed alcohol or by using the so-called standard unit of alcohol (in Europe it is 10 grams of pure alcohol). Depending on the type of alcohol, a unit is 250 ml of 5% beer, 100 ml of 12% wine and 30 ml of 40% vodka. The test contains 10 questions scored appropriately from 0 to 4. Four levels of alcohol consumption were identified in AUDIT: drinking within the low risk of developing alcohol-related disorders, risky consumption, harmful drinking, and suspected alcohol dependence. Higher test scores indicate a higher probability of harmful alcohol consumption. Obtaining eight or more points in questions 1-3 indicates dangerous and risky alcohol consumption. The  $\chi^2$  test was used in statistical analyses, establishing statistical significance at the level of  $p < 0.05$ .

## Results

Among the surveyed population, every fifth student admitted that they were abstinent and did not consume alcohol (20%, i.e. 140 people), while 80% of the respondents (560 people) consume alcoholic beverages with different frequency. Alcohol is consumed by 224 students (32%) once a month or less, 252 of the study participants (36%) drink 2-4 times a month, 70 respondents (10%) drink 2-3 times a week, while 14 people (2%) drink

<sup>1</sup> EurEcas – European assessment of behavior toward health and addiction among students. Statutory research to maintain the research potential in the years 2017-2019, No. S/17/17.

more often than 4 times a week. During a typical day on which the respondents consume alcohol, 43.2% (242 students) drink 1-2 units, 3-4 units – 35% (196), 5-6 – 13% (73), 7-8 units – 3.2% (18), above 10 units – 5.6% (31). When asked about the frequency of consuming more than six units of alcohol at a time, 42% of the students (235) answered that they never exceed this amount. Every third student admitted that they drank more than six units of alcohol less than once a month (31.5% – 176), such a dose is consumed every day by 0.7% of the respondents (7 students). During the year preceding the survey, 7.6% of the students (43 people) were unable to stop drinking once they started. This happened less than once a month, and 5.7% of the participants (32 respondents) were in this situation at least once a month. Over the last year, at least once a month, every tenth respondent needed at least one portion of alcohol the following morning after excessive alcohol consumption the previous day (10.1% – 57 people). Memory problems were reported in 23.1% (129) of the students who could not remember what they were doing the previous evening while they were consuming alcohol. This happened less than once a month. 10.1% of the respondents (129 people) declared memory problems after drinking alcohol once a month, and 5.5% (31 of the participants) experienced this problem once a week. Table 1 shows the distribution of alcohol consumption levels among the surveyed students. The vast majority of the respondents, both men and women, consumed alcohol within the low-risk of developing alcohol-related disorders. The gender of the respondents significantly differentiated the level of alcohol consumption among the students ( $\chi^2=42.2262$ ;  $p<0.0001$ ). More women than men consumed alcohol within the low-risk of developing alcohol-related disorders (406 women, i.e. 89.04% and 175 men, i.e. 71.72%). The obtained results indicate that more men 5.33% (13) than women 0.66% (3) drink alcohol within the level involving risk (19.26% – 47 men; 9.86% – 45 women). It has been observed that suspicion of alcohol dependence is more common in the case of men (3.69% – 9 men; 0.44% – 2 women). A detailed analysis showed that the BMI value significantly differentiated the level of alcohol consumption ( $\chi^2=17.513$ ;  $p=0.008$ ). Subjects who were overweight (26 people, i.e. 17.81%) and those with the correct BMI value (65 people, i.e. 13.4%) consumed alcohol within the level involving risk significantly more frequently than those who were underweight (1 person, i.e. 1.45%).

**Table 1.** The level of alcohol consumption among the students

Differentiating factor		The level of alcohol consumption									
		low level of risk		harmful drinking		risky drinking		suspected alcohol dependence		total	
		N	%	N	%	N	%	N	%	N	%
sex $\chi^2=42.262$ $p<0.0001^*$	male	175	71.72	13	5.33	47	19.26	9	3.69	244	100
	female	406	89.04	3	0.66	45	9.86	2	0.44	456	100
place of residence during college $\chi^2=8.537$ $p=0.201$	renting	270	81.33	8	2.41	48	14.46	6	1.81	332	100
	with parents	255	82.26	8	2.58	42	13.55	5	1.61	310	100
	dormitory	56	96.55	0	0	2	3.45	0	0	58	100
marital status $\chi^2=1.579$ $p=0.664$	single	334	83.08	10	2.49	50	12.44	8	1.99	402	100
	in a relationship	247	82.89	6	2.01	42	14.09	3	1.01	298	100
year of study $\chi^2=7.028$ $p=0.318$	1	327	84.72	7	1.81	46	11.92	6	1.55	386	100
	2	138	82.14	7	4.17	20	11.9	3	1.79	168	100
	3	116	79.45	2	1.37	26	17.81	2	1.37	146	100
being in college and working $\chi^2=1.107$ $p=0.775$	yes	123	82.56	2	1.34	21	14.09	3	2.01	149	100
	no	458	83.12	14	2.54	71	12.86	8	1.48	551	100
scholarship $\chi^2=3.837$ $p=0.279$	yes	377	84.72	8	1.8	55	12.36	5	1.12	445	100
	no	204	80	8	3,14	37	14.51	6	2.35	255	100
BMI $\chi^2=17.513$ $p=0.008^*$	underweight	68	98.55	0	0	1	1.45	0	0	69	100
	normal	401	82.68	10	2.06	65	13.4	9	1.86	485	100
	obesity / overweight	112	76.71	6	4.11	26	17.81	2	1.37	146	100

\*significance level of  $p<0.05$



## Discussion

Alcohol consumption is associated with the risk of physical health loss and it can also lead to mental and social disorders. WHO states in the 2019 report that alcohol consumption in the European region, including the EU, is the highest in the world, which may result in an increased incidence of non-communicable diseases. The study results showed a slight decrease in alcohol consumption in 2016 compared to 2010 (11.5-11.3 liters of pure alcohol per person).

In the EU countries, the percentage of alcohol consumption decreased from 78.6% in 2010 to 75.9% in 2016 in the 20-24 age group [23]. According to data from the Central Statistical Office [17], in 2014 the percentage of alcohol users aged between 15 and 29 decreased compared to 2009 (from 71.5% to 69.1%) and the percentage of people declaring abstinence increased (2009 – 28.5%; 2014 – 30.9%). Study results obtained on a group of over 9,000 students of Polish universities at the request of PARPA indicate high alcohol consumption in this age group. 75% of students consumed alcohol at least once in the month preceding the study, three or more times a month – almost 44% [8]. The problem of high alcohol consumption by students exists not only in Poland but also in other countries, which is confirmed by the results of other studies [9, 10, 11, 13, 14, 15, 16, 24]. The results of our research confirm these observations. Most respondents 80% (560 people) drink alcohol, while 20% (140 people) declared abstinence. Kurpas and colleagues previously reported a significantly smaller percentage of non-drinkers among the students of the Medical University of Wrocław – 3.79% [15]. Binkowska-Bury et al. arrived at similar conclusions among the freshmen from Rzeszów universities – 4.7% [22]. The results of the presented research regarding the number of units of alcohol consumed during a typical day are similar to those of other authors. One or two units are consumed by 43.3% of the surveyed students, a slightly higher percentage of students consuming the same amount of alcohol was recorded among the students of the Medical University of Wrocław – 47.41% [15], students in Lublin – 48% [21] and among medical university students – 55% [11]. Every third student at the Faculty of Medicine at the Medical University of Białystok consumed one or two units of alcohol – 34.4% [18]. Similar results to the results of our study were observed in the case of students consuming of three or four units at a time – 34.8% of the respondents, 28.16% [15], 37.1% [18], 26% [11], 22.8% [22]. The consumption of five or six units of alcohol was recorded among 13% of the respondents, while in the studies of Kurpas et al. – 11.49% [15] and 9.8% [11]. 5.6% of the respondents consume more than ten units of alcohol, similar results were obtained by other researchers – 6.15% [16], 5.9% [19], 4% [12].

The prevalence of alcohol consumption among students is high, men are more likely to declare the consumption of this type of substance. An analysis of our research results showed that gender is a factor that significantly differentiates the level of alcohol consumption, which is consistent with the results of other authors [9, 15, 18, 19, 20]. The results of AUDIT suggest that in the case of the majority of the respondents the current model of alcohol consumption is within the low-risk level (89.04% – 406 women; 71.72% – 175 men). Alcohol consumption that is risky to health was reported by more male students than female students (19.26% – 47 men and 9.86% – 45 women). 17.7% of students from Rzeszów universities consumed alcohol within the level involving risk [22]. Risky drinking correlated with gender and was more common in men in the studies of Kurpas et al. ( $r_s=0.166$ ;  $p<0.001$ ) [15].

Going to college very often involves a change of residence, leaving the family home to live in a dormitory or a rented place. In the conducted study, no statistically significant differences were found between the place of residence during college time and the level of alcohol consumption among the students. Such a relationship was also not found among the students at the Medical University of Wrocław ( $p>0.05$ ) [15]. Different results were obtained in studies involving Irish students ( $p<0.001$ ) [14]. In the cited studies, the value of BMI did not significantly differentiate the level of alcohol consumption ( $p=0.96$  for women and  $p=0.97$  for men), while this correlation was evident in our research results ( $\chi^2=17.513$ ;  $p=0.008$ ).

## Conclusions

Alcohol is an inseparable part of student life, however, it is very important to control the frequency and amount of alcohol consumption. Not everyone who drinks alcohol is addicted but even a single dose is a health risk.

1. Most respondents, both men and women, consume alcohol within the low-risk level of developing alcohol-related disorders and gender significantly differentiates the level of alcohol consumption, men drink more often.
2. The problem of alcohol abuse among students prompts us to take preventive actions, the need for which has recently been highlighted in our country. It is therefore extremely significant to organize cyclical

preventive lectures on the harmful effects of alcohol consumption at universities, highlighting the impact of alcohol on the bodies of women and men.

3. Students are often away from home, they tend to lead a different – irregular – lifestyle, often associated with irregular, poorly balanced nutrition, which can lead to being overweight or underweight. It should be emphasized that it was overweight study participants who consumed alcohol within the level involving risk more frequently. Therefore, in order to improve the quality of life of students with an incorrect BMI, it is necessary to intensify their motivation to participate in afternoon sports and recreation activities. It should be noted that physical activity plays a positive role in promoting health, even if unhealthy habits, such as excessive alcohol consumption, appear at the same time [25]. Currently, many universities in the Lublin province offer a wide range of extracurricular physical activities, such as wall climbing, indoor rowing for men and women, fitness, volleyball, football, table tennis, weight training, badminton, futsal, and many others. Such classes not only increase the level of physical activity amongst students in their free time, but they also contribute to meeting the recommendations of the recommended weekly dose of physical activity while reducing the negative effects of excessive alcohol consumption.
4. The aim of these initiatives is, among others, to reach out to students who abuse alcohol and help them. It is also expedient to conduct systematic research on the prevalence of alcohol abuse among students and on their beliefs and expectations related to the effects of alcohol.

### Disclosures and acknowledgements

The manager of the “EurEcas – European assessment of behavior toward health and addiction among students” project was the late Professor Józef Bergier. He will be remembered not only as a great promoter of research on health behavior but also as a tireless originator and advocate of new scientific challenges.

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## ANALYSIS OF RESISTANCE TO ANTIMYCOBACTERIAL DRUGS AMONG MTBC STRAINS ISOLATED FROM CATTLE IN POLAND AS A THREAT TO HUMAN HEALTH

### ANALIZA OPORNOŚCI NA LEKI PRZECIWPĄTKOWE WŚRÓD SZCZEPÓW MTBC IZOLOWANYCH OD BYDŁA W POLSCE JAKO ZAGROŻENIE DLA ZDROWIA LUDZI

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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.** Tuberculosis is a highly contagious disease affecting humans and animals. It is caused by mycobacteria that are part of the *Mycobacterium tuberculosis* complex (MTBC). The etiological agent causing bovine tuberculosis is mycobacteria *bovis*: *Mycobacterium bovis* and *Mycobacterium caprae*. According to the World Health Organization bovine tuberculosis is classified as direct zoonosis.

**Material and methods.** The study material consisted of 129 MTBC strains isolated from Polish cattle, which were microbiologically analyzed. The resistance phenotype was tested for first-line anti-tuberculosis drugs used in the treatment of tuberculosis in humans. The drugs included streptomycin, isoniazid, rifampicin, ethambutol, and pyrazinamide. The MTBC strains tested in this study were isolated from cattle tissue *post mortem* so that the determination of drug resistance could meet only the epidemiological criterion.

**Results.** Polish strains of mycobacteria *bovis* have not acquired environmental resistance despite the huge dynamics of changes in the phenotype of mycobacterial tuberculosis resistance. Strains classified as *M. bovis* are characterized by natural resistance to PZA, which is typical of this species.

**Conclusions.** Drug resistance imposes the use of additional drugs. Drugs that are less effective than the basic drugs, drugs causing side effects more frequently and drugs that are much more expensive.

**Keywords:** drug resistance, *Mycobacterium tuberculosis*, bovine tuberculosis, public health, antimicrobial

#### Streszczenie

**Wprowadzenie.** Gruźlica jest wysoce zakaźną chorobą ludzi i zwierząt, którą powodują prątki wchodzące w skład kompleksu *Mycobacterium tuberculosis* (MTBC). Czynnikiem etiologicznym gruźlicy bydłowej są prątki bydłowe: *Mycobacterium bovis* i *Mycobacterium caprae*. Zgodnie z klasyfikacją Światowej Organizacji Zdrowia, gruźlica typu bydłowego zaliczana jest do zoonoz bezpośrednich.

**Materiał i metody.** W pracy poddano analizie mikrobiologicznej 129 szczepów MTBC wyizolowanych od bydła w Polsce. Fenotyp oporności zbadano pod kątem leków przeciwprątkowych pierwszej linii stosowanych w leczeniu gruźlicy u ludzi: streptomycyny, izoniazydu, rifampicy, etambutolu i pyrazynamidu. Szczepy MTBC badane w niniejszej pracy wyizolowano z tkanek bydła pobranych *post mortem*, tak że oznaczenie lekooporności w tym zadaniu spełniło jedynie kryterium epidemiologiczne.

**Wyniki.** Polskie szczepy prątka bydłowego nie nabyły oporności środowiskowej. Szczepy sklasyfikowane jako *M. bovis* cechują się charakterystyczną dla tego gatunku naturalną opornością na PZA.

**Wnioski.** Wystąpienie lekooporności zmusza do stosowania leków dodatkowych, mniej skutecznych niż leki podstawowe i powodujących częściej objawy uboczne, a jednocześnie znacznie droższych.

**Słowa kluczowe:** lekooporność, *Mycobacterium tuberculosis* complex, gruźlica bydłowa, zdrowie publiczne, leki przeciwprątkowe

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## Introduction

Tuberculosis is a highly contagious disease for humans and animals. It is caused by mycobacteria that are part of the *Mycobacterium tuberculosis* complex (MTBC) [1]. The etiological factor of bovine tuberculosis is mycobacteria bovis: *Mycobacterium bovis* and *Mycobacterium caprae* [2, 3]. According to the World Health Organization classification, bovine tuberculosis is classified as direct zoonosis in which we can observe a direct transmission of the infectious agent from an infected vertebrate (animal) to a susceptible vertebrate, namely a human, without the participation of indirect hosts. Due to the direction of transmission of the infectious agent, bovine tuberculosis can be included in all types of zoonotic diseases. Anthroponosis occurs when a disease is transmitted from an animal to a human, but there are also known cases of zooanthroponosis when a human is the source of the disease for an animal.

Bovine tuberculosis is a disease that is eradicated by authorities. Currently, the obligation to combat this zoonotic disease is imposed primarily by the "Veterinary Inspection Act" (Ustawa o Inspekcji Weterynaryjnej), which regulates the obligations of veterinarians operating within the structures of the Inspection. The legal act referring directly to the control of infectious diseases is the "Protection of Animal Health and the Control of Infectious Animal Diseases Act" (Ustawa o ochronie zdrowia zwierząt oraz zwalczaniu chorób zakaźnych zwierząt). The most important act of Polish legislation is the Ordinance of the Minister for Agriculture and Rural Development of November 23, 2004. This act specifies methods for combating bovine tuberculosis in Poland as well as the different ways of dealing with the suspicion, detection, and termination of an outbreak of bovine tuberculosis. Poland has the status of a country that is free from this zoonotic disease despite the fact that there have been from 12 to 18 outbreaks of bovine tuberculosis each year for the last 5 years [4]. Animals that are diagnosed with tuberculosis are not treated in most cases but removed from the herd and subjected to sanitary slaughter. The only described case of tuberculosis treatment among animals in Poland concerned a 10-year-old male giraffe living in the Silesian Zoological Garden in Chorzów (Śląski Ogród Zoologiczny w Chorzowie) [5].

The first research results on pyrazinamide resistance (PZA) among MTBC strains isolated from the tissue of various animal species were published in Poland in 2013 [6]. So far, there has been no data on drug resistance to other antimycobacterial drugs among mycobacteria bovis (*M. bovis* and *M. caprae*), which are the cause of tuberculosis in animals in Poland. This study describes the phenomenon of drug resistance to streptomycin (MS), isoniazid (INH), rifampicin (RMP), and ethambutol (EMB) for the first time – S.I.R.E.

The aim of the study is the analysis of the resistance phenotype of 129 strains of MTBC to first-line anti-tuberculosis drugs used in the treatment of tuberculosis in humans: SM, INH, RMP, EMB, and PZA.

## Material and methods

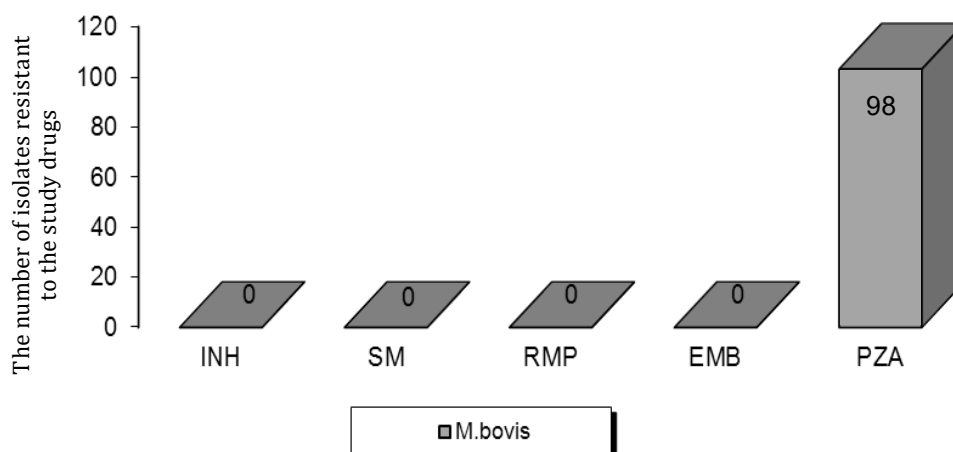
The study material consisted of 129 MTBC strains isolated from the tissue of cattle. The tissue was cultured in the Stonebrink medium. The membership to MTBC was confirmed by means of an immunochromatographic test, which is used to detect the MPT64 protein fraction secreted by MTBC mycobacterial cells – Identification Test MGIT TBC®. Species identification was performed using the GenoType MTBC® test. This allowed us to classify 98 strains as *Mycobacterium bovis* and 31 strains as *Mycobacterium caprae*.

Drug resistance to S.I.R.E. was determined utilizing Bactec MIGIT 960 and Middlebrook 7H9 liquid medium with a concentration limit SM 1.0 µg/ml, INH 0.1 µg/ml, RMP 1.0 µg/ml and EMB 5.0 µg/ml. The apparatus determines sensitivity by comparing fluorescence analysis in test tubes containing drugs to fluorescence in control test tubes.

