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The effects of selected lifestyle components on the risk of developing dynapenia in women – a pilot study

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Abstract: Aging processes in a body inevitably lead to changes which may decrease the quality of life of the elderly. Dynapenia is a phenomenon which is still not well known and needs to be studied in the population. The aim of the research was to determine the effects of lifestyle on the risk of developing dynapenia in post-menopausal women. The study included 46 females aged 71.4 ±5.6 living in the town of Wysokie Mazowieckie. Basic body dimensions and body composition elements were assessed with the use of anthropometry and bioelectrical impedance analysis (BIA). A direct interview method with the use of the modified Sedentary Behavior Questionnaire (SBQ) was applied. In order to assess the prevalence of dynapenia, handgrip strength was measured with the use of hydraulic dynamometer. Physical activity was assessed with the use of a pedometer. The respondents' nutrition was examined in an interview concerning their diet from the 24 hours preceding the examination according to the methodology of Food and Nutrition Institute (FNI). The intake of energy and nutritional elements in a diet was calculated with using DIETA 5.0 computer software. Dynapenia was diagnosed in 21.7% of the examined women. The women with dynapenia had significantly bigger waist and hip circumferences and higher BMI ($p<0.05$) as well as significantly weaker hand muscles than healthy women ($p<0.001$). Females with dynapenia spent significantly more time in a sedentary position, i.e. talking on the phone, participating in religious rituals or watching TV ($p<0.05$) compared to women without dynapenia. No significant differences concerning the diet of women with and without dynapenia were revealed. Physical activity may significantly decrease the risk of dynapenia among women over 60 years of age. Furher research is needed to assess the risk of dynapenia and methods of its prevention.

Key words: age, dynapenia, lifestyle, physical activity, nutrition

Introduction

Current demographic prognoses show that life expectancy in developing countries, including Poland, is constantly increasing. The highest percentage of elderly people in the population is noted in Europe and North America. According to the Polish Central Statistical Office (CSO 2014), in 2050 people over 65 years of age will constitute approximately one-third of the whole Polish society and the number will be higher than in the European Union countries by 6% (CSO 2014).

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A global process of aging in societies brings about the need for further research aimed at determining factors ensuring physical and mental well-being of seniors until very advanced age. Currently, experts are seeking the answer to the question of how to counteract unfavorable health effects connected with involution processes and how to maintain the highest possible level of functional fitness. Identifying threats which lead to numerous limitations seems to be a priority in the research on old age. These limitations include being dependent on other people, general fitness and health deterioration and, as a consequence, death. The phenomenon of dynapenia, i.e. reduced muscle strength and muscle function, also constitutes a significant factor decreasing the quality of life of seniors (Clark et al. 2010). The loss of muscle strength leads to a higher risk of falls and injuries. It limits independent performance of everyday activities and is an element of another serious health issue, i.e. sarcopenia (Strzelecki et al. 2011).

Dynapenia is usually assessed using an isometric handgrip measurement, which provides information not only about hand muscle function, but also about an individual's health state (Zasadzka et al. 2017). The research proved that handgrip strength significantly correlates with power and strength of lower limbs and the size of the triceps (Cruz et al. 2010). Dynapenia is a marker of low-intensity physical activity among seniors (Janssen et al. 2002). Long-term research by Massy-Westropp et al. (2011) indicated that weak hand muscles (dynapenia) increases the risk of death among patients with cardiovascular diseases and in men with cancer.

The health state of a human is affected by numerous biological, environmental, social and cultural factors. Lifestyle which affects an individual's well-being in 50% of the cases is thought to be the main determinant of health (Lalonde 1978). In scientific research, more and more attention is paid to sedentary lifestyle (Owen et al. 2010) and sedentary activities which have a low level of energy expenditure. Most often they are connected with being still in a sitting position (Hu et al. 2003). In the case of seniors, sedentary lifestyle activities mainly include watching TV, listening to music, participating in religious rituals, talking on the phone and reading books and newspapers. It was concluded that time spent in front of the TV is accompanied by other negative health behaviours connected mainly with improper nutrition (Verecken et al. 2006).

