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Original Research

Lifestyle with particular emphasis on physical activity and genital carcinomas in women

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Summary

Positive effects of physical activity on the reduction of the risk of chronic diseases such as cardiovascular diseases, diabetes, hypertension, but primarily to reduce the risk of breast, colorectal and endometrial cancer. The aim of the study was to determine the effect of physical activity on the risk of developing cancer of female reproductive organs. The study involved women with ovarian, cervical, and endometrial cancer (diagnosed on the basis of histopathological evidence) and healthy controls. A total number of 953 women (aged 21 to 84 years) was included. Moderate (600 - 1500 MET) and vigorous (> 1500 MET) physical activity during household chores reduces the risk of ovarian cancer (OC). The odds ratio of developing OC is OR = 0.35; 95% Cl 0.09 – 1.31 and OR = 0.23; 95% Cl 0.07 – 0.80, as compared to women with low physical activity (< 600 MET). The respondents who reported engaging in sports activities between 600 and 1500 MET/day have a lower risk of cervical cancer, OR = 0.52; 95% Cl 0.19 – 1.46. In order to reduce the risk of malignant neoplasia in female reproductive organs, physical effort of 600 - 1500 MET should be undertaken.

Key words: Ovarian cancer; Cervical cancer; Endometrial cancer; Physical activity; Lifestyle; Disease odds ratio.

Introduction

Epidemiological studies have reported the protective effect of physical activity on the development of malignant tumors, mainly breast, endometrial, prostate, and colorectal cancer [1-4]. In addition, exercise has been known to reduce the risk of cardiovascular disease, diabetes, and osteoporosis [5].

Regular physical activity is believed to positively affect the following: weight maintenance, with BMI in the range of 18.5 –25 kg/m2, secretion of sex hormones, metabolism by lowering insulin and insulin-like growth factor-1 (IGF-1), reduction of inflammatory cytokines concentr-ation: tumor necrosis factor α (TNF–α), interl-eukin–6 protein (IL–6), C–reactive protein (CRP) in serum and increase in the number and activity of macrophages and natural killer lymphocytes (NK) lym-phocytes [6-8].

Moderate or vigorous physical activity is recommended for a minimum of 60 min./day, with up to 60 to 90 min./day of moderate physical activity per day for over-weight subjects [5]. In addition, it is vital to reduce caloric intake by lowering the consumption of sugars, saturated and trans fats, as well as alcoholic beverages in the diet.

Epidemiological studies have shown that control of the type of food intake and physical activity is important in controlling weight [9]. Lifestyle modifications, properly balanced diet and physical activity can contribute to the reduction of the incidence of malignant neoplasms of reproductive tract in women.

The aim of study was to determine the effect of effects physical activity on the risk of developing cancer of female reproductive organs.

Materials and Methods

The study was conducted at the Gynecological and Obstetric Hospital of the Medical University of Poznan between October 2011 and June 2013. A total of 953 women (aged: 21 to 84 years) was included: healthy controls (n = 683, the control group) and women diagnosed with ovarian (n = 79; the CA-O group), cervical (n = 35; the CA-C group) and endometrial (n = 68; the CA-E group) cancer on the basis of histopathological examinzation.

A questionnaire which included questions concerning physical activity at work and during leisure time was used as the research tool. The respondents identified all forms of physical activity in which the engaged before cancer diagnosis. The list of acitivities is presented in Table 1. In order to determine their intensity, a metabolic equivalent expressed in MET (metabolic equivalent of task), calculated as the product of days of physical activity per week, and duration (min./day) was assigned to each acitivity.

Basing on MET values, the women were classified into three categories of physical activity: low (< 600 MET), moderate (600–1500 or 600 –3000 MET) or vigorous (> 1500 or 3,000 MET).

With the use of the questionnaire developed by Freidenreich *et al.* [11], work-related physical activity was assessed with the following formula:

*completion age-starting age*monthsyear*4,33*number of daysweek*hours-day/52age*

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Table 1. — *MET values for various physical activity (Ainsworth et al., 2000) [10].*

Type of physical activity	Value of MET
HOUSEHOLD CHORES	
Preparation of meals, cooking, cleaning	3.5
Shopping	2.3
Cleaning at home	3.5
Washing and ironing	2.0
Caring for children at home (pre-school and others)	2.5
Care for the disabled or elderly	4.0
Mowing the lawn	5.5
Planting the plants in the garden	2.0
Raising the lawn	4.0
SPORTS	
Classic and recreational swimming	5.3
Pedalo (water bike)	4.0
Water aerobics	5.5
Ice skating, ice dancing	14.0
Skiing - only during winter	7.0
Cycling	7.5
Walking	3.5
Jogging	7.0
Gymnastics	3.8
Horse riding	5.5
Dancing	7.8
LEISURE	
Watching TV	1.3

The intensity of work-related physical activity was defined as: 1) work requiring only sitting position with minimal walking, 2) work requiring little physical effort, without increased bre-athing and slightly accelerated heart rate, 3) work requiring moving light loads (2.2–4.5 kg), with accelerated heart rate, and 4) work requiring moving heavy loads of more than 4.5 kg, fast march, mainly in the open air, with accelerated heart rate and increased breathing.