Drug resistance to PZA was determined in the Bactec 460-Tb isotopic system [7] and Middlebrook 7H12 liquid medium containing palmitic acid [14C] with pH in the range 5.9-6.0 and PZA concentration limit 100 µg/ml. Growing mycobacteria metabolized the substrate contained in the medium to  $^{14}\text{CO}_2$ . The amount of the produced  $^{14}\text{CO}_2$  was directly proportional to the intensity of the mycobacterial growth in the medium. The addition of PZA to the medium inhibited the growth of *M. caprae*. This phenomenon was reflected in the decrease in the amount of  $^{14}\text{CO}_2$  compared to the control strain, in which the amount of  $^{14}\text{CO}_2$  and the growth index increased systematically. In the case of resistant strains, little or no difference was observed in the growth index between the control and the tested strain [8].

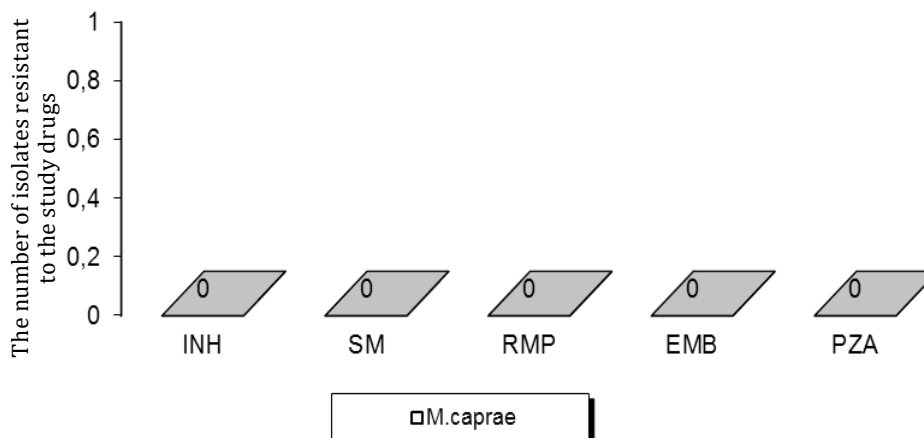
## Results

In the group of 98 mycobacteria bovis strains, which were identified as *M. bovis*, all the strains were susceptible to 4 primary antimycobacterial drugs: INH, RMP, SM, and EMB as well as resistant to PZA (Figure 1).



**Figure 1.** The results of the drug resistance analysis for *M. bovis* strains to S.I.R.E. and PZA

In the group of 31 mycobacteria bovis strains identified as *M. caprae*, all the strains exhibited sensitivity to PZA and 4 primary antimycobacterial drugs: INH, RMP, SM, and EMB (Figure 2).



**Figure 2.** The results of the drug resistance analysis for *M. caprae* strains to S.I.R.E. and PZA

## Discussion

The incidence of bovine tuberculosis among Europeans tends to increase compared to previous years. Therefore, determining the resistance phenotype in MTBC strains isolated from animals to first-line anti-tuberculosis drugs used in the treatment of tuberculosis in humans seems to be justified in the aspect of public health. The data from 2014 concerning bovine tuberculosis in humans and included in the 2015 EFSA Report came from 27 EU Member States (except for France) as well as Iceland, Norway, and Switzerland. 134 cases of disease caused by *M. bovis* were confirmed. The highest incidence was reported in Germany – 45 cases, Great Britain – 29 cases and Spain – 25 cases. Other cases were found in Belgium – 12, the Netherlands – 9, Ireland – 6, Italy – 6, Switzerland – 2, and isolated cases in Austria and Finland [9]. The World Health Organization (WHO) estimates that in countries where Tuberculosis Programs are inadequately monitored, 1% of human cases is caused by mycobacteria bovis. To date, two cases of tuberculosis in humans caused by mycobacteria bovis have been described in Poland. The patients came from the southern region of Poland [10]. According to the EFSA report, the main source of *M. bovis* infections in humans is incorrectly pasteurized milk from infected cows.

The largest reservoir of mycobacteria bovis in Poland is sick cattle. The reservoir can also include wild animals living in close proximity to farms [11]. The badger population in Great Britain is the largest reservoir of mycobacteria bovis [12]. In Spain, however, the largest reservoir of mycobacteria bovis is the wild boar [13]. The transmission of mycobacteria bovis can occur on joint pastures. It can also be the result of a bite but this happens less frequently. There was a reported case from around Cornwall (France) where a dog owner was bitten by a badger and fell ill. The owner was diagnosed with tuberculosis caused by *M. bovis*. Four months later,

her dog displayed respiratory symptoms, and a mycobacterial strain with the same molecular pattern as the in the case of the owner was isolated from the dog's tracheal washings [14].

*Mycobacteria bovis* can also cause tuberculosis in other livestock species. *Mycobacteria bovis* shows high virulence in natural conditions in goats [15] pigs [16, 17], sheep [18] and cats [19], lower in horses [20] and dogs [21]. Cattle are not very sensitive to mycobacteria, but there are known cases of *M. tuberculosis* infection in cattle [22].

Multidirectional tuberculosis transmission indicates the need for close cooperation between veterinary services and human medicine (sanitary and epidemiological supervision services). In the event of tuberculosis in cattle, District Veterinary Officers should take into account the transmission of the disease to humans and notify the District Sanitary and Epidemiological Station as indicated by the regulation which is in force in Poland.

The most important component of modern tuberculosis control programs is the early detection of the disease [23, 24] and properly selected TB treatment [25]. The last breakthrough in TB treatment was the discovery of RMP in 1965 – half a century ago. The biggest problem in implementing tuberculosis control programs around the world is the phenomenon of mycobacterial tuberculosis resistance and the lack of new drugs [26]. Drug-resistant tuberculosis, especially its varieties MDR-TB (multidrug-resistant) and XDR-TB (extensively drug-resistant), is a highly fatal disease. In the case of people infected with HIV, the mortality of drug-resistant TB is 90%.

Drug resistance imposes the use of additional drugs. Drugs that are less effective than the basic drugs, drugs causing side effects more frequently and drugs that are much more expensive. The treatment of drug-resistant TB is 100 times more costly than treatment involving the basic drugs [27].

## Conclusions

The MTBC strains were isolated from cattle tissue *post mortem*, and the determination of drug resistance met only the epidemiological criterion. The obtained results showed that the Polish strains of mycobacteria *bovis* isolated from the animals have not acquired environmental resistance. The strains classified as *M. bovis* are characterized by natural resistance to PZA, which is typical of this species.

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## THE EFFECT OF CONCOMITANT GASTROESOPHAGEAL REFLUX DISEASE ON CLINICAL COURSE AND LUNG FUNCTION IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

### WPLYW WSPÓLISTNIEJĄCEJ CHOROBY REFLUKSOWEJ PRZEŁYKU NA PRZEBIEG KLINICZNY I CZYNNOSĆ PŁUC U PACJENTÓW Z PRZEWLEKŁĄ OBTURACYJNĄ CHOROBA PŁUC

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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.** Chronic obstructive pulmonary disease (COPD) is one of the leading causes of morbidity and mortality in modern society and can lead to the development of comorbidities. Among the last, gastroesophageal reflux disease (GERD) is frequently present, but often gets a close attention from doctors in the treatment of pulmonary patients. The aim of the current study was to determine the characteristics of clinical and lung disorders in the pathogenesis of COPD with concomitant GERD.

**Material and methods.** We examined 113 COPD patients with isolated COPD or with COPD and concomitant GERD. All the patients underwent spirometry, endoscopy, radiological and pH-metric procedures.

**Results.** Many patients (95%) with concomitant pathology complained of heartburn, dysphagia, especially after meals, burning tongue, hoarseness and a lump in the throat. Among COPD patients without concomitant GERD, both clinical pulmonary manifestations met with almost the same frequency but were less pronounced ( $p > 0.05$ ). During the lung examination, we determined the level of FEV<sub>1</sub>, VC, FVC, FEF<sub>25-75</sub> and FEV<sub>1</sub>/FVC, which differed significantly in COPD patients ( $p < 0.05$ ) compared to predicted normal values in human of the same sex, age, height and body weight. In the COPD with concomitant GERD cohort, a sharp decrease in spirometry indices was found compared to patients with isolated COPD ( $p < 0.001$ ).

**Conclusions.** COPD patients with concomitant GERD had significantly greater extraesophageal manifestations and lung disorders compared with COPD patients without comorbidity.

**Keywords:** gastroesophageal reflux disease, chronic obstructive pulmonary disease, comorbidity

#### Streszczenie

**Wprowadzenie.** Przewlekła obturacyjna choroba płuc (POChP) jest jedną z głównych przyczyn umieralności i zachorowań we współczesnym społeczeństwie, co w konsekwencji prowadzi do rozwoju chorób współistniejących. Choroba refluksowa przełyku (GERD) występuje często, ale zazwyczaj jest dokładnie badana u pacjentów z chorobami płuc. Celem badania jest określenie zaburzeń klinicznych i chorób płuc w patogenezie POChP z towarzyszącym GERD.

**Materiał i metody.** Przebadanych zostało 113 pacjentów z POChP z izolowaną POChP oraz z POChP ze współistniejącym GERD. Wszystkich poddano zabiegom, takim jak: spirometria, endoskopia, a także działaniom radiologicznym i pH-metrycznym.

**Wyniki.** Większość pacjentów (95%) ze współistniejącą patologią skarżyło się na zgagę, dysfagię, zwłaszcza po spożyciu posiłków, pieczenie języka, chrypkę oraz występowanie guzka w gardle. W tym czasie wśród pacjentów z POChP bez współistniejącej GERD oba objawy kliniczne w płucach spotkały się z prawie taką samą częstością, ale były mniej wyraźne ( $p > 0,05$ ). Podczas badania płuc ustalono poziomy FEV<sub>1</sub>, VC, FVC, FEF<sub>25-75</sub>, FEV<sub>1</sub> / FVC, które znacznie różniły się u pacjentów z POChP ( $p < 0,05$ ) w porównaniu do normalnych wartości u osób tej samej płci, wieku, wzrostu i masy ciała. W grupie pacjentów z POChP z towarzyszącym GERD stwierdzono gwałtowny spadek wskaźników spirometrycznych w porównaniu z pacjentami z izolowaną POChP ( $p < 0,001$ ).

**Wnioski.** Pacjenci z POChP ze współistniejącym GERD mieli znacznie większe objawy pozaprzętkowe i choroby płuc w porównaniu z pacjentami z POChP, ale bez chorób współistniejących.

**Słowa kluczowe:** choroba refluksowa przełyku, przewlekła obturacyjna choroba płuc, choroby współistniejące

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## Introduction

Chronic obstructive pulmonary disease (COPD) remains a major health problem as the global rates of COPD morbidity have rapidly increased. Mortality from COPD is more than 2 times higher than the death rate from lung cancer [1, 2]. Currently, COPD is not only a medical but also a social problem and can lead to the formation of significant complications and comorbidities [3, 4]. Gastroesophageal reflux disease (GERD), for example, has emerged as a COPD comorbidity and typically in clinical practice, it is one of the causes of worsening respiratory symptoms [5, 6]. Currently, prompt comprehensive diagnostics, prevention and treatment of COPD are among the most important challenges in the clinic [7, 8]. At the same time, the number of COPD patients with comorbid disorders, including GERD, is increasing [9, 10]. Many questions related to both the appearance of concomitant GERD in patients with COPD and its timely diagnosis do not have a clear answer. These issues often remain outside the field of view of medical doctors and require further research. Therefore, the aim of the study is to determine the effect of concomitant GERD in COPD patients on clinical manifestations and lung function.

## Material and methods

This study was conducted at the pulmonological departments of Kharkiv Medical Academy of Postgraduate Education and City Clinical Hospital no. 13 in Kharkiv, Ukraine, from 2015-2018. The study was conducted in accordance with the basic provisions of the Council of Europe Convention on Human Rights and Biomedicine (dated 4<sup>th</sup> April 1997) and Helsinki Declaration of the World Medical Association on ethical principles of conducting scientific medical research with the participation of a person (1994-2008).

COPD diagnoses were made according to the recommendations of the GOLD (2018) [11] and the order of the Ministry of Health of Ukraine no. 499 from 28<sup>th</sup> October 2003. The GERD diagnosis was established according to ICD-10 based on a detailed survey, evaluation of complaints, history of the disease and the patient's life. Diagnosis of both diseases was performed if the patient had cough and dyspnea and bothersome heartburn one or more times a week for the past 6 months (as recommended by the Mayo Clinic and the Montreal Consensus, 2006) [12, 13], and based on data from spirometry, endoscopy, radiological and pH-metric methods. Patients were excluded from the examination if they had a malignancy, Barrett's esophagus, active stomach ulcers or duodenal ulcers, autoimmune diseases, coronary heart disease, diabetes, asthma, pregnancy, or if the patient refused to participate in the study.

The study was approved by the Institutional Ethics Committee of Kharkiv Medical Academy of Postgraduate Education and City Clinical Hospital no. 13, Kharkiv. Written informed consent was obtained from all patients.

We observed 113 COPD patients of similar sex, age and duration of disease. Depending on the presence or absence of concomitant GERD, two groups were formed. The first group included 69 COPD patients with GERD, and the average age was  $57.81 \pm 7.82$  years. The second group included 44 patients with COPD but without GERD, and the average age was  $54.82 \pm 9.43$  years old. The frequency of clinical manifestations, complaints and physical conditions were recorded. Pulmonary function test variables (forced vital capacity (FVC [L]), vital capacity (VC [L]), forced expired volume in one second ( $FEV_1$  [L]), forced expiratory flow at 25%-75% vital capacity ( $FEF_{25-75}$  [L/sec]), and ratio of  $FEV_1$  to FVC ( $FEV_1/FVC$  [%])) were conducted using the Spirosvit-3000 (Japan). For the tests, the patient inhaled deeply, holding their breath for a few seconds, and then exhaled as forcefully as possible into the breathing mask. The patient then received one dose of the bronchodilator salbutamol and after waiting 15 minutes, another set of measurements was performed. To estimate gastric secretion, the intragastric pH-metry method was used with application of calomelantimony electrodes (antral and framed) on the AI-2 (the Acidity Indicator machine, Ukraine) with the standard method. As the standard, we took mean values of 20 healthy people of the same age and sex who were the control group with an average age of  $55.40 \pm 4.18$  years. Statistical data analysis was performed using the statistical package SPSS 16. We processed the research results by the variation statistics method with application of correlation analysis standard programs with the M, m average values calculation. Results were expressed as mean  $\pm$  standard deviation (SD). A Student's t-test was performed to assess the reliability indices. Analysis of variance (ANOVA) was used to analyze the differences among group means in a sample. Pearson's correlation coefficients (r) was used to identify the associations between figures with 95% confidence interval (CI), and statistical significance was defined as a  $p < 0.05$ .

## Results and discussion

The clinical picture of the 69 patients with comorbidity was characterized by dyspnea (98%) and cough (94%), which was similar to patients with isolated COPD. At the same time, patients with comorbidity often

expressed extraesophageal manifestations of GERD and many complained of heartburn (97%), dysphagia, especially after meals (95%), as well as burning tongue (56%), hoarseness (58%), and a lump in the throat (61%). At that time, clinical pulmonary manifestations were met with almost the same frequency among COPD patients without concomitant GERD compared to patients with GERD but were less pronounced ( $p>0.05$ ); 93% of patients experienced cough and 97% of patients experienced dyspnea. Moreover, these patients did not complain of heartburn and dysphagia, the main symptoms of GERD, with the exception of three patients who experienced recurrent heartburn, dysphagia and hoarseness, especially after a long dry cough (Table 1).

**Table 1.** Comparative evaluation of clinical symptoms between groups

Patients' complaints	Patients with concomitant GERD (%)	COPD patients without comorbidity (%)
Dyspnea	98	97
Cough	94	93
Heartburn	97	7
Dysphagia	95	7
Burning tongue	56	0
Hoarseness	58	7
Lump in the throat	61	0

Thus, the COPD patients with concomitant GERD experienced a much higher level of extraesophageal manifestations compared with either the control group or with the group of COPD patients without GERD.

Analysis of spirometry data revealed that patients with comorbidity had a more pronounced decline in the main COPD indicators  $FEV_1$ , VC, FVC,  $FEF_{25-75}$ , and  $FEV_1/FVC$  compared to the predicted normal values in humans of the same sex, age, height and body weight ( $FEV_1>80\%$ ,  $FEV_1/FVC>70\%$ ). In patients with comorbidity,  $FEV_1$ , VC, FVC and  $FEV_1/FVC$  indices were significantly different ( $p<0.001$ ) than patients with isolated COPD. The data are presented in Table 2.

**Table 2.** Distribution of patients' spirometry indicators

Patients' spirometry indicators	COPD patients with concomitant GERD	COPD patients without comorbidity	Control group	$t_{1-2}$	$t_{1-c}$	$t_{2-c}$
$FEV_1$ [L]	57.28±9.95	63.40±11.59	96.68±6.30	2.89 ***	22.66 ***	15.45 ***
VC [L]	70.07±9.80	76.72±8.46	98.84±9.59	3.83 ***	12.77 ***	9.60 ***
FVC [L]	68.72±6.29	75.93±9.55	96.80±7.02	4.43 ***	17.59 ***	10.37 ***
$FEF_{25-75}$ [L/sec]	34.74±11.94	39.45±13.86	74.96±10.85	1.86 <sup>0</sup>	15.45 ***	11.78 ***
$FEV_1/FVC$ [%]	58.61±5.58	66.07±12.84	99.08±11.71	3.64 ***	16.61 ***	10.86 ***

Note: <sup>0</sup> $p\leq 0.1$ ; \* $p\leq 0.05$ ; \*\* $p\leq 0.01$ ; \*\*\* $p\leq 0.001$

Thus, we established a clear correlation between the frequency of clinical manifestations and the characteristics of lung function in COPD patients with concomitant GERD ( $r_s = -0.57$  to  $-0.66$ ,  $p<0.01$ ).

We found that the COPD patients with concomitant GERD had significantly greater extraesophageal manifestations compared with COPD patients without comorbidity. Such results were also obtained by other clinical researches that confirmed the presence of such comorbidity in COPD [14, 15, 16]. The obtained results have led us to consider that atypical clinical manifestations (heartburn, regurgitation, burning tongue, hoarseness) in COPD patients may be a factor that leads to the appearance of concomitant GERD. Previously, it was shown that COPD patients have pronounced lung disorders [17, 18]; in our research, we demonstrate that these were significantly more pronounced in COPD patients with concomitant GERD. Moreover, we found a clear correlation between the frequency of clinical manifestations and the characteristics of lung function in COPD patients with concomitant GERD. The obtained results have led us to consider that extraesophageal manifestations may be a factor that leads to a decline in respiratory function, feeding into COPD pathogenesis.

## Conclusions

We found reliable differences in the spirometry indices of COPD patients with concomitant GERD compared with patients with isolated COPD. The obtained data permits development of additional pathogenic therapy with the aim of correcting gastrointestinal disorders of COPD patients with concomitant GERD.

## Disclosures and acknowledgements

We thank all members of the research team. The author declares no conflict of interest regarding this article. The author declares that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975 as revised in 2008(5), as well as national laws. The study was approved by the ethics committee. Informed consent was obtained from all subjects included in the study. This work was not supported by any funding.

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

PHYSICAL ACTIVITY IN PRIMARY AND SECONDARY PHYSIOPROPHYLAXIS

AKTYWNOŚĆ FIZYCZNA W FIZJOPROFILAKTYCE PIERWOTNEJ I WTÓRNEJ

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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

Physioprophyllaxis is a physiotherapeutic procedure consisting in counteracting, slowing down, inhibiting or removing adverse effects associated with an incorrect lifestyle, involuntary changes and disease processes. Physical activity (PA), health education, reduction of risk factors, and functional diagnostics are used to implement these goals. Physioprophyllaxis makes it possible to avoid or stop the development of functional problems or disorders. It enables the prevention of civilization diseases, aging processes and disability by performing professional and daily activities ergonomically. Physioprophyllaxis introduces PA and behaviors that strengthen the factors influencing health protection by preventing health threats. The lack of theoretical studies devoted to physioprophyllaxis highlights the need to examine this topic. The purpose of this article is to describe an exemplary description (the author's) of primary and secondary physioprophyllaxis using PA as an integral component of physical therapy, including its tasks. Primary physioprophyllaxis strives to prevent the occurrence of diseases, and is directed towards healthy people. Secondary physioprophyllaxis involves patients and is a selective process that prevents the recurrence of the disease being treated and also reduces other risks to health. Physioprophyllaxis focusing on health threats in healthy people has been scientifically demonstrated to maintain and strengthen the current physiological and functional state. It is also a way to minimize the scope of adverse disorders associated with diseases for people with medical conditions achieved using PA.