Despite a number of studies aimed at assessing the influence of numerous factors on muscle strength (Bohannon 2008; Sapilak et al. 2014; Zasadzka et al. 2017), there is still a scarcity of investigations which would try to determine the correlation between lifestyle and the risk of dynapenia.

The aim of this research was to assess the effects of selected lifestyle components on the risk of developing dynapenia in elderly women.

Material and methods

The research included 46 post-menopausal women over 65 years of age (71.4±5.6) living in the town and county of Wysokie Mazowieckie in Podlaskie province. A written consent of the women to participate in the study and the lack of health counterindications to body composition examination were the inclusion criteria. The study was conducted in the period from July to November 2017.

The project, its aims and applied methods were approved by the Senate Research Ethics Commission of the University of Physical Education in Warsaw. The pilot study was financed from the resources granted to projects of young scientists (DM-62) realised at Józef Piłsudski University of Physical Education in Warsaw. The pilot study is aimed at verifying tools and research methods and is a starting point for preparing the main population study.

Anthropometric measurements were made, i.e. body mass and height as well as waist and hips circumference were measured. Body mass was measured with the use of the First Australia scales with the accuracy to 0.1kg. Body height was measured with an anthropometer with the accuracy to 1mm. Waist and hips circumferences were measured with a measuring tape with the accuracy to 0.5cm, according to the methodology of the World Health Organization (WHO 2008). On the basis of the measurements of body mass and height, BMI was calculated with the classification for adults recommended by the WHO (WHO 2003). Fat tissue distribution was assessed on the basis of anthropometric measurements, waist and hips circumferences and Waist to Hip Ratio (WHR). WHR value higher than 0.8 or waist circumference greater than 88 cm were regarded as abdominal obesity in women (WHO 2008). In order to diagnose dynapenia, handgrip strength was measured with the use of hydraulic dynamometer. The measurement was made twice for the right upper limb and the left upper limb (alternately after a 30-second break). The best mean result (BMR) was included in the analysis and was referred to the cut-off points for low muscle strength in connection with BMI (Cruz- Jentoft et al. 2010).

Table 1. Cut-off points in dynapenia for BMI and handgrip strength

BMI value	Cut-off point in diagnosing dynapenia
≤23	≤17 kg
23.1-26.0	≤17.3 kg
26.1-29.0	≤ 18 kg
>29.1	≤ 21 kg

In order to diagnose dynapenia, body composition was assessed. Tissue components were measured by means of bioelectrical impedance with the use of Tanita BC-418 analyzer. The measurements were made in the morning with the participants wearing no clothes. Taking into account the classification of dynapenia indicators, the examined women were divided into two groups, i.e. women with dynapenia and healthy women.

Lifestyle of the study participants was determined on the basis of the data obtained from the direct interview conducted with the use of the modified Sedentary Behavior Questionnaire (SBQ). Current physical activity of the respondents was measured by means of Onwalk 900 Geonaute pedometer. The period of 48 hours (2x24h) was taken into account in the measurement. The device registered the number of steps and the distance covered. The mean result from two measurement days was included in the analysis.

To assess the nutrition of elderly women, an interview concerning their diet from the last 24 hours preceding the examination was applied (Charzewska 1997). The interview was performed twice on non-successive days of the week. The content of selected nutrients important in the nutrition of elderly women was assessed with the use of DIETA 5.0 licenced computer software (extended version), according to the methodology of the Food and Nutrition Institute.

The deficiency criteria were based on the norms calculated for the Estimated Average Requirement (EAR) for the Polish population (FNI 2012).

The research results were analysed statistically with the use of STATISTICA 13.1 software. Normal distribution was assessed with Shapiro-Wilk test. Furthermore, Student's t-test for independent samples, Chi^2 test, and Pearson correlation test were performed. Statistical significance was set at the level of $p<0.05$.