Statistical analysis was conducted using statistical package StatSoft, Inc. (2011), STATISTICA, version 10. The odds ratio with a 95% confidence interval was calculated using the logistic regression model. The significance of the odds ratio was examined with a test using the following formula: H0: ORi = 1, H1: ORi ≠ 1. The Wald test was used in the research. The statistics have asymptotic $\chi 2$ distribution with 1 degree of freedom, and based on the p-value compared with a significance level $\alpha = 0.05$, the decision was made: if $p \leq \alpha$ rejected H0 accepting H1, and if $p > \alpha$, there was no reason to reject H0.

Local Ethics Committee approved of the study (no. 574/11).

Results

The majority of the respondents were 40-49 and 50-59 years old (27% and 25.1%, respectively), representing 52.1% of the study sample. The differences between the groups were statistically significant. The analysis of age distribution is presented in Table 2.

Body Mass Index was calculated for all subjects. Using the BMI criterion, the respondents were classified as: underweight (BMI < 18.9), normal (BMI 18.9-24.9), overweight (BMI 25-29.9), class I obesity (BMI 30-34.9), class II obesity (BMI 35-39.9), and class III obesity (BMI >= 40). The results are presented in Table 3. The number of coffee cups consumed per day was another parameter analyzed in the present study. In the CA-O group, consumption of one cup of coffee/day was reported by 40.12% of the respondents. Five cups of coffee/day were consumed by 2 patients, representing 1.2% of the CA-O group. In the CA-C group, consumption of three, two and one cups of coffee/day was declared by 37.1% , 22.9% and 20% of the women, respectively.

In the control group, consumption of three, two and one cups of coffee/day was declared by 37.8%, 16.3% and 17.7% of the subjects, respectively. The exact data for all study groups and controls are presented in Table 4. The frequency, amount and type of alcohol consumed were also analyzed. In the CA-O group, 52.1% of the women did not consume alcohol at all, and 38.9% - rarely. Daily alcohol consumption was declared by 2 respondents (1.2%). The most often consumed types of alcohol in this group were as follows: wine (37.8%), beer (13.2%), vodka (5.9%) and other spirits (4.2%). In the CA-C group, 68.6% of the women did not drink alcohol at all, and 31.4% - rarely. The most often consumed types of alcohol in this group were as follows: wine (17.4%), beer (14.3%), and vodka (5.7%). In the CA-E group, 72% of the respondents did not consume alcohol at all, 25% - rarely, and 2.9% - once every two weeks. The most often consumed types of alcohol in this group were as follows: wine (16.8%), beer (5.9%), vodka (5.9%), and other spirits (2.9%). In the control group, 31% of the women did not drink alcohol at all, 50.7% - rarely, and 8.4% - once a week. Two respondents (0.3%) declared alcohol consumption on daily basis. The most often consumed types of alcohol in this group were as follows: wine (50.1%), beer (32.5%), vodka (18.7%), and other spirits (6%). The exact data are presented in Table 5.

The lowest mean amount of alcohol was consumed by the respondents from the CA-O and CA-E groups (48 ml/day and 54 ml/day, respectively), while in the control group the amount was 135 ml per day. The differences between the groups were statistically significant.

The differences between the groups were statistically significant. Instead the number of cigarettes smoked per day is presented in Table 6.

As far as physical exertion is concerned, in the CA-O group, recreational swimming less than once a month and 2-3 times/week was reported by 11.9% and 3.6% of the subjects, respectively, whereas 78.4% of the respondents did not swim at all. Cycling less than once a month was declared by 11.9% of the women, once a week and three times a week by 4.8% and 13.8%, respectively. Notably, 41.3% of women with OC did not in any physical exercise at all.

In the CA-C group, nearly half of the women (48.6%) did not ride a a bicycle, 28.6% took a daily stroll, while 17.1%

Table 2. — *Age distribution in the study population*

	CA – O		CA – E		CA – C		Controls		*p*
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
20 – 29	3	1.80	0	0.00	0	0.00	21	3.07	
30 – 39	10	5.99	0	0.00	4	11.43	183	26.79	CA–O, $p < 0.0001$
40 – 49	33	19.76	5	7.35	8	22.86	232	33.97	CA–E, $p = 0.00001$
50 – 59	62	37.13	18	26.47	12	34.29	169	24.74	CA–C, $p = 0.000157$
60 – 69	43	25.75	32	47.06	9	25.71	59	8.64	BZ, $p = 0.00$
70 – 79	16	9.58	12	17.65	2	5.71	15	2.20	
≥ 80	0	0.00	1	1.47	0	0.00	4	0.59	