**Keywords:** health, disease, primary prevention, secondary prevention, physical activity (PA), physiotherapy

Streszczenie

Fizjoprofilaktyka jest to postępowanie fizjoterapeutyczne polegające na przeciwdziałaniu, spowolnieniu, zahamowaniu lub wycofaniu się niekorzystnych skutków nieprawidłowego stylu życia, zmian inwolucyjnych oraz procesów chorobowych. W realizacji tych założeń stosowana jest aktywność fizyczna (AF), edukacja zdrowotna, redukcja czynników ryzyka oraz diagnostyka funkcjonalna. Fizjoprofilaktyka umożliwia uniknięcie lub zahamowanie rozwoju problemów funkcjonalnych lub schorzeń, zapobieganie chorobom cywilizacyjnym, procesom starzenia się i niepełnosprawności przez ergonomiczne wykonywanie czynności życiowych i zawodowych, AF i zachowania wzmacniające czynniki ochrony zdrowia ukierunkowane na zapobieganie zagrożeniom zdrowia. Brak teoretycznych opracowań fizjoprofilaktyki w literaturze przedmiotu zobowiązuje do podejmowania tego tematu. Celem pracy jest zaprezentowanie przykładowego (autorskiego) opisu fizjoprofilaktyki pierwotnej i wtórnej poprzez AF, jako integralnej składowej fizjoterapii z uwzględnieniem jej zadań. Profilaktyka pierwotna to uniwersalne działanie zapobiegające powstaniu choroby, a jej adresatami są ludzie zdrowi. Fizjoprofilaktyka wtórna obejmująca pacjentów jest procesem selektywnym, dzięki któremu zapobiega się nawrotowi leczonej choroby i pojawieniu się innych antyzdrowotnych konsekwencji, na przykład niepełnosprawności. Fizjoprofilaktyka zagrożeń zdrowia osób zdrowych poprzez AF jest potwierdzonym naukowo sposobem na utrzymanie i umacnianie dotychczasowego stanu morfologiczno-funkcjonalnego, a w stanie choroby na minimalizowanie zakresu niekorzystnych zaburzeń towarzyszących procesom chorobowym.

**Słowa kluczowe:** zdrowie, choroba, profilaktyka pierwotna, profilaktyka wtórna, aktywność fizyczna (AF), fizjoterapia

Tables: 1

Figures: 1

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## Introduction

Physioprophylaxis has been part of the educational, legal and professional world for several years. It is an integral component of physiotherapy, encourages theoretical studies on its tasks, types and means. According to the Polish Chamber of Physiotherapists [1], physioprophylaxis is a physiotherapeutic procedure consisting in counteracting, slowing down, inhibiting or removing the adverse effects of an incorrect lifestyle, involutory changes and disease processes. The assumptions of physioprophylaxis are implemented, among others, by popularizing physical activity (PA), health education, reducing risk factors and functional diagnostics. Physioprophylaxis allows, to a large extent, to avoid or inhibit the development of functional problems or diseases. It also helps to prevent civilization diseases, the aging process and disability by doing professional and daily tasks ergonomically as well as behaviors that strengthen health protective factors aimed at preventing health threats [1-5]. It is a new and effective alternative in the health care system. Its purpose is to meet the constantly growing medical needs. For the time being, physioprophylaxis, as a health need and a medical service, is officially included only in the area of law, specialist education and the professional work of a physiotherapist [1, 6, 7, 8].

## The aim of the study

The lack of theoretical studies on the subject of physioprophylaxis increases the need to deal with this subject, define and describe the concept of physioprophylaxis as a health competence (a factor protecting health). It also creates the need to present physioprophylaxis in the aspect of health threat prevention. The purpose of the following work is to present an exemplary (the author's) description of primary and secondary physioprophylaxis, which involves physical activity. Primary physioprophylaxis "introduces" healthy people to the field of physiotherapy, while secondary physioprophylaxis is a valuable complement to the process of medical rehabilitation. At the moment, one cannot find a definition of physioprophylaxis in encyclopedic or specialist studies, which is why demonstrative studies that generate scientific achievements become the source of discussion and serve as a didactic tool.

## Physioprophylaxis through PA in childhood and youth

Systematic PA has a positive impact on the condition and functioning of the human body at any age. A special role in this process is played by the musculoskeletal, cardiovascular, respiratory and neurohormonal systems as well as the internal organs [9].

PA in childhood and youth is a health behavior that has a beneficial influence on health, its strengthening and maintenance, i.e. building potential health for life. Research confirms the impact of PA on the development of children and adolescents by accelerating the conversion of cartilage into bone, stimulating the growth processes, preventing defects in the musculoskeletal system [10] and many other diseases of the developmental age. PA supports the nutrition process of the joints and improves their elasticity, flexibility and endurance [9]. Systematic PA in childhood and youth strengthens the bone structure. In turn, good mineralization prevents osteoporosis [11]. It also has a positive effect on the development of muscle mass by stimulating physiological changes in the tissue, i.e. improving blood supply, elasticity and, as a consequence, the regular range of motion in the joints. PA is a source of stimuli for the nervous system and it shapes and corrects the functions of the nervous system. These functions are important in the acquisition of motor activities. PA is also the basis for creating and consolidating motor patterns. Regular training improves neuromuscular coordination, that is, intentional muscle involvement to perform a specific movement. Also, it makes it possible to make specific movements more efficiently at lower energy costs [10]. Systematic PA among children has a positive impact on the structure of the chest and the respiratory muscle function. It increases basic respiratory parameters, which means a better oxygen supply for body tissue and an improved physical fitness [9, 10]. Regular PA can slow down the natural rate of changes in the respiratory system, affecting the respiratory rhythm and improving the ventilation-perfusion ratio. Thus, it prevents respiratory muscle sarcopenia and improves chest mobility [12, 13].

PA plays a preventive and therapeutic role in the treatment of developmental disorders, i.e., ASD (pediatric autism, Asperger disease), the incidence of which is 17.6/10,000 children aged 0-18, and diabetes [14, 15]. The results of Szot's research showed that systematic PA in the case of children with autism affects the development of communicative intentionality in contacts with loved ones. It can also reduce the incidence of stereotypical and aggressive behaviors. According to the researcher, these changes stem from the decrease in mental tension as well as a large number of diverse stimuli that provide little opportunity to present stereotypical behaviors. Moreover, targeted home therapy positively affects the functioning of the recipients in the social

sphere, their self-service and gross motor skills [16]. Regardless of the type of diabetes, the physiological, social and emotional benefits of regular exercise and a physically active lifestyle are well documented. In the case of type 1 diabetes, effective treatment is based on individualized insulin therapy and the right diet. Regular exercise helps improve overall health and fitness and reduce risk factors for vascular complications. In the case of adolescents suffering from diabetes, systematic PA contributes to the improvement of blood lipid profile and increased insulin sensitivity, mainly in the skeletal muscles, which leads to a situation when the diabetic person needs the hormone less frequently [15].

PA is one of the recommended preventive factors in the European anti-obesity plan for 2014-2020 [17]. Childhood obesity prevention that combines balanced nutrition and PA leads to a much greater reduction in systolic and diastolic pressure than in the case of actions based only on proper nutrition or only PA. The conducted analyses revealed additional benefits of conducting obesity prevention programs based on a proper diet and PA [18].

The results of HBSC study involving 42 countries showed that PA among Polish children ranked them 12<sup>th</sup> in accordance with WHO requirements (60 minutes of moderate PA daily). These requirements are met by 27% of 11-year-old girls and 34% of 11-year-old boys, 19% of 13-year-old girls and 29% of 13-year-old boys. The numbers are even lower in the case of 15-year-olds: 16% and 18% [19].

### **Physioprophyllaxis through PA in adulthood**

Systematic PA among adults is a manifestation of acquired knowledge, skills, beliefs, attitudes and identified health needs as part of caring for their health. According to experts, a sedentary lifestyle contributes to an increase in the incidence of civilization diseases and premature aging. According to Eurobarometer, 59% of Europeans never do PA, and according to the Public Opinion Research Center (Centrum Badania Opinii Społecznej, CBOS), 58% of Poles never or almost never exercise, and 37% of them do not run, swim or cycle at all [17, 20]. The impact of PA on the health of adults is stressed in studies that point to the essence of the positive impact of PA on the prevention, treatment and rehabilitation in the case of cardiovascular diseases, atherosclerosis, hypertension, obesity, diabetes, osteoporosis, cancer, mental and neurogenic diseases as well as the quality of aging [21-24].

The important benefits that can be gained from regular PA include the ability to reduce the risk of cardiovascular conditions, lower resting blood pressure, improved lipid profile, obesity therapy as well as a beneficial effect on endothelial function, inflammatory processes, coagulation, and sex hormone levels [9, 10, 25]. The focus of US research has been the evaluation of the potential underlying the mechanisms thanks to which higher levels of PA are associated with a lower risk of cardiovascular events in the case of women aged 45+. Mora et al. identified potential underlying mechanisms through which even moderate PA levels (at least 600 kcal/week or the equivalent – over 2 hours of walking per week) contribute to a lower risk of clinically important cardiovascular events. Small changes in the known risk factors, especially those associated with inflammation, homeostasis and blood pressure, constitute a significant part of the benefits of PA in relation to the risk of developing a cardiovascular condition and therefore may have significant consequences for further prevention of these diseases [26].

The study of middle-aged men (41+) carried out over a period of 17 years clearly indicated a significant inverse relationship between the level of PA and cardiovascular risk. Energy expenditure above 1975 MET/min/week seemed to be a strong element that prevented the development of cardiovascular risk factors [21]. Scientists claimed that doing regular exercise as part of therapy is one of the measures that limit the overweight epidemic in the population of people after the age of 20 [27]. The goals of this therapy are to prevent civilization diseases, increase utilitarian physical fitness, and improve the well-being of adults. The effects of the therapy along with a health program last for a longer time and may result in the improvement of the condition of the whole society [28].

### **Physioprophyllaxis through PA among the elderly**

The significance of PA in the life of the elderly consisting in weakening and delaying involutory processes has contributed to the isolation of a special area of research, i.e. gerokinesiology and geronto-prophyllaxis. According to researchers, physical activity can now be considered the common denominator of all preventive and rehabilitation activities, regardless of the well-being and fitness of the elderly. PA during this period of life can be seen as a drug used in the prevention and treatment of diseases significantly related to age (coronary artery disease, hypertension, obesity, hypercholesterolemia, diabetes, osteoporosis, depression, neurogenic changes). As an anti-involutory factor, it helps to maintain the body's efficiency and endurance. It alleviates



the dysfunctional effect of age, such as cognitive impairment, dementia, susceptibility to infection and disability. It also improves lung function [12, 29, 30, 31, 32, 33]. Prączko and Kostka's study showed that the number of episodes and days when the elderly experience the symptoms of upper respiratory tract infection may decrease as the levels of PA increase [13]. Regular physical exercise (also resistance training) is recommended for seniors even over the age of 80-85. The benefits of strength training include health-promoting changes in the musculoskeletal system, which include slower development of sarcopenia, the prevention of osteoporosis, fractures and falls, and increased (functional) mobility to facilitate daily activities [34]. Research by Marchewka and colleagues demonstrated that the level of PA in the developmental period of life (before the age of 35) has a positive effect on the quality of life in the old age [35].

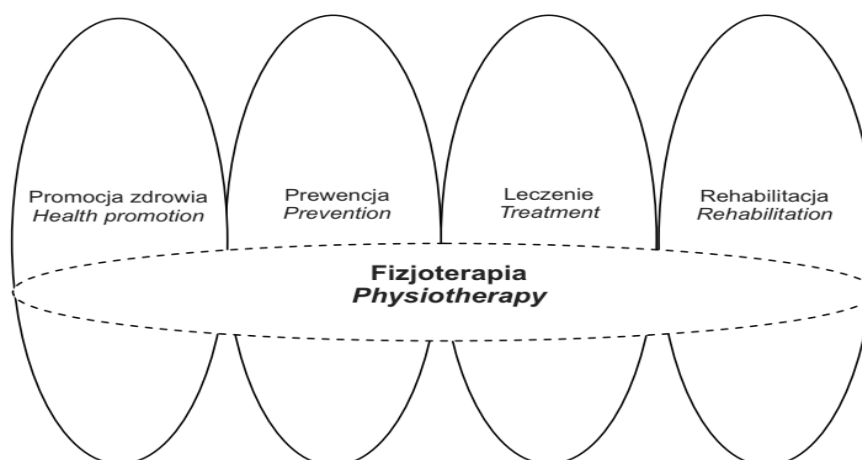
Systematic PA contributes to the disappearance of depression and anxiety symptoms, as well as improves mental performance and mental well-being by increasing the concentration of endorphins in the blood due to its preventive and therapeutic effect on mental health [30, 36]. PA also helps to maintain normal cognitive functions, reduces the risk of developing neurodegenerative diseases and alleviates the symptoms of diagnosed disorders, e.g. dementia and Alzheimer's. Improvements in mental and cognitive functions are directly associated with the discoveries related to exercise-induced neurogenesis [25, 37]. The results of the Central Statistical Office from 2016 implied that fewer people over the age of 60 do sport regularly and take part in recreational activities: (10.6%) women, (10.9%) men. 40.5% of all older people exercise for pleasure, and 31.7% do it due to medical recommendations [38].

### Physioprophylaxis in the structure of physiotherapy

The ways of influencing health in individual and social terms include promoting health, restoring health and preventing diseases, i.e. the prevention of health risk factors, developmental disorders, lifestyle diseases, the aging process and disability. According to Demel, disease prevention is more difficult than treatment because it requires up-to-date knowledge about health, appropriate (professional) association of cause and effect relationships, imagination, experience, forward thinking, and a willingness to act when it is not necessary [39].

According to Mika and Kasprzak, physioprophylaxis is "a branch of physical medicine in which natural and artificially created physical factors are used to meet the needs of the system or to increase its resistance." The authors stated that this field was currently developing dynamically because of the growing technicization of life and the associated threat of civilization diseases (epidemics). They also pointed out that the reason for the occurrence of these diseases was the disturbance of the natural state of balance between the human body and its surroundings. These conditions led to exhaustion of the reserves of self-regulation of the system, caused disorders in the adaptation of the system to the environment in the form of neuroses, coronary artery disease, hypertension, gastric and duodenal ulcers, allergic diseases and other conditions [40].

The definition of physiotherapy according to WCPT (World Confederation of Physiotherapy) and the European Declaration of Standards in Physiotherapy (Europejska Deklaracja Standardów w Fizjoterapii) states that "... physiotherapy deals with detecting and restoring the potential of motor activities in the areas of health promotion, prevention, treatment and rehabilitation to the fullest possible extent." (Figure 1) [41].



**Figure 1.** The place of physiotherapy in medicine as defined by WCPT [41]

Mikołajewska noticed that “the figure above shows that physiotherapy, as opposed to medical rehabilitation, also includes prophylaxis, which significantly expands the area of its application” [41].

According to the provision in the Act on the profession of physiotherapists, the preventive dimension of physiotherapy is now officially called **physioprophylaxis**.

### Examples of physioprophylaxis types

According to Sieroń, modern physiotherapy can be divided into pro-health physiotherapy, primary preventive physiotherapy, in-treatment physiotherapy, recovery physiotherapy and secondary preventive physiotherapy since it includes healthy people. Preventive physiotherapy is primarily devoted to people at the risk of developing metabolic syndrome and cardiovascular diseases as well as people at the risk of suffering from the reduction of the functions of the muscular system. Secondary preventive physiotherapy involves patients with a medical history, especially coronary artery disease and diabetes [42].

It should be remembered that the source and subject literature dealing with the topic of preventing health threats contains such terms as primary, secondary, tertiary and quaternary prevention. Primary prophylaxis aims to prevent diseases, its recipients are healthy people, while secondary prophylaxis involves patients and is a process that prevents the recurrence of the currently treated disease and the appearance of other anti-health consequences, e.g. disability. Another example of the use of different terminology connected to prevention is contained in the current, still valid, edition of the National Health Program (Narodowy Program Zdrowia). In the description of the implementation of the tasks included in the sixth operational objective, the document talks about universal prevention, selective prevention and indicative prevention [43].

In the resolution of May 2019, the Polish Chamber of Physiotherapists developed, adopted, and published the definition of physioprophylaxis (the definition is included in the introduction). The resolution also specified and described the types of physioprophylaxis [1]. These types are described below:

- **Early physioprophylaxis**, physiotherapeutic procedures aiming to popularize physical activity as a factor to reduce social, economic and cultural life patterns, which in turn contribute to increasing the likelihood of an illness and/or health problems. Impact level: universal (targeted at the entire population).
- **Primary physioprophylaxis**, physiotherapeutic treatment whose goal is to prevent the development of diseases and/or reduce the likelihood of health problems through early diagnosis, control and the prevention of internal and external risk factors. Impact level: selective (targeted at high-risk groups).
- **Secondary physioprophylaxis**, physiotherapeutic procedures involving supplementing treatment by implementing PA adapted to a particular condition in order to stop the development of negative effects of the disease and/or health problems. Impact level: selective.
- **Phase-III physioprophylaxis** (tertiary), physiotherapeutic procedures aiming at preventing the effects of a past/ongoing disease/health problem and preventing their recurrence, as well as minimizing secondary damage, complications and/or compensation. Impact level: selective [1].

The knowledge and ability to put this definition and the types of physioprophylaxis into practice will apply to both students of physiotherapy and professionally active physiotherapists. However, only scientific literature makes it possible to understand the legitimacy of using various concepts to define preventive actions.

### Our original approach to physioprophylaxis

The concept of primary and secondary prophylaxis (or prevention) exists in the Polish outpatient and hospital medicine. It seems that this practical division may also apply to physioprophylaxis regarding health threats.

The authors of this study have used this simple and transparent division, which is also a perfect introduction to this new field, to help understand the concept and structure of physioprophylaxis seen as a competence and a health service devoted to health threats.

The table below presents an original approach to primary and secondary physioprophylaxis in physiotherapy, including its tasks, PA types and selected scientific sources (Table 1).

**Table 1.** Primary and secondary physioprophyllaxis in physiotherapy through PA (an original approach)

<b>Types of physiotherapy</b>	<b>Types of physioprophyllaxis</b>	<b>The tasks of physioprophyllaxis</b>	<b>Physical activity (PA) – types, forms (sources)</b>
Promotional physiotherapy	<b>Primary physioprophyllaxis universal</b>	Improving knowledge about the impact of movement on health. Conscious development of physical fitness and physical efficiency, creating health potential. Maintaining the level of physical fitness and physical efficiency.	PA as an important health behavior in life. Dynamic recreational PA (physical games and activities, fitness), physical aerobic exercises (aerobics, walking, Nordic walking, running, swimming, cycling), resistance training – strength exercises, healing exercises, stretching exercises – flexibility, breathing, relaxation. Developmental PA, generally improving our physical health according to WHO recommendations, EU guidelines, experts of medical societies.
Preventive physiotherapy		The prevention of identified external and internal health threats (risk factors, the variability of body parameters) using adapted, systematic, moderate physical activity. Minimizing identified risk factors.	PA focusing on identified health threats (hereditary diseases, pain, control of body parameters). Corrective, breathing, therapeutic – active, passive exercises, physical, aerobic, resistance, general development, general fitness, relaxation, PA according to WHO recommendations, EU guidelines, experts of medical societies [10, 25, 37].
Therapeutic physiotherapy	<b>Secondary physioprophyllaxis selective</b>	The treatment of developmental disorders, civilization and occupational diseases as well as aging processes. PA should not exceed individual tolerance.	Therapeutic exercises – active, passive, (kinesiotherapy with local and general goals), neurophysiological methods, PA according to the recommendations of a physiotherapist, WHO and EU guidelines, experts of medical and scientific societies [15, 16, 33, 34, 37, 46, 47, 48, 49].
Physiotherapeutic rehabilitation		Maintaining functional fitness and physical efficiency after undergoing treatment (surgery). The prevention of complications, negative consequences of medical conditions, surgeries, accidents. The stabilization, adaptation and confirmation of disability.	Functional and adjusted PA [50], therapeutic exercises – passive, active [51], kinesiotherapy with local and general goals according to the recommendations of a physiotherapist, experts of medical [21] and scientific [49] societies.