Results

Dynapenia was diagnosed in 21.8% of the study participants. Females with dynapenia had a significantly lower BMI ($p<0.01$) as well as waist and hips circumferences ($p<0.05$) than females without dynapenia. Women with dynapenia had a significantly lower mean handgrip strength than their healthy peers ($p<0.001$). No statistically significant differences were noted in body composition, nutrition or physical activity (Table 2).

Among the study participants, there were no underweight women. Proper body mass with regard to body height was revealed in 19.4% of the females without dynapenia. In the group of women with dynapenia, no participants with normal BMI were noted. In the group of females with dynapenia, obesity was observed in over 90% of the participants, while among healthy women, the percentage was significantly (nearly three times) lower ($p<0.001$) and came to 33.3% (Table 3).

The study participants with dynapenia devoted the majority of time to sedentary activities such as talking on the phone

Table 2. Assessment of selected somatic features, elements of diet and physical activity parameters of females with dynapenia and healthy controls (without dynapenia)

Variable	Females with dynapenia (n=10)	Females without dynapenia (n=36)	*p-level*
	Mean ± SD		
Age (years)	73.8±4.3	70.6±5.7	NS
Height (cm)	156.3±4.7	159.6±5.4	NS
Weight (kg)	80.3±10.3	73.3±12.1	NS
BMI (kg/m2)	28.7±4.6	32.7±2.8	<0.01
Waist Circumference (cm)	107.1±11.9	97.8±12.0	<0.05
Hip Circumference (cm)	112.4±4.7	106.6±7.9	<0.05
WHR	0.95±0.09	0.92±0.08	NS
PBF (%)	39.8±5.7	36.8±5.4	NS
LBM (kg)	47.8±3.6	46.0±5.2	NS
TBW (kg)	35.0±2.7	33.6±3.8	NS
Total protein (g/day)	61.2±20.4	52.4±17.7	NS
Vitamin D (μg/day)	1.9±1.2	2.3±4.8	NS
Magnesium (mg/day)	259.8±125.6	254.1±84.9	NS
Number of steps/ day	5296±2892	7259±3849	NS
Distance (m/day)	3486±1928	5052±2927	NS
HG (kg)	17.55±2.6	25.9±4.6	<0.001

BMI- Body Mass Index; WHR- Waist to Hip Ratio; PBF- percentage of fat tissue; LBM- lean body mass TBW- total body water; HG- handgrip strength ; NS - not statistically significant

Table 3. The prevalence of abnormalities in the nutritional state and shortages of selected nutrients in the diets of females with and without dynapenia

Variable	Percent of females		*p-level*
	with dynapenia	without dynapenia	
BMI			
Underweight	0	0	-
Normal weight	0	19.4	NS
Overweight	10.0	47.2	<0.05
Class I Obesity	70.0	25.0	<0.01
Class II Obesity	20.0	5.6	NS
Class III Obesity	0	2.8	NS
Obesity Total	90.0	33.4	<0.001
Implementation of nutrition standards			
Total protein			
Deficiency	40.0	63.9	NS
Standard	60.0	36.1	NS
Vitamin D			
Deficiency	100	97.2	NS
Standard		2.8	NS
Calcium			
Deficiency	90.0	83.3	NS
Standard	10.0	16.7	NS
Magnesium			
Deficiency	80.0	55.6	NS
Standard	20.0	44.4	NS