## Conclusions

The original presentation of physioprophyllaxis presented in this study is based on the simplest and most transparent division of physioprophyllaxis into primary and secondary physioprophyllaxis and implemented

through PA. This division is a perfect introduction to this new educational, scientific and professional topic. It also facilitates understanding the concept and structure of physioprophylaxis as a competence and a (medical) health service devoted to health threats. Finally, it shows the need to learn other preventive terms and structures which are conditioned by specific specificities and assumed goals and which appear in the works from the field of health sciences.

Physioprophylaxis combines physiotherapy with the promotion of well-being in the case of a healthy person and the medical rehabilitation of patients to the greatest possible extent. In the first case, it has a universal scope and is determined by the individual level of knowledge about health. However, in relation to the patient, it is selective and requires professional and educational actions to be taken by a physiotherapist. These actions help to maintain, strengthen and regain health and functional fitness. They also prevent the recurrence of diseases, the appearance of negative consequences and disability. Physioprophylaxis minimizes identified health risk factors that are conditioned by health status, disease, undergone surgeries, the stage of ontogenesis, professional specifics, environmental conditions, lifestyle and health policy.

As far as healthy people are concerned, physioprophylaxis aims to maintain and strengthen the current morphological and functional state through PA as well as minimize the extent of adverse disorders associated with disease (postoperative) processes in the case of individuals suffering from various conditions. The therapeutic value of PA is the effect of restoring normal body functions, and if impossible, shaping compensation and adaptation mechanisms.

A physiotherapist is obliged under the law to take preventive (physioprophylactic) actions, i.e. to disseminate health-promoting behaviors and shape and maintain the fitness and endurance of people of all ages in order to prevent disability. PA, which is recommended in physioprophylaxis, requires a personalized approach, i.e. an approach adjusted to age, individual needs, functional possibilities as well as the state of health and the medical condition [1, 6, 7].

According to Maciej Krawczyk, "it is difficult to find a health area in which physiotherapy would not be useful, ... this is true for almost all the medical fields, however, many doctors and decision-makers are not yet aware of this fact... and some of them do not have full knowledge about the possibilities of modern physiotherapy" [44]. Elsewhere, the president of the Polish Chamber of Physiotherapists said that they "want the NFZ (the National Health Fund) and MZ (the Health Ministry) to pay for physioprophylaxis. Although ministers and professors from all the fields of medicine realize that prevention is the most important and the cheapest solution in medicine, no one takes any action" [45].

Without seeing the bigger picture, without appreciating the potential of the profession of a physiotherapist by decision-makers who are responsible for public health, without providing funds to pay for the solutions that physiotherapists and patients expect and need, physiotherapy will continue to function at a minimum and will be limited to commercial services. Finally, when it comes to physioprophylaxis which deals with health threats through PA, or other health protective factors, it will still remain nothing more than just a theoretical conversation topic for a very small group of people.

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PART III. OTHER  
DZIAŁ III. RÓŻNE

ASSESSMENT OF VITAMIN D CONTENT IN DIETARY SUPPLEMENTS SOLD  
IN EU PHARMACIES AND SUPERMARKETS

OCENA SUPLEMENTÓW DIETY DOSTĘPNYCH W APTEKACH I SUPERMARKETACH  
NA TERENIE UE POD KĄTEM ZAWARTOŚCI WITAMINY D

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Wkład autorów:

A. Study design/planning

zaplanningowanie 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

One of the main fat-soluble vitamins is vitamin D, whose primary function is the regulation of calcium-phosphate metabolism and mineralization of bone tissue. Vitamin D occurs in two forms: vitamin D2 (ergocalciferol) – found in plants and fungi (mainly yeasts) and vitamin D3 (cholecalciferol) – produced in animals. Hypovitaminosis of vitamin D leads to metabolic bone diseases in children and adults and can also affect the incidence of many chronic diseases such as: multiple sclerosis, diabetes, rheumatoid arthritis, bronchial asthma, cancer, atherosclerosis, coronary artery disease and heart failure. The aim of the current study was to assess the content of vitamin D in dietary supplements available in pharmacies and supermarkets in the EU. The evaluation involved analysing the ratio of vitamin D content in supplements in relation to the typical demand of the organism. This study assessed 15 popular over-the-counter dietary supplements in the form of tablets, capsules, lozenges and lollipops for children as well as in the form of effervescent tablets. On the basis of the labels on the packaging, the vitamin D content of the supplements was assessed in relation to the dietary demands of the body. Self-administration of over-the-counter multivitamin supplements is not an optimal way to increase vitamin D levels. It is recommended, therefore, that individuals requiring vitamin D supplementation seek specialist medical advice to optimal treatment strategies.

**Keywords:** vitamin D, ergocalciferol, cholecalciferol, vitamins, hypervitaminosis

Streszczenie

Jedną z głównych witamin rozpuszczalnych w tłuszczach jest witamina D. Kluczową funkcją witaminy D w organizmie człowieka jest regulacja gospodarki wapniowo-fosforanowej oraz mineralizacja tkanki kostnej. Poznane zostały dwie formy witaminy D: witamina D2 (ergokalciferol) – występująca w roślinach i grzybach (głównie drożdżach) oraz witamina D3 (cholekalcyferol) – wytwarzana w organizmach zwierzęcych. Hipowitaminoza tej witaminy prowadzi do metabolicznych chorób kości u dzieci i dorosłych, a także może mieć wpływ na występowanie wielu chorób przewlekłych takich jak: stwardnienie rozsiane, cukrzyca, reumatoidalne zapalenie stawów, astma oskrzelowa, nowotwory, miażdżycę, choroba wieńcowa, niewydolność serca. Celem pracy była ocena zawartości witaminy D w suplementach diety dostępnych w aptekach oraz supermarketach na terenie UE. Oceniano stosunek zawartości witaminy D w suplementach w odniesieniu do zapotrzebowania organizmu. Materiał badawczy stanowiło 15 popularnych suplementów diety dostępnych bez recepty w aptekach oraz supermarketach na terenie UE. Wykorzystane suplementy były w formie tabletek, kapsułek, tabletek do ssania i lizaków dla dzieci oraz w formie tabletek musujących. Na podstawie etykiet znajdujących się na opakowaniu oceniano zawartość witaminy D w suplementach w odniesieniu do zapotrzebowania organizmu. Samodzielne dozowanie suplementów diety nie jest optymalnym sposobem na zwiększenie poziomu witaminy D w organizmie. Z tego też względu stosując je należy zasięgać porad specjalisty.

**Słowa kluczowe:** witamina D, ergokalciferol, cholekalcyferol, witaminy, hiperwitaminoza

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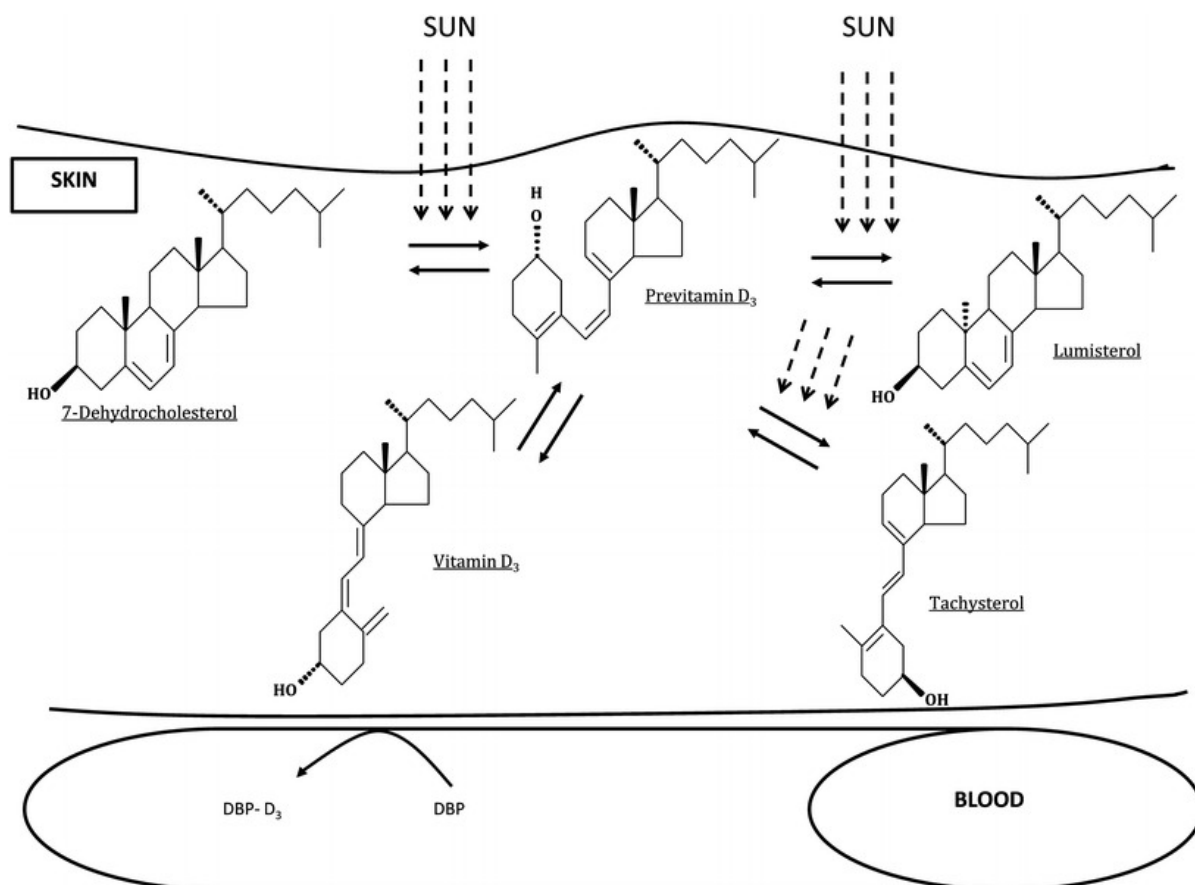
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## Introduction

Vitamin D belongs to the group of fat-soluble vitamins and it is essential for healthy physiology. Vitamin D is involved in the regulation of calcium-phosphate metabolism and mineralization of bone tissue [1, 2]. In recent years, other properties of vitamin D have also been observed. It has been found that vitamin D deficiency not only causes metabolic bone diseases in children and adults, it may also increase the risk of many common chronic diseases such as: multiple sclerosis, diabetes, rheumatoid arthritis, bronchial asthma, cancer, atherosclerosis, coronary heart disease, heart failure [3, 4, 5].

Vitamin D is one of the most commonly deficient. This is due to the fact that few foods naturally contain vitamin D, and only a small number of dietary products is enriched with it. As a consequence, vitamin D deficiency has become an epidemic for all age groups in the United States and Europe [3]. Over the years, a correlation between the geographical latitude, the length of the day and the concentration of vitamin D in the body has also been observed. This also affects the incidence of disease cases. The prolonged exposure to sunlight enables more effective vitamin D synthesis.

Vitamin D occurs in two forms: vitamin D<sub>2</sub> (ergocalciferol) – occurring mainly in plants and fungi (yeasts) and vitamin D<sub>3</sub> (cholecalciferol) – synthesized in the body. In the human body both these forms occur and can be supplied with food or produced by exposing the skin to sunlight. Moreover, Provitamin D<sub>3</sub>, upon exposure to sunlight, is converted to previtamin D<sub>3</sub>, which, under the influence of heat, undergoes isomerization to vitamin D<sub>3</sub> [1, 2]. A detailed diagram of vitamin D synthesis is presented in Figure 1 [2, 6].



**Figure 1.** Schematic diagram of vitamin D<sub>3</sub> synthesis in the skin [2, 6]

In the first stage of vitamin D<sub>3</sub> synthesis, a photolytic conversion of 7-dehydrocholesterol (provitamin D) to cholecalciferol occurs. This process takes approx. 30 minutes and in the majority of vertebrates it occurs under the exposure to sunlight with the participation of appropriate reductase. UVB absorption (within the 290-320 nm wavelength range) causes the formation of the so-called 7-dehydrocholesterol, which spontaneously undergoes isomerization forming cholecalciferol, i.e. a vitamin D molecule. In this form, vitamin D is transported into the bloodstream. The next metabolic changes, based on the synthesis of biologically active compounds of vitamin D<sub>3</sub>, are carried out in two stages. Initially, after transporting cholecalciferol with blood to the liver in



hepatocyte mitochondria, it is hydroxylated by means of 25-hydroxylase. Microsomal fraction enzymes are also involved in this process. The resulting 25-hydroxycholecalciferol – also called calcidiol – is the main form of vitamin D present in the bloodstream, however, it has a relatively low biological activity.

An important place for vitamin D activation in the body is the kidneys. In mitochondria of proximal nephron canals, under the influence of hydroxylase, hydroxylation of calcidiol is observed. The resulting calcitriol (1 $\alpha$ ,25dihydroxycholecalciferol) has about 1000 times higher biological activity than calcidiol. Another form of vitamin D – calcitic acid (1 $\alpha$ ,24,25dihydroxycholecalciferol) is also present in the body. This compound is highly soluble in water and is therefore easily and quickly removed from the organism. However, it is of little biological significance [2, 6].

### Physiological demand for vitamin D

According to the guidelines for Central Europe of 2013 [7], vitamin D supplementation is recommended from the first days of life, regardless of how the child is fed at a dose of: 400 IU/a day (10  $\mu$ g/day) in relation do daily intake. In the case of children and adolescents, vitamin D supplementation at a dose of 600-1000 IU/a day (15-25  $\mu$ g/day) is recommended. Both in adults and the elderly after 65 years of age vitamin D supplementation should be between 800 and 2000 IU/a day, i.e. 20-50  $\mu$ g/a day. The dose is adjusted depending on the human body weight and the current season. In the case of obese people, higher doses of vitamin D are recommended [7, 8]. According to the Food and Nutrition Institute, the daily requirement of vitamin D<sub>3</sub>, depending on the age, ranges between 200 and 1000 IU (Table 1) [7, 8].

**Table 1.** Norms for vitamin D intake [9]

Group/gender	Age/years	$\mu$ g of cholecalciferol/ per person/a day	JM/per person /a day
Infants	0-1	10	400
Children	1-9	15-25	600-1000
Boys	10-18	15-25	600-1000
Girls	10-18	15-25	600-1000
Men and women	19-65	20-50	800-2000
Persons over 65 years of age	20-50		800-2000

Currently, the most accurate indicator of vitamin D levels in the body is the examination of serum levels of calcidiol. People with a blood calcidiol concentration of less than 25 nmol/l are evidently suffering from vitamin D deficiency. The deficiency is indicated by values of 25-50 nmol/l, while an elevated level (hypervitaminosis) occurs when the concentration of calcidiol is in the range of 50-70 nmol/l. It is much more difficult to determine the limits of physiological norms. At present, a fairly wide range of concentrations, between 70 and 200 nmol/l of calcidiol in serum, is assumed within the limits of the norm (Table 2). The highest safe value for the organism is considered to be 250 nmol/l. However, so far, no case of vitamin D poisoning has been observed, whereas deficiency, due to its frequent occurrence, is now a serious social problem [1, 9, 10].

**Table 2.** Ranges of serum concentrations of calcidiol [1]

	Serum concentration of calcidiol	
	[ng/ml]	[nmol/l]
Deficit	0-10	0-25
Deficiency	>10-20	>25-50
Hypervitaminosis D	>20-30	>50-75
Recommended concentration	>30-80	75-200
Toxic concentration		>100 (150) >250

### Effects of vitamin D deficiency

Nowadays, vitamin D deficiency is very common and affects 50-80% of the population. This constitutes a serious epidemiological problem [11]. Long-term vitamin D deficiency causes disturbances in the regulation of calcium-phosphate metabolism as well as in the modelling and mineralization of bones. As a result, children may develop diseases such as rickets, growth disorders, skeletal deformity and an increased risk of bone fractures at

a later age. In adults, vitamin D deficiency results in osteomalacia and influences the pathogenesis of osteoporosis [2]. Vitamin D deficiency significantly increases the risk of cardiovascular diseases. This is caused, among other things, by the inhibition of the production of rennin (a hormone that affects blood pressure) by means of vitamin D. In addition, too low vitamin D concentration in the body is associated with the occurrence of myocardial infarction, ischemic heart disease and congestive heart failure. It is connected with exerting metabolic effect on the smooth muscle tissue, cardiomyocyte and endometrium of blood vessels through an active form of vitamin D. Low concentrations of 25-hydroxyvitamin D in the body are associated with an increased risk of developing certain cancers (colon, breast, prostate) by about 30 - 50%, as well as an increased mortality rate as a result of the disease. Vitamin D deficiency increases the risk of multiple sclerosis, type 1 diabetes mellitus and Crohn's disease. Vitamin D receptors are also found in the brain. Therefore, its deficiency can cause the development of psychiatric diseases such as depression and schizophrenia. Some studies have shown that the intake of vitamin D at a concentration of 2000 IU per kg for three days stimulates the production of catalicidine, which helps to combat viral infections.

### Aim of the study

The aim of the study was to evaluate the content of vitamin D in popular dietary supplements available in pharmacies and supermarkets. The analysed supplements were in the form of capsules, tablets as well as effervescent tablets, lozenges and lollipops for children.

### Material and methods

The study material consisted of 15 popular over-the-counter dietary supplements available in pharmacies and supermarkets in the EU (Table 3). On the basis of manufacturers' labels, vitamin D content in supplements was evaluated in relation to the demand of the body.

**Table 3.** Vitamin D content in the tested supplements in [ $\mu\text{g}$ ] and [IU]

OVER-THE-COUNTER SUPPLEMENTS					
Supplement	Vitamin D content per tablet		Form	Recommended intake on the packaging	RWS (%) - Reference intake value for the average adult
	[ $\mu\text{g}$ ]	[IU]			
1	50	2000	Capsule in the form of vitamin D <sub>3</sub> + K <sub>2</sub>	1 capsule per day	1000%
2	10	400	Capsule in the form of vitamin A + D <sub>3</sub>	1-2 capsules per day	200%
3	1.67	66.8	Tablet in the form of multivitamin	1 tablet 3 x daily	16.7 %
4	5	200	Multivitamin in the form of a tablet for women	1 tablet per day	100%
5	25	1000	Capsules for infants, children and adults	Infants: 1 capsule per day Children over 1 year of age and adults: 2 capsules per day	500%
6	50	2000	Capsule in the form of vitamin D <sub>3</sub> + K <sub>2</sub>	1 capsule per day	1000%
7	25	1000	Capsules	1 capsule per day	500%
8	100	4000	Capsules for adults	1 capsule per day	2000%
9	50	2000	Capsules	1 capsule per day	1000%
10	50	2000	Effervescent tablets	1 tablet per day	1000%
11	5	200	Calcium effervescent tablets + vitamin D <sub>3</sub>	1 tablet per day	100%
12	25	1000	Lozenges	1 tablet per day	500%
13	25	1000	Lozenges	2 tablets per day	500%
14	0.25	10	Lollipop with vitamins C and D	1-2 lollipops per day	50%
15	10	400	DHA + vitamin D capsules for children	1 capsule per day	100%

## Results and discussion

The studies have shown that vitamin D content in the analysed supplements ranged from 1.67 to 100 [ $\mu\text{g}$ ] (Table 3). Furthermore, only one case of critically low vitamin D content (1.67  $\mu\text{g}$ ) in the tested supplement (supplement 3) was found. In two dietary supplements, 4 and 10 respectively, the recommended content of vitamin D for people aged up to 50 years and pregnant/lactating women was reported (Table 1). High content of vitamin D in supplements 2, 5, 7 in the range from 10 to 25  $\mu\text{g}$  and extremely high content of vitamin D in supplements 1, 6, 9 and 8 in the range from 50 to 100  $\mu\text{g}$  were also observed.