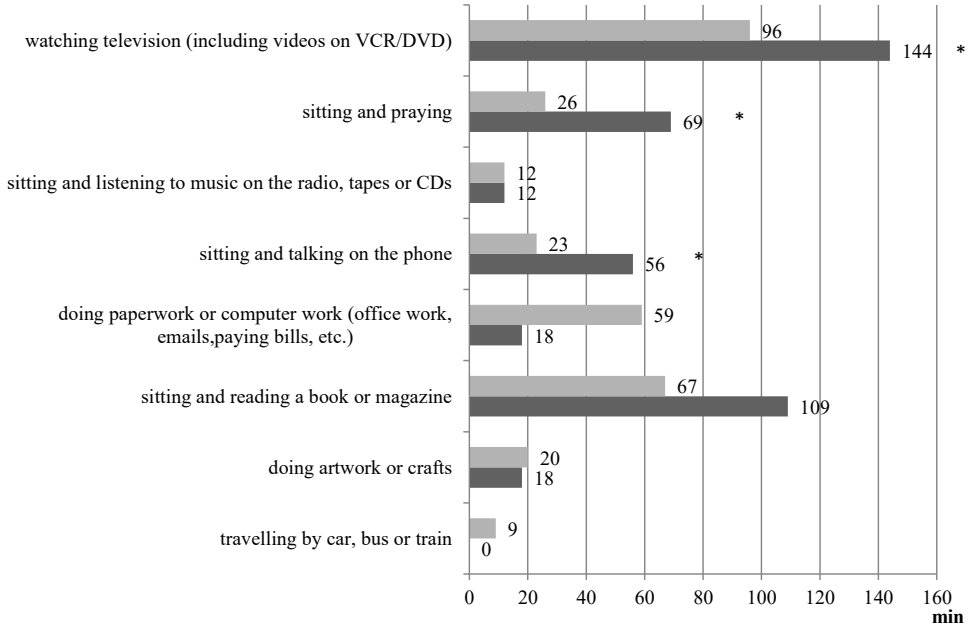
NS- not statistically significant

in a sitting position, participating in religious rituals or watching TV ($p<0.05$). The women in this group also spent more minutes per day reading books and taking a nap. However, these differences were not statistically (Fig.1).

No significant correlations of handgrip strength with BMI, physical activity and nutrition were revealed. However, among females with dynapenia, handgrip strength was inversely proportional to the level of physical activity. In the group of females without dynapenia, a similar correlation was noted between handgrip strength and BMI. Women with high BMI had lower handgrip strength than the remaining study participants (Table 4).

Discussion

Dynapenia poses a threat to fitness in old age. It is connected with the loss of muscle strength which progresses with age and is not caused by neurological diseases (Clark et al. 2012). Dynapenia increases the risk of functional limitations



Statistically significant at *p<0.05

Figure 1. Mean amount of time devoted to sedentary activities on an average weekday by females with (dark colour) and without dynapenia (light colour)

Table 4. Correlations between handgrip strength, BMI, physical activity and nutrition

Variable	Number of steps (day)		Protein intake (g/kg/bw)		Vitamin D intake		BMI		FAT %	
	r	*p*	r	*p*	r	*p*	r	*p*	r	*p*
Females with dynapenia										
Mean upper limb muscle strength (BMR)	-0.12	0.74	0.13	0.72	0.35	0.32	0.34	0.33	0.26	0.47
Right upper limb muscle strength	-0.12	0.72	0.18	0.62	0.26	0.45	0.40	0.25	0.03	0.92
Left upper limb muscle strength	-0.09	0.79	0.07	0.84	0.35	0.31	0.23	0.5	0.38	0.28
Females without dynapenia										
Mean upper limb muscle strength (BMR)	0.16	0.34	0.20	0.23	0.21	0.21	-0.05	0.76	-0.26	0.12
Right upper limb muscle strength	0.07	0.67	0.24	0.15	0.14	0.40	-0.13	0.44	0.07	0.67
Left upper limb muscle strength	0.17	0.29	0.09	0.56	0.19	0.25	-0.13	0.42	-0.28	0.09

of seniors (Cesari et al. 2009) and may simultaneously increase mortality in this group (Takata et al. 2011). The research revealed that dynapenia affects from 16% to 18% of women over 65 years of age living in the United States (Federal Interagency Forum on Aging Related Statistic 2008). Our research revealed that dynapenia occurred in 21.8% of the study participants. A bigger percentage of women with this health problem revealed in our study may result from the participants' age. In Poland, there is a lack of studies on the prevalence of this condition. Dynapenia is most often diagnosed as a part of another serious health problem, i.e. sarcopenia.