Bjelakovic et al. [12] based on research and observations, suggest that optimal vitamin D status may be associated with fewer cases of cancer and cardiovascular diseases (such as heart attack or stroke). Vitamin D is synthesised in the skin as vitamin D<sub>3</sub> (cholecalciferol) or it is obtained from dietary sources or supplements as vitamin D<sub>3</sub> or vitamin D<sub>2</sub> (ergocalciferol).

It should be noted that among healthy middle-aged adults the target concentration of 25-hydroxyvitamin D (25(OH) D) is 50 nmol/L and due to natural intake (exposure to sun and diet) they are sufficient and there is no indication for systematic blood testing or supplementation. However, for middle-aged adults who are ill or weakened, such natural intake is generally insufficient. In this population, the supplementation phase is directed at 25 (OH) D 75 nmol/L and the supplementation pattern (200 000 to 400 000 IU orally for 2 months). In adults over 65 years of age, the phase of supplement administration should be systematic and ultimately be at 75 nmol/L (formula 300 000 IU orally for 3 months). Regardless of age, the administration phase should be followed by a prolonged maintenance phase of the supplementation to keep the concentration of 25 (OH) D at a constant level [13].

Therefore, it is necessary to differentiate pathological states in the human body and react by adjusting an appropriate dose in a supplementation within a specified period of time. It is worth remembering, however, that this type of treatment has to be consulted with a specialist. According to the studies presented above, on the EU market one can find vitamin D supplements with very different contents. The inappropriate analysis of the labels provided by the manufacturer may lead to pathological conditions related to the poisoning caused by this vitamin. Such incidents may occur particularly often among healthy adults in the spring-summer season, when the diet is rich in bioactive substances and the human body is exposed to sunlight.

## Conclusions

The dietary supplements analysed here contained a broad range of vitamin D concentrations, which satisfy different physiological demands. It should be noted that the use of dietary supplements, without medical consultation, may lead to overdose and cause a number of pathological processes in the body. This is particularly important for children and infants, as the supplements for this group contain a broad spectrum of vitamin D. A well-balanced diet and rational exposure to sunlight are sufficient for a healthy organism. However, it should also be noted that excessive sun exposure at any age and among any occupational group is not recommended for the human body. The main objective of numerous socio-economic programmes is to promote the implementation of safety in a strategic perspective. Sustainability at global level is increasingly attracting the attention of safety, health and environmental (SHE) professionals, however, it is generally limited to issues at management level, while efforts towards achieving sustainable growth should be directed towards balancing social, economic and environmental needs [14].

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## DIETARY SUPPLEMENTS THAT CONTAIN BIOTIN DO NOT INFLUENCE FLUORESCENCE THYROID-STIMULATING HORMONE VALUES WHEN SCREENING FOR CONGENITAL HYPOTHYROIDISM IN NEWBORNS

### SUPLEMENTY DIETY ZAWIERAJĄCE BIOTYNĘ NIE WPŁYWAJĄ NA STĘŻENIE FLUORESCENCYJNE TSH OKREŚLONE W PRZYPADKU WRODZONEJ NIEDOCZYNNOCI TARCZYCY W BADANIACH PRZESIEWOWYCH NOWORODKÓW

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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  
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#### Summary

**Background.** Biotin levels may interfere with immunological tests that use biotin-streptavidin complexes. Although the recommended daily intake (RDI) of biotin is 30 µg, some dietary supplements that are available without prescription contain double or even tenfold the RDI.

**Material and methods.** To assess if biotin levels influence thyroid-stimulating hormone (TSH) serum concentrations using two different methods (chemiluminescent assay [CLIA] and fluorescent immunoassay [FEIA]), 110 samples from newborns and 64 samples from pregnant women in the first trimester were collected. Participants completed a questionnaire regarding dietary supplement use. Biotin levels were determined using the ELISA technique.

**Results.** Biotin levels for newborns were 0.004-0.170 ng/ml and for pregnant women were 0.070-0.155 ng/ml (22 women were taking supplements containing from 30 µg to 35 mg of biotin). Biotin levels were below the value of 400 ng/ml stated by the manufacturer of the CLIA method to influence TSH levels. The FEIA manufacturer does not state the influence of biotin levels in the insert. Correlation tests results between TSH value and biotin were  $r=-0.1$  for CLIA method and  $r=0.04$  for FEIA method.

**Conclusions.** According to our results, TSH values are not influenced by biotin levels even if the RDI was exceeded.

**Keywords:** dietary supplements, biotin, immunological tests

#### Streszczenie

**Wprowadzenie.** Poziomy biotyny mogą zakłócać testy immunologiczne wykorzystujące kompleksy biotyna-streptawidyna. Chociaż ZDS (zalecane dzienne spożycie) wynosi 30 µg, niektóre suplementy diety dostępne bez recepty zawierają podwójne lub nawet dziesięciokrotne wartości ZDS.

**Materiał i metody.** Zebrano 110 próbek od noworodków i 64 próbki od ciężarnych kobiet w pierwszym trymestrze ciąży, aby ocenić, czy poziomy biotyny mogą wpływać na stężenie TSH w surowicy przy dwóch różnych metodach (CLIA i FEIA). Wykorzystano też kwestionariusz dotyczący zastosowanego suplementu diety. Poziomy biotyny określono za pomocą techniki ELISA.

**Wyniki.** Poziomy biotyny w przypadku noworodków znajdował się w przedziale 0,004-0,17 ng/ml, a w przypadku kobiet ciężarnych: 0,07-0,155 ng/ml (22 kobiety przyjmowały suplementy diety zawierające od 30 µg do 35 mg biotyny). Poziomy biotyny był poniżej wartości 400 ng/ml podanej przez producenta metody CLIA, aby mógł wpłynąć na poziomy TSH. Producent FEIA nie deklaruje takiego wpływu we wkładce. Wyniki testów korelacji pomiędzy wartością TSH a biotyną wynosiły:  $r=-0,1$  w metodzie CLIA i  $r=0,04$  w metodzie FEIA.

**Wnioski.** Zgodnie z wynikami, poziomy biotyny nie mają wpływu na stężenie TSH, nawet jeśli ZDS zostało przekroczone.

**Słowa kluczowe:** suplementy diety, biotyna, testy immunologiczne

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## Introduction

Immunoassays are widely used in the clinical laboratory because they can be easily automated and have high precision and sensitivity. Although robust, some of these tests may be influenced by several factors that can lead to erroneous results [1]. In some cases, this may lead to increased or decreased values of the analyte and could consequently mask a pathology [2]. Alternatively, hormonal profiles may be modified in such a manner that another pathology could be suspected or misdiagnosed [3]. Sandwich immunoassays are commonly used for determining levels of large molecules such as thyroid-stimulating hormone (TSH), human chorionic gonadotropin (HCG), or other pituitary hormones. TSH is recognized by two different antibodies: one is bound with the solid phase used in the reaction and one is tagged with a signal molecule that will be measured (enzyme marked, chemiluminescent, or fluorescent substrate). The antibody bound to the solid phase (capture antibody) separates the antigen-antibody complexes, and this reaction is enhanced by biotin-streptavidin complexes. Biotin-streptavidin complexes are used by manufacturers due to their stability and lack of interference with the molecular properties of the substances. According to data from external quality control programs, 50% of all immunoassays for hormones used in France use biotin-streptavidin complexes [4].

Biotin is a soluble vitamin which is part of the B complex and is also referred to as vitamin B7 or vitamin H. Biotin is a coenzyme for carboxyl transfer in five different carboxylases. A daily intake of 30 µg is recommended for healthy adults [5]. Some supplements that contain biotin may influence immunoassays that use biotinylated antibodies or streptavidin [6], although others may contain a low dose of biotin that is unlikely to influence immunoassays [7, 8]. Normal serum concentrations of biotin are 0.1-0.8 ng/ml. Biotin is rapidly absorbed and reaches peak serum concentration 1-2 hours after ingestion. Doses of about 10 mg can lead to concentrations of 55-140 ng/ml, while doses of 100 mg can lead to concentrations of 375-450 ng/ml. Continuous administration of biotin can lead to the accumulation of biotin in serum and may double the initial value [9]. Biotin is used in supplements for pregnant women and for products that claim to help hair and skin health, and is available without a prescription. Considering that the food supplement market has expanded in the EU, although advertising is regulated [10], some accumulation of biotin is expected in patients who consume supplements containing a high dose of biotin. The aim of this study was to assess biotin influence on TSH values determined with fluorescent immunoassay (FEIR), a method that is used in a newborn screening program for early detection of congenital hypothyroidism (CH), and on TSH values determined by chemiluminescent immunoassay (CLIA).

## Material and methods

The study was approved by the Ethics Committee of the Târgu Mureş Emergency County Hospital. After written consent was obtained from the mothers, a 7 ml tube with no additives was used to collect blood samples from 122 newborns. Samples were centrifuged for 20 minutes at 4000 rpm and the serum obtained was stored at -80°C until TSH and biotin levels were determined. On the same day, from each newborn a sample of whole blood was collected on dried blood spots (DBS) on filter paper grading 903 (Whatman 903, Sigma Aldrich), according to regulations from the national screening program.

To establish biotin influence on TSH values determined by the CLIA method in adults, blood samples from 64 women in the first 14 weeks of pregnancy were collected. At the date of collection, participants completed a questionnaire concerning any dietary supplements that were prescribed or that had been taken without prescription from a physician. 7 ml of blood was collected and the serum was stored at -80°C until TSH and biotin values were determined.

Serum TSH values were determined with CLIA using the Immulite 2000 instrument (Siemens, Germany) with Siemens reagents. Analytical sensitivity of third-generation Siemens TSH is 0.004 µUI/ml, inter-assay precision is 5.1%, and analytical recovery is 100%. For newborns, TSH was also determined using DBS samples and the FEIA method (LabSystems Diagnostics Oy, Norway). The sensitivity of the TSH FEIA kit is 0.9 mUI/L blood, inter-assay imprecision (CV%) is 8.8 %, and analytical recovery is 81%. CLIA manufacturer states that tests are not influenced by biotin below 400 ng/ml and FEIA manufacturer does not state such in interference.

Biotin concentrations in serum were determined with enzyme-linked immunosorbent assay (ELISA) kits from Cusabio (USA) with a direct competitive inhibition immunoassay. A competitive inhibition reaction was initiated between biotin from samples and horseradish peroxidase (HRP) conjugated biotin from the kit, in avidin pre-coated ELISA wells. After the substrate was added, a colour reaction developed according to the amount of biotin conjugated in the initial step. The ELISA kit had a detection range of 0.012–0.020 ng/ml and a sensitivity of 0.004ng/ml. A four-parameter logistic standard curve with 6 calibrator values was used.

Data from questionnaires and serum TSH and biotin levels were tabulated on Excel spreadsheets and statistically analyzed using MedCalc software version 14.8.1. The Kolmogorov-Smirnov test was used to verify

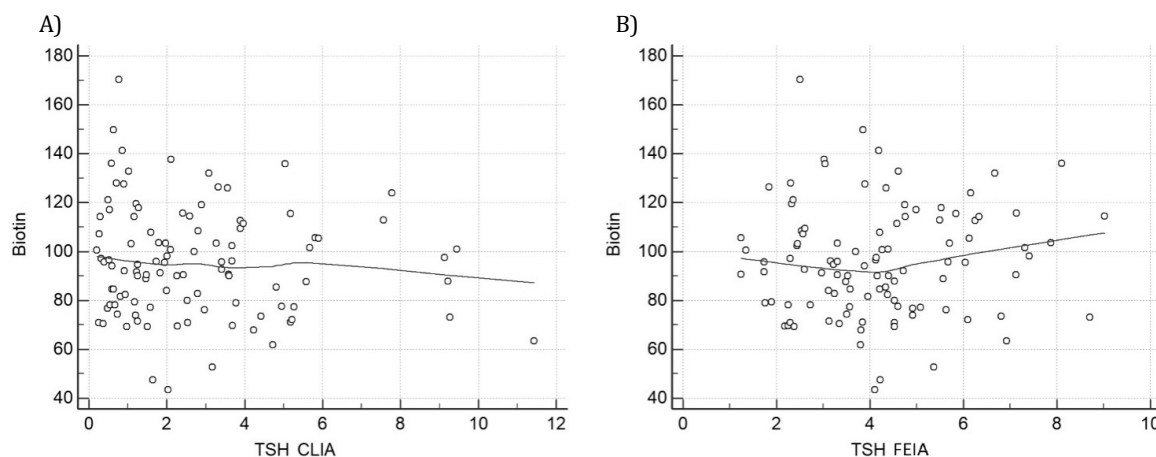
normal distribution. In order to evaluate the influence of biotin levels on TSH values, correlation coefficient tests were performed. A p-value <0.05 was considered as statistically significant.

## Results

Of 122 samples that were collected from newborns, biotin was determined from 110 specimens; for the remaining 12, serum was insufficiently collected. Values obtained from newborns were 0.004-0.170 ng/ml, with a parametric distribution. Of the 64 questioned women, 22 had taken three different type of supplements that contained biotin (in 15 cases the biotin concentration was 35 mg, while in the remaining 7 cases the concentration of biotin in two types of supplements was 60 µg), 17 had taken supplements that contained only folic acid, and 25 declared that they did not take any supplements. The most commonly used supplement contained 10 times the recommended daily intake (RDI) of biotin, which is 30 µg, while the other two contained two times the RDI. Biotin serum levels from pregnant women were 0.070-0.155 ng/ml.

TSH values in newborns using both techniques (FEIA and CLIA) were tabulated on Excel spreadsheets. Values obtained with the FEIA technique from DBS were 1.24-9.01 mUI/L, with a non-parametric distribution. To compare values from whole blood with values from serum, values obtained in serum were multiplied by 0.45. The value of 0.45 was used because it is considered a normal value for haematocrit in newborns; this value also used when reporting External Quality Assurance results and is recommended by the manufacturer of the FEIA kit.

Values obtained in serum with the CLIA technique were 0.20-11.43 µUI/L after the transformation was applied. TSH values in serum also presented a non-parametric distribution. Data from patients who did not have TSH values determined using both methods, and a biotin serum level, were excluded from the analysis.



**Figure 1.** Correlation tests for serum biotin and TSH levels using CLIA ( $r=-0.1$ ) – A; correlation between biotin levels and TSH using FEIA ( $r=0.04$ ) – B

Correlation tests between TSH values from serum and whole blood and serum biotin levels are shown in Figure 1. Results obtained using the CLIA method ( $p=0.27$ ) showed that there was no correlation between serum TSH values and biotin level. For the FEIA method, statistical tests showed no correlation between whole blood TSH values and biotin levels in patient serum ( $p=0.62$ ).

## Discussion

Biotin may influence different types of immunoassays (both competitive and sandwich) in different ways, leading to a false increase or decrease in the concentration of a specific analyte. In a study on the influence of biotin on hormone and vitamin levels, Piketty et al. listed 5 cases in which TSH values were lower than reference levels, due to biotin interference [1]. Jenkins et al. published a review on the influence of biotin on immunoassays and evaluated data provided by manufacturers. Siemens states that biotin influences TSH values only above the value of 400 µg/L in serum [11]. Li et al. showed that in the case of 6 healthy adults who were taking 10 mg of biotin/day for 7 days, an influence was observed in 9 out of 23 immunoassays evaluated. The authors used immunoassays from 3 different manufacturers (Roche, Siemens, and Orthoclinical Diagnostic). The influence of biotin was assessed using in vivo studies, in which certain amounts of biotin were administered, and in vitro by adding biotin to patient samples. Effects on TSH values were dependent on dosage and manufacturer; 300 ng/ml of biotin supplementation led to a 7-10% increase in TSH using Siemens Vista, while only 6-15 ng/ml of biotin

supplementation was necessary to produce the same effect on Roche Elecsys and Vitros methods [12]. In our study none of the patients had such high levels of biotin in serum and no biotin was added in patients samples.

In a published document from the Food and Drug Administration (FDA), it is recommended that manufacturers should investigate the influence of biotin up to 1200 ng/ml, and determine the smallest concentration of biotin that changes the results significantly (this threshold for change was set at 10%) [13]. In a document published by American Association of Clinical Chemistry (AACC) regarding biotin influence on immunoassays, 20 studies on biotin influence were listed. Most of these studies referred to influences on thyroid hormones, and the most common consequences were a misdiagnosis of Graves' disease. Of the 20 studies reported, only 2 studies referred to serum thyroid hormone levels in newborns. In these two cases, both newborns were misdiagnosed with Graves' disease and one was taking 10 mg of biotin as a prophylactic treatment for organic academia [14]. Even if such cases are rare, such treatments should be known by laboratory staff in order to properly evaluate patient's results.

## Conclusions

In the present study, we did not find any significant correlation between biotin levels in serum and TSH levels measured with CLIA (Siemens) and FEIA (LabSystems Diagnostics Oy). Values of biotin measured in newborns were below the value stated by the manufacturer (Siemens) to produce analytical interference in serum thyroid hormone assessment. Regarding the FEIA method, the manufacturer does not state the possible influence of biotin on TSH results. This may be due to the lack or insufficient investigation of this aspect. As for biotin serum levels obtained in pregnant women, these were below the values stated by Siemens, irrespective of whether or not they were taking supplements that contain biotin.

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## PROCESSING INFORMATION IN THE GO/NOGO/GO PARADIGM: INTERACTIONS BETWEEN COGNITIVE FUNCTION AND THE AUTONOMIC NERVOUS SYSTEM

## PRZETWARZANIE INFORMACJI W PARADYGMACIE GO/NOGO/GO: INTERAKCJE POMIĘDZY FUNKCJĄ POZNAWCZĄ I AUTONOMICZNYM SYSTEMEM NERWOWYM

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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.** The association between cognitive function and the autonomic nervous system (ANS) was studied using a go/nogo/go paradigm. **Material and methods.** Cognitive tasks involved determining signal modality, visual shapes or word meaning, as well as quick error-free reactions with the left (gol) or right (gor) hand or motor inhibition (nogo). The rate of signal presentation increased gradually (30, 60, 90 and 120 per minute). The ANS was examined based on heart rate variability (HRV), scattergram area (S), periodic (SD2) and aperiodic (SD1) oscillations of correlation rhythmography (CR). **Results.** Differentiation of verbal and visual cues presented at a low rate was associated with increased activity of cognitive and neurophysiological mechanisms of ANS regulation, coordinated sympatho-parasympathetic interaction, and enhanced integrative processes. High rate presentations led to divergent changes in cognitive function and ANS: increased HRV and decreased SD1 and SD2, increased number of errors, and decreased motor reaction time and S. **Conclusions.** Interactions between cognitive function and ANS were related to the rate of presentation and signal modality: increased interactions occurred with low rate presentations, whereas, high rate (visual) presentations impaired performance and also reduced autonomic-cognitive interactions.

**Keywords:** neurocognitive tests, autonomic nervous system, heart rhythm variability, go/nogo/go paradigm

### Streszczenie

**Wprowadzenie.** Zbadano interakcje pomiędzy funkcją poznawczą i autonomicznym systemem nerwowym (ANS) pod względem przetwarzania w paradygmacie go/nogo/go. **Materiał i metody.** Zadania poznawcze obejmowały określenie modalności sygnału, kształtu figur lub znaczenia słowa i szybką, bezbłędną reakcję dotyczącą lewej (gol) lub prawej (gor) ręki bądź hamowania czynności motorycznych (nogo). Szybkość prezentacji sygnału wzrastała stopniowo od 30, przez 60 i 90, aż do 120 na minutę. Autonomiczny układ nerwowy był badany zgodnie ze wskaźnikami regulacji częstości akcji serca: częstością HRV, obszarem regulacji (S), okresowymi (SD2) i nieokresowymi (SD1) oscylacjami rytmografii korelacyjnej (CR). **Wyniki.** Zróżnicowanie sygnałów ustnych i sygnałów wizyjnych o niskim tempie charakteryzowało się zwiększeniem aktywności w kognitywnych i neurofizjologicznych mechanizmach regulacji ANS, skoordynowaną interakcją połączenia sympatyczno-przywspółczulnego oraz usprawnienie procesów integracyjnych. Prezentacja z wysoką częstotliwością doprowadziła do przeciwnych zmian funkcji poznawczych i ANS: zwiększyło się tętno i zmniejszyło SD2 i SD1, zwiększyła się też liczba błędów i zmniejszył czas reakcji motorycznych i S. **Wnioski.** Odkryto zależność od wzajemnego powiązania funkcji poznawczych i ANS przy trybie prezentacji i modalności sygnału: interakcja wzrosła przy niskim trybie, z kolei niedobór aktywności mechanizmów neurokognitywnych i autonomiczno-poznawczych został stwierdzony przy dużej częstotliwości sygnałów obrazowych.

**Słowa kluczowe:** testy neuropoznawcze, autonomiczny układ nerwowy, częstość akcji serca, paradygmat go/nogo/go

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## Introduction

According to the World Health Organization (WHO), the dissonance of neurocognitive and autonomic mechanisms underlies the development of depression, leads to a decrease in working capacity, an increase in disability, and a deterioration in quality of life [1]. Therefore, studying the interaction between cognitive functions and the autonomic nervous system (ANS) in terms of processing complex information, is an important area of focus. In order to understand the mechanisms of regulation, to identify information indicators of the functional state of the brain, and to prevent the deterioration of health, it is important to investigate the influence of information loads of different complexities on the interaction of cognitive functions and the ANS.

Cognitive assignments require the processing of information arriving from different afferent channels and rates. Simple and complex motor reactions can be investigated through differentiation tasks, i.e. go/go (simple) and stop-signal and go/nogo (complex). This task specifically measures the ability of an individual to cancel motor activity, even after initiation of response – thus, providing a measure of inhibitory control [2-5]. To evaluate the regulatory functions of the ANS, the method of heart rate variability (HRV) can be applied [6].

Integrative functions of cognitive systems can be studied by utilizing variants of the two-stimulus go/nogo tasks [7, 8]. For instance, such dual tasks are used in the diagnosis of Alzheimer's disease, Parkinson's disease, schizophrenia, dementia, hypo-frontality, and hyperactivity, as well as for risk assessment of behavior in extreme conditions [7, 9, 10]. A three-stimulus differentiation task, such as the "gol/nogo/gor" paradigm (a differentiating reaction with the left/right hand (gol/gor) and inhibition of a motor action (nogo)), is used to assess more complex cognitive processing that requires constant switching of the focus of attention, processing signals in working memory, and the emergency construction of a response program [11]. The three-stimulus sensorimotor task is thought to link the effectors of the neurocognitive networks responsible for the interaction of analyzer, motor, and motivational systems of the brain. Brain sensorimotor integration is measured qualitatively by reaction accuracy; whereas, reaction time acts as a quantitative characteristic. The qualitative interaction of brain cognitive systems can be assessed in terms of the number of errors committed during the task [5, 12].

The neuro-emotional and autonomic components of cognitive processing are associated with the activation of regulatory functions of the ANS. Studying visceral functions of the nervous system requires consideration of the roles of cortical structures in orientation and the mobilization of attention and memory features, including the ANS in terms of heart rate [12, 13]. During the processing of complex information from different modalities in the go/nogo/go task, both differentiation and switching the focus of attention are known to be accompanied with changes in the interactions of neurocognitive systems of the brain [2, 3] and changes in quantitative and qualitative regulation of the cardio-vascular system [14, 15]. Relevant measures include diagnostic and prognostic value from HRV analysis and characteristics of correlation rhythmography (CR) [16, 17]. This method allows for discrimination between periodic and aperiodic oscillations of HRV on the Poincaré-Lorenz graph [6, 15].

Analysis of existing studies shows that results differ depending on individual characteristics of subjects, task type, activity conditions, and the speed of stimulus presentation. Despite significant progress in studying individual elements of the brain and the systems that support it during the processing of information of different complexities and modalities, there is not a clear understanding of how the interaction of brain systems results in successful cognitive activity or of the brain systems' interplays with regulators of the ANS. Successful complex multi-modal information processing is associated with both increasing and decreasing coherence of neurocognitive and neuroautonomic regulatory links [2-5, 7-13]. In general, the results are conflicting without distinguishing clear correlates for the processing information of different complexities and modalities in cognitive systems with neuroautonomic support. Therefore, the goal of the research is to find out the peculiarities of cognitive functions and their relation to the regulatory mechanisms of the ANS in terms of differentiating visual and verbal information in the go/nogo/go mode at different rate of signal presentation.

## Material and methods

The correlation of cognitive and autonomic nervous systems was studied in 56 medical students, aged 16-17 years, who provided informed consent in accordance with the World Health Association Helsinki Declaration of 1964. Cognitive activity was investigated using the computer system "Diagnost-1M" in the "imposed rhythm" mode [11]. A neurophysiological three-stimulus task in which the subject differentiated image and verbal stimuli in the go/nogo/go paradigm with random (33%) presentation of response cues (go) and non-response cues (nogo signal), was used [12].

The task consisted of two tests: I – to determine error number and motor reaction speed for shapes; II – to determine error number and motor reaction speed for words. The subjects received an instruction to press the left button with the thumb of the left hand (gol) when a circle or a plant name appeared on the screen, to press

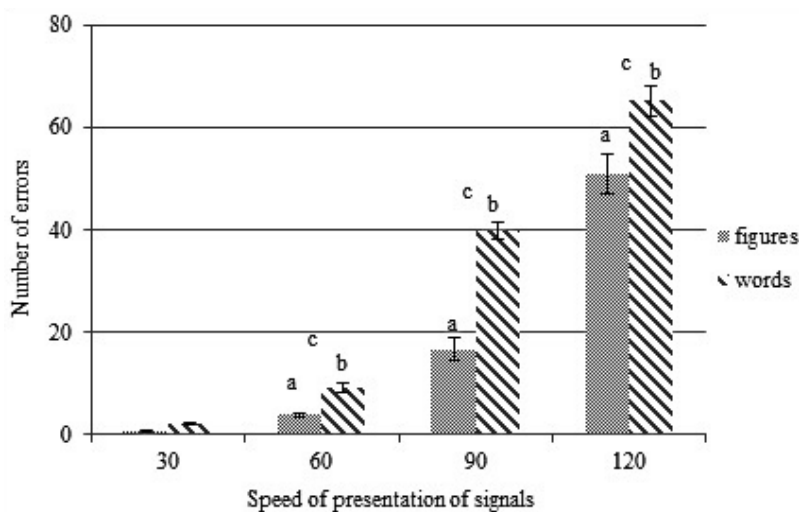
the right button with the right hand (gor) when a square or an animal name appeared on the screen and not to press any button (nogo) when a triangle or an object name (inhibitory stimulus) appeared on the screen. Testing started with the image stimulus presentation at rate of 30 signals per minute. Then, signal presentation rate increased by 30 frames and progressed to 60, 90, and 120 stimuli per minute. The interstimulus interval varied randomly from 0.01 to 0.4 s for each task group. Rest between tasks was 30 seconds. When performing the tests, attention was paid to the success of the subject's performance, to the prevention of errors, to omissions of signals, to delayed or advanced reactions and to the maximum speed of the motor reaction. A 60-second signal differentiation was used for cognitive load. The order and timing of signal presentation varied and was random. The exposure time of a signal was 0.5 s, and the pause time was changed randomly by the algorithm based on the software. After rest, the tasks were repeated for verbal stimuli [12].

To assess ANS function, correlation rhythmography (CR) was used (Holter monitor, KhAI MEDICA). Measurements for HRV, periodic and aperiodic oscillations, and characteristics of CR were determined at rest and while performing the task during the gradually increased rate of image and verbal signal presentation [6, 15, 16]. Frequency of heart rate was recorded (HR, bpm); the maximum amplitude of periodic oscillations was determined (SD2 ms) showing the activation of the parasympathetic division; the amplitude of the aperiodic oscillations of R-R intervals was represented by the transverse axis of the scattergram (SD1 ms) showing the sympathetic activation; and the scattergram area ( $S, \text{ms}^2$ ) using the formula of  $S=(n \times l \times w)/4$  was determined representing total activity of both divisions of autonomic regulation [6, 15, 16, 17, 18].

Statistical verification of the normality of data distribution was performed using the Shapiro-Wilk test. HRV data are represented by the median, first and third quartiles (25% and 75% percentiles). The reliability of the differences between the samples, in the case of normal distribution, was evaluated by the Student's t test, and in the case of nonparametric distribution, using the Wilcoxon and Mann-Whitney criteria. According to the Shapiro-Wilk test, the number of errors and the speed of reaction were parametric, and the heart rate variability indicators were non-parametric. The significance of probable values was assumed to be  $p < 0.05$ .

## Results

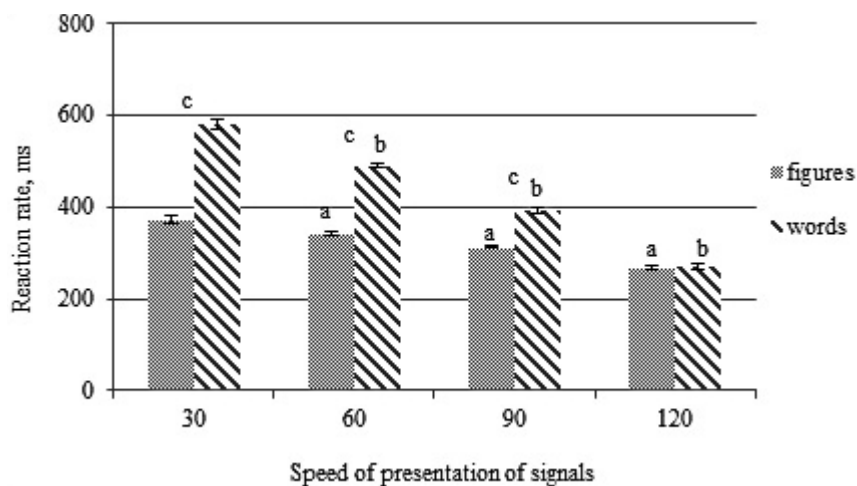
The results of cognitive tests revealed that the speed of motor reaction and the quality (number of errors) of multimodal information processing in the gol/nogo/gor task depended on the rate of stimuli presentation. As the rate of signal presentation increased, there was an increase in the number of errors and a decrease in the motor reaction time (Figure 1). Figure 1 shows that the number of false reactions increased with the increasing rate of information presentation at 30 and up to 60, 90, and 120 stimuli per minute. The smallest number of errors were made at the presentation rate of 30 stimuli per minute and the largest number of errors at 120 stimuli per minute. The number of false reactions in the gol/nogo/gor differentiation task were found to be statistically significantly less for image stimuli compared to verbal stimuli ( $p < 0.034-0.047$ ).



**Figure 1.** Number of errors while responding to image and verbal stimuli in a cognitive test

Note: a – statistically significant differences in the number of errors at different speeds of presentation of figures compared to 30 stimuli per minute; b – statistically significant differences in the number of errors at different speeds of presentation of words compared to 30 stimuli per minute; c – statistically significant differences in the number of errors at different speeds of presentation between figures and words.

Analysis of motor reaction time in the gol/nogo/gor task showed a decrease in the time of sensorimotor reaction with gradually increased rate of stimuli presentation (Figure 2). The motor reaction time while performing cognitive tasks ranged from  $267.4 \pm 24.7$ – $373.0 \pm 70.5$  ms for image stimuli and  $271.3 \pm 62.0$ – $580.3 \pm 78.8$  ms for verbal stimuli. The reaction time was the highest in tasks with a presentation of 30 stimuli per minute at  $373.0 \pm 70.5$  ms for images and  $580.3 \pm 78.8$  ms for verbal cues. Motor reaction time gradually decreased with increasing rate of stimuli presentation and achieved the highest values at rate of 120 signals per minute being  $267.4 \pm 24.7$  ms for image stimuli and  $271.3 \pm 62.0$  ms for verbal.

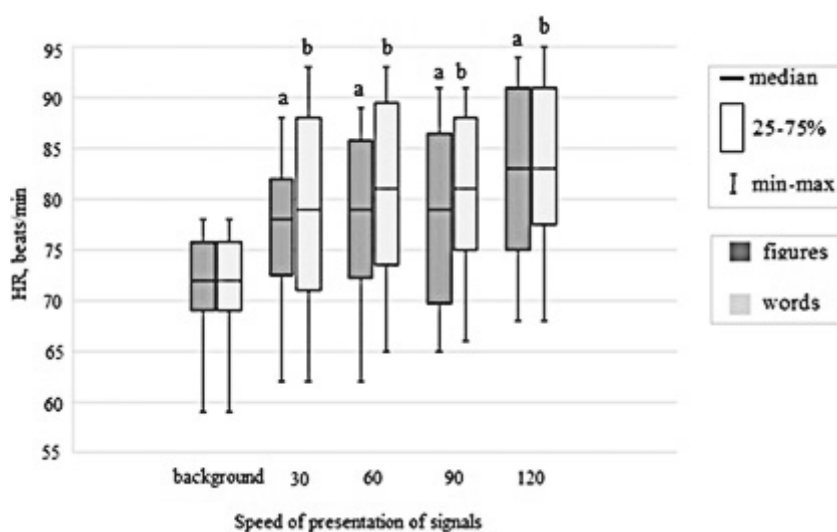


**Figure 2.** Reaction rate while responding to image and verbal stimuli in a cognitive test

Note: a – statistically significant differences between the processing speed of figures at different presentation rates compared to 30 stimuli per minute; b – statistically significant differences between the processing speed of words at different presentation rates compared to 30 stimuli per minute; c – statistically significant differences between the processing speeds at different presentation rates between figures and word tasks.

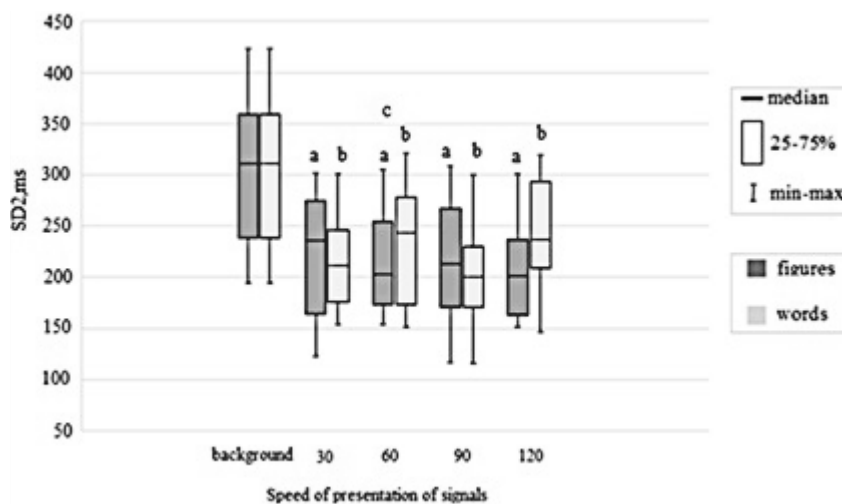
The results gol/nogo/gor task revealed statistically reliable differences between the reaction times to image and verbal stimuli. The reaction time for image stimuli in the tests at 30, 60, and 90 stimuli per minute was less than for verbal stimuli ( $p < 0.034$ – $0.047$ ). The reaction time for image and verbal stimuli at 120 signals per minute was the least and did not differ between image and verbal stimuli ( $p > 0.065$ ).

Based on CR results the activation of the ANS was dependent on the rate of stimulus presentation. The HRV analysis showed a gradual increase in HR ( $p < 0.01$ – $0.001$ ). In the task with a gradual increase in presentation rate from 30 to 60, 90, and 120 stimuli per minute, the indicators of S, SD2, and SD1 decreased ( $p < 0.047$ – $0.012$ ). Figures 3, 4 and 5 show the changes in HR and indicator dynamics of HRV analysis according to S, SD2 and SD1 characteristics. The lowest HR values of 72 [69; 75] bpm were found at rest; they gradually increased with increasing stimuli presentation rates of 30, 60, and 90 signals per minute and maximum HR values were achieved at 120 stimuli per minute at 83 [77; 89] bpm for image stimuli and 83 [78; 89] bpm for verbal stimuli. There were no reliable between factor differences in HR for verbal stimuli and image stimuli at rates of 30, 60, 90, and 120 stimuli per minute ( $p > 0.072$ ).



**Figure 3.** HR dynamics versus increased rate of image and verbal stimuli presenting  
 Note: a – statistically significant differences in HR versus background for figure stimuli; b – statistically significant differences in HR versus background for word stimuli.

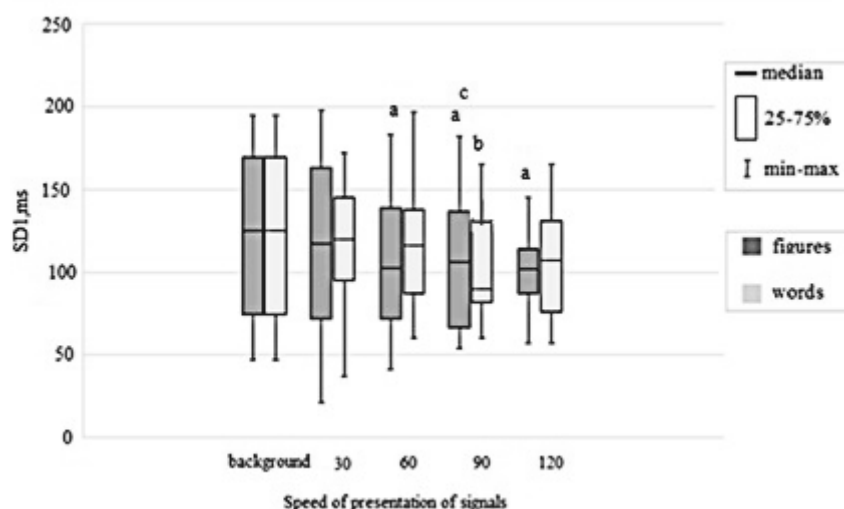
While performing a cognitive task with a gradually increased stimuli presentation rate from 30 to 60, 90 and 120 stimuli per minute, a deceleration of SD2 was observed ( $p < 0.01-0.001$ ) (Figure 4). The highest values for SD2 (236 [166; 272] ms) were found with a stimuli presentation rate of 30 per minute; this indicator decreased by 55-65% with increasing presentation rate. SD2 for verbal and image stimuli was similar; statistical differences were not found ( $p > 0.067-0.081$ ). The results showed that a gradual decrease of SD2 indicated the effect of increasing cognitive load on periodic oscillations in HR and a decrease in activation of the parasympathetic section of the ANS [16-18].



**Figure 4.** SD2 dynamics of correlation rhythmography for increased rates of presentation of image and verbal stimuli  
 Notes: a – statistically significant differences of SD2 at different figure processing speeds versus the background; b – statistically significant differences of SD2 at different word processing speeds versus the background; c – statistically significant differences between figure stimuli and word stimuli for SD2 at different processing speeds.

The analysis of aperiodic oscillations in CR (Figure 5) during an increasing rate of stimuli presentation, both verbal and image, showed a gradual decrease of SD1 ( $p > 0.059$ ). The highest values for SD1 (117 [76; 160] ms) were observed at 30 stimuli per minute and at higher presentation rates of 60 and 90 stimuli per minute the amplitude of aperiodic oscillations for SD1 gradually decreased (10-25%) and reaching their lowest values of 102 [89; 113] ms for verbal stimuli and 107 [77; 127] ms for verbal stimuli at the 120 stimuli per minute rate. There were no statistically significant differences for amplitude of SD1 aperiodic oscillations while processing image and verbal information ( $p > 0.073$ ). The above results can be summarized as enhancing the effect of increasing

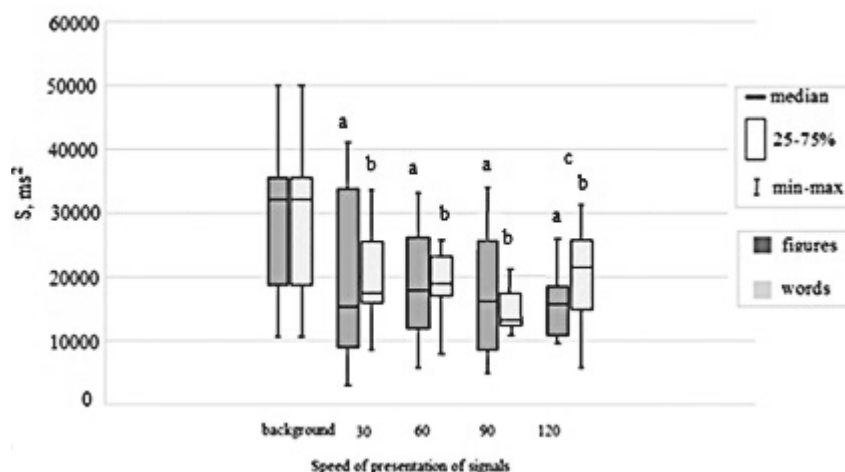
cognitive load on the sympathetic part of ANS. The gradual decrease in amplitude of SD1 aperiodic oscillations reflects the decrease in activation of the sympathetic division of the ANS [6, 17, 18].