In their research conducted on 30 inhabitants of social care home in Poznan, Krzymińska-Siemaszko and Wieczorowska-Tobis (2012) revealed that a mean value of handgrip strength among women was 8.5 ±5.1 kg for the right limb and 7.8 ±5.9 kg for the left limb. In our study, mean handgrip strength in the right limb was 26.5± 6.9 kg in the group of physically active women, and 23.4± 4.04 kg among non-active women. The results for the left limb were 26.2± 8.3 kg and 21.4±4.6 kg, respectively. A large difference in the results of handgrip strength measurements indicates that persons living in social care homes are more vulnerable to dynapenia. Similar results concerning handgrip strength were published by Saraiva Lino et. al. (2016). They concluded that mean handgrip strength in women was 21.7 kg. Sapilak et al. (2014) noted that mean strength of the dominating hand in hospital patients was 21.3 ± 11.9 kg.

Numerous researchers have analysed the correlation between handgrip strength and nutritional state defined on the basis of BMI (Sapilak et al. 2014; Massy-Westropp et al. 2011). However, research results are not unanimous. Sapilak et al. (2014) did not reveal statistically significant correlations between handgrip strength and BMI. However, they confirmed that the study participants with BMI close to an upper limit of the norm demonstrated greater handgrip strength. In turn, Massy-Westropp et al. (2011) revealed that, depending on the subjects' age, nutritional state correlated significantly with handgrip strength. A negative correlation between BMI and strength of the right hand was noted in the subjects below 60 years of age, while in the study participants over 70 years of age, the correlation between these two parameters was positive. In our study, we did not find any significant correlations between BMI of the examined women and their handgrip strength.

In the literature, there is a lack of research defining the influence of seniors' lifestyle on the risk of developing dynapenia. Our research revealed that the females with dynapenia devoted significantly more time to such sedentary activities as watching television, participating in religious rituals or talking on the phone ($p<0.05$). Women with low handgrip strength spent an average of 468 minutes per day in a physically passive manner (approximately 8h/day). Therefore, it may be concluded that sedentary lifestyle is one of the main risk factors of dynapenia. Our research also showed that females with dynapenia demonstrated lower levels of physical activity assessed on the basis of a daily number of steps than females with proper handgrip strength.

There are more and more studies assessing the influence of nutrients on an individual's health and on the functioning of the nervous and muscle systems (Clark 2009). In recent years, an inte-

rest in the influence of vitamin D on the functioning of muscles has grown significantly (Annweiler et al. 2009). It was revealed that vitamin D supplementation affects muscle strength (Annweiler et al. 2009). In our own study, the intake of vitamin D in the subjects' diet was assessed. It was revealed that 97.8% of all the study participants had insufficient levels of vitamin D in their diet. It was also noted that 60.9% of all the subjects had deficits of magnesium.

The fact that there is a scarcity of research regarding dynapenia leads to an assumption that this problem is neglected. Our study proved that the problem of dynapenia is present in the Polish society and it is going to grow due to the fact that the society is aging. Thus, taking up research aimed at establishing efficient rules of preventing dynapenia seems to be completely justified.

The study has certain limitations. The size of the study group did not let us draw far-reaching conclusions. However, the presented results come from a pilot study. Further research will involve a random selection of a big sample of women over 60 years of age.

Conclusion

Physical activity may significantly decrease the risk of dynapenia among females over 60 years of age. Assessing the risk of dynapenia and methods of preventing this condition requires further research.

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Authors' contributions

AB was involved in concept, study protocol, data collection, interpretation of results; AK was involved in study protocol, interpretation of results. AG provided data analysis. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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