**Figure 5.** SD1 dynamics of correlation rhythmography for increasing rates of image and verbal stimuli presentation

Notes: a – statistically significant differences of SD1 at different speeds of figure processing versus background; b – statistically significant differences of SD1 at different speeds of word processing versus background; c – statistically significant differences between figure stimuli and word stimuli for SD1 at different processing speeds.

The increase in the rate of processing cognitive information in go/nogo/gor task was accompanied by a decrease in scattergram area, S (Figure 6). The highest scattergram area values were found at a rate of 30 stimuli per minute with 17,530 [16420; 23743] ms<sup>2</sup> for verbal stimuli. With the increased presentation rate of 60 and 90 stimuli per minute, the area on the scattergram, reflecting regulation, decreased by 30% and 40% and reached the lowest value of 13,249 [12928; 14059] ms<sup>2</sup> at 90 per minute for the verbal stimuli and 15,872 [11949; 18365] ms<sup>2</sup> at 120 per minute for image stimuli. When performing test tasks with a presentation rate of 30 and 60 per minute, the area of the scattergram showed no statistical differences between verbal and image stimuli ( $p > 0.072$ ). With the increased presentation rate of 90 stimuli per minute, the scattergram area became statistically higher for image versus verbal stimuli ( $p < 0.013-0.025$ ). With the presentation rate of 120 stimuli per minute, the area, representing autonomic regulation of heart rate, was reliably higher for verbal stimuli than image stimuli ( $p < 0.024$ ). The decrease in the S indicator while performing the cognitive task of processing information with a gradual increase in presentation rate confirms increased stress on the HR regulatory systems, also reflected by decreased periodic and aperiodic oscillations in cardio intervals. This suggests that the gradual decrease in scattergram area is an effect of increased cognitive load which decreased the activation of ANS, both its parasympathetic and sympathetic links [16, 17].



**Figure 6.** S dynamics of correlation rhythmography for increasing rates of presenting image and verbal stimuli

Notes: a – statistically significant differences of S at different presentation speeds of figures versus background; b – statistically significant differences of S at different presentation speeds of words; c – statistically significant differences between figure stimuli and word stimuli for S at different presentation speeds.

Thus, functional interaction of the cognitive and autonomic nervous systems, the success and speed of processing information, depends on the rate of presentation and modality of cognitive stimuli.

## Discussion

The analysis of the results shows that functional interaction of cognitive and autonomic nervous systems during processing of information in the go/nogo/go task depends on the presentation rate of stimuli and their modality. The gradual increase in differentiation rates of image and verbal stimuli in the go/nogo/go task from 30 to 60 stimuli per minute was found to increase the activation and integration of cognitive functions and regulation mechanisms of ANS. One might think that the subjects, when differentiating the signals in the go/nogo/go task with an increased rate of stimulus presentation from 30 to 60 per minute, have a subconscious ability to increase the speed of motor reactions with a small number of errors. That the subjects only exhibited a few errors (3-5%) at this rate of stimulus presentation, shows they had time to perceive, analyze and respond to the information load correctly. Processing information at this rate is likely within the functional speed constraints of the nervous system, which is inherent to each subject [11, 19], corresponding the optimal ratio between the rate of signal presentation, the speed of motor reaction and the number of errors. This indicates that in the cerebral cortex, there is neurointegration which is characterized by information synthesis, a focused interaction of a large number of neurons (networks/columns) that discharge in the same rhythm [20]. We can assume that in neuronal networks, there are optimal processing pathways of interaction for image and verbal signals. When presented with stimuli at a rate of 90 per minute for verbal and 120 per minute for images, most subjects could not correctly process the information because the rate of the presented stimuli exceeded the functionality of the nervous system [19, 20]. Each subsequent stimulus entering the central nervous system for differentiation was met with system already in a state of excitation from the previous stimulus. Under conditions of rapidly presented stimuli, the subjects had insufficient time to analyze the information and prepare to perceive a new signal, which led to the high psychophysiological stress. Despite the maximum rate of motor reactions and the mobilization of psychophysiological functions, the subjects made a great number of errors (21-32%); this measure demonstrates a significant decrease in the quality of task performance and a predominance of inhibitory processes [10, 19, 20, 21, 22]. Tasks exceeding the optimum rate of presenting information result in dissonance in the cognitive systems of the brain and may contribute to the development of fatigue and pathological conditions.

Our results confirm that the success of processing information and the speed of reaction to stimuli depends on the modality of signals. The number of errors was statistically higher and the reaction speed was lower during the processing of verbal information versus image stimuli, indicating the involvement of various neurophysiological mechanisms. According to the literature, the speed of performing a cognitive task depends on the type, form, signal modality and complexity of the task [7, 10, 19, 20, 21]. In this cognitive test, we used visual images (geometric shapes) and verbal stimuli (word meanings) which are assigned to different signal

systems and afferent channels [23, 24]. The subjects had to react as quickly as possible by pressing the button of the remote with the left or right hand upon the appearance, according to the instruction of the stimulus modality, of the shape of the figure or the meaning of the word. The cognitive task performance of gol/nogo/gor using geometric figures was, on average, 64% higher than using words ( $p < 0.042$ ), and the success rate using image stimuli was 13% higher than verbal stimuli ( $p < 0.034$ ). We assume that processing verbal information in the gol/nogo/gor task, includes the ability to determine the semantic meaning of words, switching attention, mapping stimuli in memory, compiling an action program, a left (gol) or right (gor) quick reaction, or restraining from a motor reaction (nogo) [20, 22]. Therefore, the speed of performing a cognitive task in the three-stimulus paradigm gol/nogo/gor is faster for image stimuli than for verbal stimuli ( $p < 0.023-0.043$ ). The greater success in task performance using image stimuli can be explained with the hypothesis that, at the stage of primary selection of signal modality, two neuron systems are involved: the magno-pathway, being sensitive to stimuli with temporal characteristics, and the parvo-pathway, sensitive to information with spatial characteristics [23, 24]. The differences in the number of errors and the speed of reaction to image and verbal stimuli entering the brain are probably caused by different speeds of information transmission through magno- and parvo-pathways. Image signals are likely transmitted along the axons of parvocellular and magnocellular systems with a higher speed than verbal stimuli [23, 24].

Differences in image and verbal stimuli analysis can be further explained when considered in terms of Pavlovian signaling systems. Image processing occurs in the first signaling system characterized by flexibility, ease of switching attention and high sensorimotor integration and automation [7, 12]. In contrast, verbal functions are associated with the operation of the second signaling system, which is more corticalized in the frontal areas, less stable and has limited neurophysiological resource [7, 25].

It should be noted that an increase in the presentation rate of cognitive information was accompanied by a gradual increase in the number of errors, a significant increase in HR, a decrease in reaction time, and a decrease in S, SD2, and SD1. An increase in the presentation rate of cognitive image and verbal information in the gol/nogo/gor task gradually enhanced the activity of heart rate regulation mechanisms. It was found that the faster the signals were presented, the higher the observed activity of HR regulation mechanisms. Low values of HR and high values of CR S, SD2 and SD1 were registered in the background and at rate of 30-60 stimuli per minute. At a rate of 90-120 stimuli per minute, the indicators of S, SD2 and SD1 decreased to their lowest values, and HR achieved a maximum level. It is noteworthy that an increase in the activity of the ANS in response to the gradual increase in the rate of information presentation occurred not by activating the sympathetic division but by more pronounced changes in its parasympathetic division. This was supported by the fact that, in response to an increase in information presentation rate, the changes of SD1 were less pronounced than for SD2, decreasing by 12-15% and 50-60%, respectively. The observed asymmetry in HRV reflects different contribution of periodic and aperiodic oscillations in HR to the general variability. The results of our investigation and the concept of vagal asymmetry of HR [16, 26] allow for the assumption that the vagal complex was involved in removing the inhibitory effect of the sinoatrial node. Most likely, the cardiovascular system function increases when processing information with a gradually increasing rate of presenting information due to an increase in the activity of the vagus nerve of the ANS removing the inhibitory effect of the sinoatrial node, thereby preserving the body's metabolic resources without involving more significant metabolic costs [16, 26]. Therefore, the increase in HR in cognitive tasks with increased rate of stimuli presentation primarily occurred due to more pronounced changes in the parasympathetic division of the ANS.

Other explanations of asymmetry in HR regulation, when performing tasks with gradual increased presentation rates of stimuli of different modalities, include differential sensitivity of baroreflex to the increase and decrease in blood pressure [16], the mechanical mechanism of asymmetry of respiratory sinus arrhythmia [26, 27], and other mechanisms of asymmetry: changes in action potential, concentration of potassium and sodium in the sinoatrial node, and the concentration of acetylcholine and adrenaline or other mediators [28].

The gradual increase in the differentiation rate in the gol/nogo/gor task for verbal stimuli from 30 to 60 per minute and for image stimuli from 30 to 90 stimuli per minute was found to result in increased activation of regulatory mechanisms of the ANS, their coordinated interaction and enhanced integrative processes. Differentiation of positive and inhibitory stimuli at the latter rates was accompanied by a moderate (5-9%) number of errors, a high rate of motor reaction, and the coordinated increase in activation processes of the ANS, with parasympathetic activation predominating [15].

An increase in the rate of presented information in the gol/nogo/gor task to 90 per minute for verbal stimuli and to 120 signals per minute for image stimuli led to weakened cognitive interaction and decreased activation of the ANS and is characterized by multidirectional changes in HR regulation. According to the CR results, an increase in HR in response to significant increase in the rate of information presentation was accompanied by



a decrease in the scattergram area and ANS regulation, the occurrence of asymmetry in periodic and aperiodic oscillations of HRV, and an increase in the rate of motor reactions, which coincides with the significant number of false reactions indicating the occurrence of interference [12], cognitive dissonance [29], and vegetative cognitive disintegration [10]. The imbalanced ANS resulting from reduced activation in parasympathetic and sympathetic divisions may indicate the predominant protective type of regulation [15].

This research shows that the interaction of neurocognitive brain systems associated with perception, analysis and motor functions, as well as the activation of autonomic mechanisms of heart rate regulation while processing information depend on the rate of stimulus presentation and modality. Integrative functions of neurocognitive brain systems and the ANS are most pronounced when information is presented at a rate of 30 and 60 stimuli per minute for verbal cues and 60 and 90 per minute for images. Our results confirm that there is not only information integration but vegetative and metabolic synthesis under such conditions [10]. We should emphasize that information metabolism in the interaction of neurocognitive brain systems and their operational components do not only play an energetic role reflected in conservative changes of the ANS. The subjects cannot process information successfully and create some operational order from chaos at high rate of presenting information; there is a cognitive dissonance [29] and vegetative cognitive interference [12].

## Conclusions

Functional interaction of cognitive and autonomic nervous systems while processing information in the go/nogo/gor task was dependent on the rate of stimulus presentation and modality. The interaction of cognitive and autonomic systems increased with increased rate of stimulus presentation up to 60 per minute for verbal stimuli and up to 90 per minute for images. When the differentiation rate increased to 120 per minute for image stimuli and 90 per minute for verbal cues, vegetative cognitive interference and cognitive dissonance occurred.

The success of processing information and the rate of motor reaction depended on signal modality. The number of mistakes and the time of motor reaction were statistically higher while processing verbal information compared to image cues. The motor reaction times to both image and verbal stimuli were highest with the differentiating rate of 120 stimuli per minute.

The gradually increased rate of for differentiating verbal stimuli, from 30 to 60 per minute, and for image stimuli, from 30 to 90 per minute, caused an increase in the activation of regulatory mechanisms of ANS and in the coordinated interaction of sympathetic and parasympathetic links and enhanced the integrated processes.

In the go/nogo/gor task, increasing the rate of information presentation to 90 verbal stimuli per minute and 120 image stimuli per minute weakened interactions between cognitive processes and decreased the activation processes of ANS characterized by multidirectional changes in the HR regulation. According to CR results, an increase in the HR in response to a significant increase in the information presentation rate was accompanied by a decrease in scattergram area and the occurrence of asymmetry for the periodic and aperiodic oscillations in HRV. An increase in the rate of motor reactions coincided with a significant increase in the number of false reactions, indicating the occurrence of cognitive dissonance and vegetative cognitive interference.

These research results can be used for prognostic evaluation of human cognitive activity in conditions of complex information loads, in the detection of hypofrontality, in hyperactive and deviant children with attention deficits, as well as in neurodegenerative diseases.

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## CHANGES IN ELECTROENCEPHALOGRAM (EEG) POWER DURING SUBDOMINANT (LEFT) HAND FINGER MOVEMENTS IN FEMALES WITH DIFFERENT ALPHA RHYTHM CHARACTERISTICS

### ZMIANY MOCY ELEKTROENCEFALOGRAMU W TRAKCIE WYKONYWANIA RUCHÓW PALCAMI MNIEJ DOMINUJĄCEJ (LEWEJ) RĘKI U KOBIET Z RÓŻNYMI ZMIENNYMI RYTMU ALFA

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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  
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#### Summary

**Background.** This study investigates the indicators of electroencephalographic (EEG) oscillatory activity and processes that are correlated with manual movements executed by the subdominant (left) hand in women with a high or a low individual  $\alpha$ -frequency.

**Material and methods.** 113 healthy right-handed women from the ages of 19 to 21 were divided randomly into two experimental groups with high ( $n = 59$ ,  $\alpha F > 10.25$  Hz) and low ( $n = 54$ ,  $\alpha F \leq 10.25$  Hz) individual EEG  $\alpha$ -frequency ( $\alpha F$ ). EEG power during flexion or extension of the subdominant hand fingers was evaluated.

**Results.** Manual movements performed by women, especially those exhibiting high modal  $\alpha$ -frequency, were accompanied by reduced  $\alpha$  and  $\beta$  power in mid and posterior cortical areas. These changes occurred in combination with a local power increase in  $\alpha 1$ -oscillations in the frontal leads. A local increase of  $\alpha 3$ -activity in the frontal cortex areas was also revealed in women with low  $\alpha F$ . In this same group of women, generalized increases in EEG power of  $\theta$ -,  $\beta$ - and  $\gamma$ -oscillations were observed in the cortex.

**Conclusions.** These results revealed a greater redundancy of brain processes in women with low  $\alpha F$  power compared to women with high  $\alpha$ -frequency.

**Keywords:** brain, motor activity, attention, alpha rhythm

#### Streszczenie

**Wprowadzenie.** Niniejsza praca poświęcona jest badaniu wskaźników elektroencefalograficznej aktywności oscylacyjnej i procesów, które są skorelowane z ruchami manualnymi, u kobiet z wysoką lub niską indywidualną częstotliwością  $\alpha$  określoną podczas ruchów manualnych wykonywanych przez mniej dominującą (lewą) rękę.

**Materiał i metody.** 113 zdrowych praworęcznych kobiet w wieku od 19 do 21 lat zostało podzielonych na dwie grupy eksperymentalne z wysoką ( $n = 59$ ,  $\alpha F \geq 10,254$  Hz) i niską ( $n = 54$ ,  $\alpha F \leq 10,25$  Hz) indywidualną wartością częstotliwości EEG  $\alpha$  ( $\alpha F$ ). U tych kobiet oceniona została aktywność EEG podczas zginania lub prostowania mniej dominujących palców.

**Wyniki.** Ruchom manualnym wykonywanym przez kobiety, zwłaszcza o wysokiej modalnej częstotliwości  $\alpha$ , towarzyszyło pewne zmniejszenie mocy fal EEG  $\alpha$  i  $\beta$  w środkowych i tylnych obszarach kory mózgowej. Takie zmiany połączono z lokalnym wzrostem mocy w oscylacjach  $\alpha 1$  w przednich przewodach. Lokalny wzrost aktywności  $\alpha 3$  w obszarach kory czołowej został również ujawniony u kobiet z niską wartością  $\alpha F$ . Pewne uogólnione zwiększenie mocy fal EEG oscylacji  $\theta$ ,  $\beta$  i  $\gamma$  zaobserwowano w korze kobiet należących do tej grupy.

**Wnioski.** Wyniki ujawniają większą nadmiarowość procesów mózgowych u kobiet z małą mocą fal  $\alpha F$  w porównaniu z kobietami z wysoką częstotliwością  $\alpha$ .

**Słowa kluczowe:** mózg, aktywność motoryczna, uwaga, rytm alfa

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## Introduction

Movements carried out by any of the upper limbs (manual movements, MM) are the basis of the manipulator motor activities primarily used in human daily life, education and work. The qualitative characteristics of their realization become critical in the context of the enrichment and congestion of the human information environment and the total computerization that is taking place today. Therefore, the scientific community is increasingly interested in the individual characteristics of brain processes underlying motor programming. According to recent studies [1-6], MMs are clearly associated with significant alterations in cerebral cortex activities which program and order appropriate motor formations. However, the specific details of these cerebral processes have not been fully elucidated. It is presumed that defined brain process indicators can be correlated with MM activities.

According to some literary information [7-9] the individual amplitude-frequency characteristics of the EEG  $\alpha$ -rhythm, in particular the modal frequency of this rhythm, can be highly informative for determining a number of human psychophysiological functions. Individuals with different  $\alpha$ -rhythm characteristics use different behavioral strategies, mechanisms of perception, and information processing [10]. Bazanova [11] found out that the most optimal coordination of the processes of motion organization correlated linearly with the power of the individual  $\alpha$ -activity EEG and reversely with the tension of the muscles of the forehead. Kristeva et al. [12] noted that an increment of the EEG  $\alpha$ -amplitude and a decrease of the integral power of the facial muscle electromyogram can be considered as an increase of the ability to self-control movement. It should be emphasized that the modal  $\alpha$ -frequency of EEG is often considered [13-18] as a sign that reflects important innate features of the structural organization of thalamic and cortical neurons, in particular, the features of ionic processes in these cells [19-21].

Taking into account the exceptional importance of the results obtained by various scientists, we have to note some insufficiency of such information to fully understand how the modal frequency of the EEG  $\alpha$ -rhythm can be related to the control of the activity of the distal muscles of the hand. Previous studies [20, 21, 23] showed the brain processes' features during execution of manual movements in men with different modal frequency of EEG alpha rhythm. According to the available results, examinees with initially high EEG  $\alpha$ -rhythm modal frequency had higher levels of selective attention and more local changes in electrical activity of the cerebral cortex during the regulation of MM. People with a low  $\alpha$ -frequency were characterized by less specific and differentiated cortical activation processes [20, 21, 23]. The functional differences previously identified in men during their performance of MMs by the subdominant hand [22] may reflect a generally relatively lower tone of cortical activation in men with a low I $\alpha$ F that can be specifically compensated for by increased "intensity" and an observed redundancy of brain processes. Despite the significant achievements made in this field, the literature remains sparse regarding the features of brain processes in women during MMs executed with the help of the subdominant hand.

The purpose of this study is to assess spectral-frequencies of electrical activity in the cerebral cortex during subdominant (left) hand movements performed by women with different characteristics of alpha-activity. This will contribute to the currently sparse data on objective indicators of brain activity directly associated with programming of female MM.

## Material and methods

### *Participants*

136 female volunteers from the ages of 19 to 21 participated in our study. Every examinee gave written consent. Biomedical ethics rules in accordance with the Helsinki Declaration of the World Medical Association on the Ethical Principles of Scientific and Medical Research involving Human Subjects were followed. In keeping with the medical advisory conclusions every examinee was healthy and had normal hearing.

### *Procedure*

### *Psychophysiological examination*

The nature of responses in the survey and execution of the motor and psychoacoustic tests were determined. The individual profiles of the manual motor asymmetry as well as auditory asymmetry were counted for each woman (K skew) (Formula 1) [20-24].

**Formula 1.**

$$K_{\text{skew}} = \frac{\Sigma_{\text{right}} - \Sigma_{\text{left}}}{\Sigma_{\text{right}} + \Sigma_{\text{left}}} \times 100\%,$$

where

$\Sigma_{\text{right}}$  – the number of tasks where the right hand (right ear) is dominating during their execution,

$\Sigma_{\text{left}}$  – the number of tasks under which the left hand (left ear) is dominant.

Further studies involved dextral examinees whose coefficients of manual and auditory asymmetries were positive and were above 50% [21, 22]. There was a total of 113 female subjects.

All examinations were performed in the morning. The profile of the asymmetry was evaluated 30 minutes before the EEG recording registration. This prevented it from influencing the experiment, particularly, the EEG results [21, 22].

*EEG testing procedures*

The examinees were in a quiescent state with their eyes closed and in a reclining position with their limbs relaxed and not crossed during the EEG testing [22]. The experiment was carried out in a room which was sound-proof and light-proof. The entire experimental procedure consistently included the following steps for each examinee:

Step 1. An EEG recording for functional balance (background);

Step 2. An EEG recording while performing the finger movements of the left (subdominant) hand.

Each step lasted 40 s. To exclude edge effects, the EEG recording registration was initiated 15 s after the beginning and stopped 5 s before its completion [22, 23].

All instructions were reported to the examinees before the test. Finger movements were consisted of flexion or extension. Each finger was flexed or extended by the examinees in response to a sound [20-23]. The electronic version of the drum battle (Finale 2006 software) was used for this purpose. Binaural stimuli were produced by four speakers placed in different corners of the room at a distance of 1.2 m from the examinee's right or left ear. The stimulus duration was 130 ms; the playback sound volume did not exceed 55-60 dB at the speakers, measured by a sound level meter (DE-3301, DER EE, Taiwan; certificate # 025-2009, valid until 21.12.2014). Additionally, the sound level was individually regulated for each examinee to achieve functionally necessary volumes. The rate of the sound stimuli delivery was 2 Hz.

*Registration and primary analysis of EEG data*

Active electrodes were placed in accordance with the International 10-20 system at nineteen points on the scalp during the monopolar EEG (Neurocom EEG System, Xai-Medica, Ukraine; Certificate # 6038/2007, valid until 18.04.2014) recording, using ear electrodes as a reference. The Fourier analysis era was 4 s with a 50% overlap. Duration of sample was 40 s. ICA-procedure analysis was used for the rejection of EEG anomalies [20-23].

The power ( $\mu V^2$ ) of brain electrical activity in the  $\theta$ -,  $\alpha$ -,  $\beta$ - and  $\gamma$ -frequency intervals were also evaluated. Taking into consideration the functional heterogeneity of different sub-bands of the EEG  $\alpha$ - and  $\beta$ -rhythms, the changes in power for each were considered [23].

The maximum frequency peak of the  $\alpha$ -rhythm was determined for each woman in each EEG lead at a functional balance [24]. Its value was averaged for all leads and the values were considered to be the examinee's individual  $\alpha$ -frequency (the individual alpha-frequency of EEG, I $\alpha$ F and Hz). The I $\alpha$ F median was also determined and calculated for the entire subject group. Thus, subjects were grouped according to individual values relative to the median – a high I $\alpha$ F group and low I $\alpha$ F group [20-23].

The EEG frequency interval limits were determined individually, relying on the value of the examinee's I $\alpha$ F. The following algorithm [20, 21, 22, 23, 25, 26] was used and the upper limit of the  $\alpha$ 3-subband was set to the right side of the I $\alpha$ F in increments of 2 Hz. It corresponded to the lower limit of the  $\beta$ 1-band. The upper limit of the  $\beta$ 1-subband was defined according to standard concepts as 25 Hz. The lower limit of the  $\alpha$ 2-band was determined in steps of 2 Hz to the left of the peak and the  $\alpha$ 1-band in 4-Hz steps, as well as  $\theta$ -frequencies in 6 Hz steps. Limits of  $\beta$ 2- and  $\gamma$ -bands were recognized as is standard, specifically, 26-35 Hz and 36-45 Hz [21, 22, 23, 25, 26].

The resulting individual values of the power of EEG oscillations within the selected groups of women were averaged for each lead.

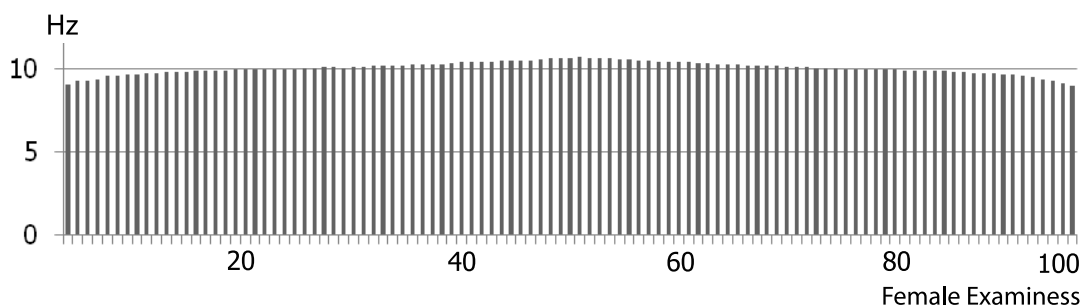
### Statistical analyses

A statistical data analysis was performed by using the Statistica 6.0 software package (Stat-Soft, 2001). Any normalcy of the data distribution in the examinees' groups was evaluated by the Shapiro-Wilk test (indicator SW). Test results showed that all of the study's samples had a normal data distribution [20-23]. To estimate the significance of differences existing in the examinees' groups, the Student's t-test (index t) was used to assess for differences between testing steps both for independent equal samples and for dependent samples. Significant differences between female groups and between testing steps were considered statistically significant at  $p \leq 0.05$  and  $p \leq 0.01$ .

## Results and Discussion

### *The individual modal frequency evaluation of the $\alpha$ -EEG activity and individual limits of the frequency content of the EEG sub-range in female examinees*

The average value of the modal frequency of any  $\alpha$ -activity in samples of female examinees was  $10.25 \pm 0.03$  Hz (Figure 1) [21]. Since the individual  $\alpha$ -frequency value histogram in the female examinees differed from a normal distribution we calculated the conditional distribution of samples under the average mean of the modal frequency of  $\alpha$ -activity. We formed two groups – a group with high values for  $I\alpha F$  ( $n=59$ ,  $I\alpha F \geq 10.25$  Hz) and a group with low values for  $I\alpha F$  ( $n=54$ ,  $I\alpha F < 10.25$  Hz).

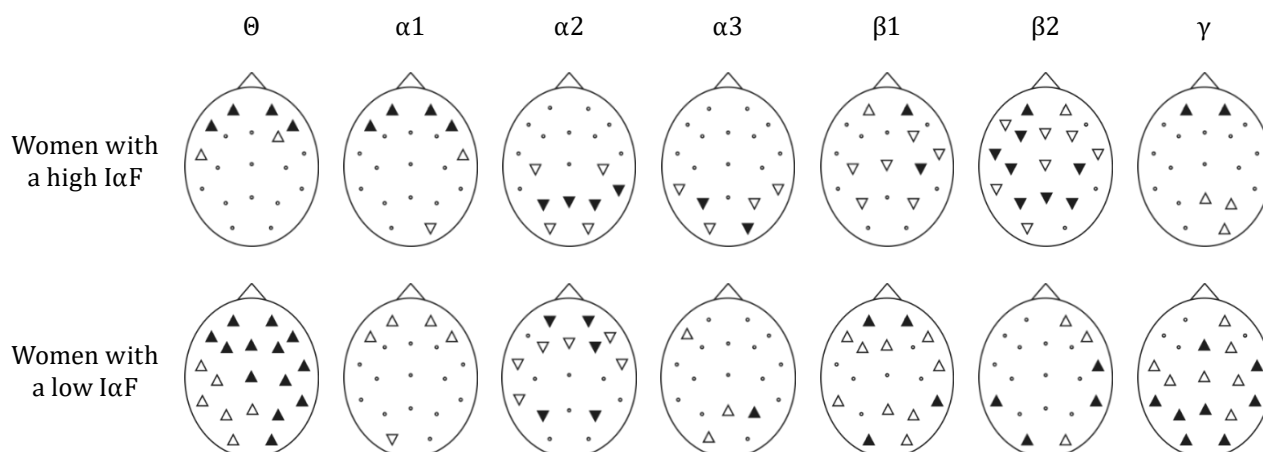


**Figure 1.** Histogram of  $\alpha$ -frequency mode in female examinees

Note: Vertical columns represent individual values of the EEG  $\alpha$ -frequency mode in samples of female examinees.

### *Indicators of EEG power during manual movements of the subdominant hand in women with different $\alpha$ -rhythm modal frequency*

Women with high  $I\alpha F$  showed a power increase for EEG  $\alpha 1$ - $\theta$ -oscillations in the frontal areas ( $p \leq 0.01$ ). According to results from Klimesh [25], Watson and Buzsáki [27] and Avery et al. [28], such changes may reflect priming in human memory, allowing for maintenance of focus on sensory and motor information as well as higher selective attention. Intense  $\gamma$ -activity under these conditions was found in the ventralis frontal ( $p \leq 0.05$ ) and parietal-occipital areas ( $p \leq 0.01$ ), while  $\beta$ -activity was only found in the ventralis frontal areas (Figure 2).



**Figure 2.** Topo maps of changes in EEG power fluctuations through the execution of manual movements by female groups  
Note:

△▲/▽▼ – increase (triangle up) /decrease (triangle down) in EEG power fluctuations through the execution of manual movements compared to power in a quiescent state,  $p \leq 0.05$  (white triangle),  $p \leq 0.01$  (black triangle).

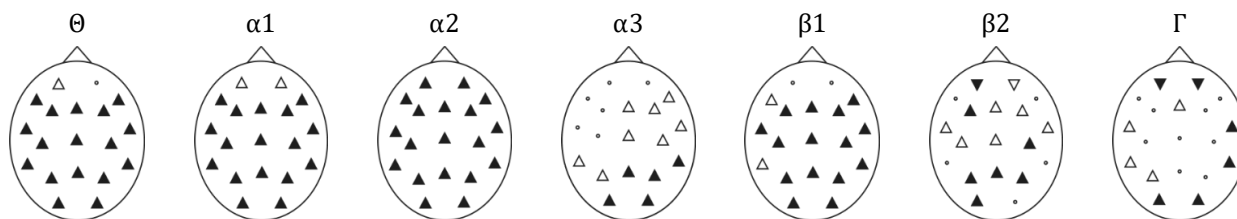
Such a local synchronization characteristics of  $\gamma$ -activity in the cortex are considered by Watson and Buzsáki [27] to be criterion for efficiency in cortical interactions of the neural detector networks encoding any sensory information. However, decreased power of EEG  $\alpha$ - and  $\beta$ -waves defined by our data, particularly in the posterior cortical areas (with  $p \leq 0.05$  to  $p \leq 0.01$ ), may prove that some activity increased in cortical areas as previously investigated by Klimesh [25], Watson and Buzsáki [27] and Tebenova [29]. Identification of activation processes in cortical structures may reveal their direct participation in the processes of sensory analysis, motor programming and integration of sensory and motor information.

Higher power rates of  $\alpha$ 1-oscillations in the frontal areas ( $p \leq 0.05$ ) were particular to women with low  $I\alpha F$ . The observation of increasing capacity measures for  $\theta$ -,  $\alpha$ 3-,  $\beta$ - and  $\gamma$ -waves were more generalized (with  $p \leq 0.05$  to  $p \leq 0.01$ ) (Figure 2). Typical power increases of  $\alpha$ 3-waves in the frontal area ( $r \leq 0.05$ ) found in women with a low  $I\alpha F$  is suggestive of an additional selective inhibition mechanism of the sensory input [1, 30] during motor programming. From a functional point of view, these results allow for the elucidation of a pattern – an EEG-correlate of the process comparing the afferent information flows with the new parameters from muscle activities, characterized by the top-down effects of the frontal cortex, with the previous motor program. According to Ioffe [1], in the course of MMs performed with the subdominant hand, such descending inhibitory influences generally prevent motor programming. Kostandov et al. [30] reported they may indicate that processes of plasticity reduced motor programming in our experiment if they were performed by women with low  $I\alpha F$ , particularly with their unresponsive hand, and a need to observe the specified tempo. Some  $\beta$ - and  $\gamma$ -activity intensively increased in the cortex was nonspecific.

Women with low  $I\alpha F$  particularly showed a decrease in power rates for cortical EEG  $\alpha$ 1- and  $\alpha$ 2-frequency oscillations contrary to such changes in the electrogenesis. These  $\alpha$ 1-activity changes occurred locally in the right occipital lobe ( $p \leq 0.05$ ) and  $\alpha$ 2-fluctuations were more common in the cortex (with  $p \leq 0.05$  to  $p \leq 0.01$ ). Similar to cases in women with high  $I\alpha F$ , this pattern may be associated with the activation of the cortical areas involved in the analysis of sensory-motor information [25, 27, 29].

### Intergroup differences

Any execution of MM by means of the subdominant (left) hand was accompanied by higher EEG power in the cerebral cortex of women with low  $I\alpha F$  versus women with high  $\alpha$ -frequency ( $p \leq 0.05$  to  $p \leq 0.01$ ) (Figure 3). According to Kostandov et al. [30] such differences may indicate a predominance of non-specific cortical activities.



**Figure 3.** Intergroup differences in EEG power fluctuations through the execution of manual movements

Note:

△▲/▽▼ higher/lower power in women with a low IαF in comparison with women with a high IαF,  $p \leq 0.05$  (white triangle),  $p \leq 0.001$  (black triangle).

## Conclusions

The subdominant hand finger flexions and extensions in response to sensory signals, especially performed in women with high modal  $\alpha$ -frequency, were accompanied with an electrogenesis power reduction in the cortical areas responsible for sensory analysis, motor programming and integration of sensory and motor information. Such changes were combined with a local power increase of  $\alpha$ 1-oscillations in the frontal leads, primarily due to the strengthening of selective attention and memory processes. Women with low IαF were characterized by an increase in local  $\alpha$ 3-activity in the frontal areas of the cortex, which may reflect additional inhibition of sensory input during the motor programming. The increase of power generally observed in the EEG  $\theta$ - and  $\beta$ -oscillations in the cortex of women with low IαF provides clear evidence of the role of non-specific mechanisms of activation. Women with low IαF power had higher EEG frequency components and a relatively greater redundancy of brain processes compared to the group of women with high  $\alpha$ -frequency.

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## WSKAZÓWKI DLA AUTORÓW/REGULAMIN PUBLIKOWANIA - *Czasopismo Health Problems of Civilization*

### Cele i zakres

„Health Problems of Civilization” to czasopismo naukowe, które jest kontynuacją czasopisma „Human and Health” (ISSN 2082-7288). Czasopismo to wydawane jest wyłącznie w języku angielskim i dotyczy różnych grup tematycznych, takich jak: biomedyczne aspekty zdrowia, współczesne choroby, aktywność fizyczna, otyłość, zachowania prozdrowotne. Wśród autorów poszczególnych artykułów znajdują się uznani specjaliści w zakresie nauk medycznych oraz nauk o kulturze fizycznej.

Misją czasopisma jest promowanie wiedzy w zakresie różnych problemów zdrowotnych człowieka w świetle szybko postępujących zmian życia współczesnego, spowodowanego rozwojem cywilizacyjnym, industrializacją, urbanizacją oraz zmianami środowiska naturalnego. Artykuły należy przysyłać do Redakcji czasopisma za pomocą <http://www.editorialsystem.com/hpc/login/>.

Przed rozpoczęciem procesu przygotowania pracy do publikacji autor/ autorzy przesłanych artykułów zobowiązani są do wniesienia bezzwrotnej opłaty w wysokości 150 zł brutto. W przypadku przesłania do Redakcji artykułu w j. polskim, Redakcja nie ponosi kosztów tłumaczenia artykułu na język angielski. Opłata za tłumaczenie wynosi 45 zł brutto za stronę obliczeniową, tj. 1800 znaków ze spacjami. W przypadku gdy Redakcja otrzyma artykuł w j. angielskim i będzie wymagał on korekty językowej (po weryfikacji Redaktora Językowego), Redakcja prześle artykuł do korekty; koszt korekty pokrywany jest przez autorów. Opłata za korektę językową wynosi 30 zł brutto za stronę obliczeniową, tj. 1800 znaków ze spacjami. Tłumaczenie/weryfikacja będzie wykonywane przez aktualnie współpracującego z Redakcją tłumacza, artykuł zostanie przekazany do tłumaczenia/korekty za pośrednictwem Redakcji po pozytywnej recenzji i ostatecznym zaakceptowaniu artykułu do publikacji. Po otrzymaniu od Redakcji informacji o zaakceptowaniu artykułu i ostatecznej kwocie tłumaczenia/korekty, Autor zobowiązany jest do przelania podanej kwoty na konto Państwowej Szkoły Wyższej im. Papieża Jana Pawła II w Białej Podlaskiej: Santander Bank Polska S.A., 45 1500 1331 1213 3001 7949 0000. Obowiązkiem Autora jest również dostarczenie do Redakcji potwierdzenia dokonania wpłaty (np. w formie elektronicznej na adres mailowy).

### Wymagania etyczne

W przypadku opisywania eksperymentów przeprowadzanych na ludziach autorzy wskazują, czy zastosowane procedury były zgodne z Deklaracją Helsińską z roku 1975, uaktualnioną w 2000 roku (dotyczącą zasad etyki dla społeczności medycznej oraz zakazu ujawniania nazwiska pacjenta, inicjałów lub numeru ewidencyjnego szpitala) oraz ze standardami etycznymi komisji ds. eksperymentów na ludziach (instytucjonalnej i państwowej). Autorzy prezentujący studia przypadków są zobowiązani do nieujawniania danych osobowych pacjentów. Odnosnie do zdjęć, w przypadku wątpliwości, czy dane zdjęcie odpowiednio zabezpiecza anonimowość pacjenta, wymagana jest zgoda pacjenta na publikację danego zdjęcia.

### Konflikt interesów

Oczekujemy od autorów opisanego źródła finansowania badań, roli potencjalnego sponsora w planowaniu, wykonywaniu i analizie badań oraz wpływu, jaki organizacja finansująca mogła mieć na zawartość artykułu. Pozostałe relacje (takie jak zatrudnienie, konsultacje, posiadanie akcji, honorarium, płatne zaświadczenia eksperckie), które mogą być potencjalnie źródłami konfliktu interesów w związku z dostarczonym artykułem, należy ujawnić.

### Ghostwriting, guest authorship i zasady dotyczące plagiatu

„Health Problems of Civilization” stosuje procedury, które zapobiegają wystąpieniu zjawisk „ghostwriting”, „guest authorship” oraz plagiatu. Każda praca zgłoszona do czasopisma jest sprawdzana za pomocą programu antyplagiatowego.

### Przygotowanie manuskryptów

Artykuł należy przygotować w j. angielskim; manuskrypt powinien być komunikatywny, przejrzysty i spójny, a także utrzymywać klasyczny wygląd edycyjny.

### Wygląd pracy

Teksty przesłanych artykułów nie powinny przekraczać:

- w oryginalnych artykułach naukowych i artykułach przeglądowych, 4400 słów, łącznie z tabelami i bibliografią – ok. 20 stron, napisanych komputerowo, z podwójnym odstępem, z czcionką 11 pkt i 30 pozycjami literatury,
- 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 uznania,
- 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).

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