Table 3. — *Distribution of BMI in the study population*

	CA – O		CA – E		CA – C		BZ		*p*
	N	%	N	%	N	%	N	%	
< 18.9	6	3.59	1	1.47	1	2.86	28	4.10	
18.9-24.9	74	44.31	12	17.65	16	45.71	347	50.81	CA–O, $p = 0.0722$
25-29.9	57	34.13	21	30.88	11	31.43	219	32.06	CA–E, $p < 0.0001$
30-34.9	22	13.17	15	22.06	6	17.14	63	9.22	BZ, $p < 0.0001$
35-39.9	7	4.19	10	14.71	0	0.00	21	3.07	
≥ 40	1	0.60	9	13.24	1	2.86	5	0.73	

Table 4. — *Number of coffee cups consumed per day in the study population*

	CA – O		CA – E		CA – C		Controls		*p*
	N	%	N	%	N	%	N	%	
1	67	40.12	18	26.47	7	20.00	121	17.72	
2	32	19.16	22	32.35	8	22.86	111	16.25	
3	55	32.93	22	32.35	13	37.14	258	37.77	CA–0, $p < 0.0001$
4	11	6.59	3	4.41	5	14.29	127	18.59	CA–E, $p = 0.000046$
5	2	1.20	2	2.94	2	5.71	38	5.56	BZ, $p < 0.0001$
6	0	0.00	1	1.47	0	0.00	20	2.93	
7	0	0.00	0	0.00	0	0.00	5	0.73	

Table 5. — *Frequency of alcohol consumption in the study population*

	C – O		CA – E		CA – C		Controls		*p*
	N	%	N	%	N	%	N	%	
Never	87	52.10	49	72.06	24	68.57	212	31.04	
Rarely	65	38.92	17	25.00	11	31.43	346	50.66	CA–0, $p < 0.0001$
Every two weeks	5	2.99	2	2.94	0	0.00	53	7.76	CA–E, $p < 0.0001$
Once a week	6	3.59	0	0.00	0	0.00	57	8.35	CA–C, $p = 0.000002$
Several times per week	2	1.20	0	0.00	0	0.00	13	1.90	BZ, $p < 0.0001$
Every day	2	1.20	0	0.00	0	0.00	2	0.29	

took a walk once a week, and 5.7% - less than once a month. In the EC group, 88.23% of the respondents resigned from recreational swimming, 29.41% of the women strolled daily, 7.35% - twice a week, and 10.29% - once a week. In the control group, 40.6% of the women did not cycle, 11.2% cycled once a week, and 9.3% - six or more times a week.

Among the women from the CA-O group, physical activity declared during household chores and leisure activity was as follows: 1256.06 MET for passive rest at home, 3957.89 MET for housework and 2147.44 MET for sports activity. The exact data are shown in Figure 1.

Analyzing occupational activity in the study groups, the following results were obtained: mean number of hours/ week for CA-O, CA-C and CA-E groups was 26.43, 26, and 39.7, respectively and 31.92 hours among controls. 26, and 39.7, respectively and 31.92 hours among controls.

The impact of physical activity on the incr-ease or decrease in the OR of reproductive tract cancer was also analyzed. Women engaged in spo-rts activity between 600 and 1,500 MET have a 1.26-fold higher risk of ovarian cancer, OR = 1.26; 95% CI 0.78 - 2.04 (p = 0.3440), while performing sport activity above 1,500 MET causes an almost two-fold increase an almost two-fold increase in the risk of developing the disease, OR = 1.96; 95% CI 1.31-2.92 (p = 0.0010) as compared to women with low-intensity physical activity, OR = 1.96; 95% CI 1.31 - 2.92 (p = 0.0010) when compared to women with low-intensity physical activity. The differences between the groups were stati-stically significant.

Table 6. — *Number of cigarettes smoked per day in the study population.*

	CA – O		CA – E		CA – C		BZ		p
	N	%	N	%	N	%	N	%	
0	149	89.22	59	86.76	19	54.29	534	78.18	
1	0	0.00	0	0.00	0	0.00	1	0.15	
2	1	0.60	0	0.00	0	0.00	6	0.88	
3	0	0.00	0	0.00	1	2.86	13	1.90	
4	0	0.00	0	0.00	0	0.00	4	0.59	
5	3	1.80	1	1.47	1	2.86	21	3.07	
6	1	0.60	1	1.47	2	5.71	9	1.32	
7	2	1.20	0	0.00	0	0.00	4	0.59	CA–O, $p = 0.001289$
8	1	0.60	0	0.00	1	2.86	3	0.44	CA–E, $p < 0.0001$
10	7	4.19	2	2.94	2	5.71	42	6.15	CA–C, $p = 0.000308$
12	0	0.00	0	0.00	1	2.86	2	0.29	BZ, $p = 0.012650$
13	0	0.00	0	0.00	0	0.00	1	0.15	
14	0	0.00	0	0.00	1	2.86	0	0.00	
15	1	0.60	2	2.94	1	2.86	17	2.49	
16	0	0.00	0	0.00	0	0.00	1	0.15	
20	2	1.20	3	4.41	5	14.29	22	3.22	
25	0	0.00	0	0.00	0	0.00	1	0.15	
30	0	0.00	0	0.00	1	2.86	1	0.15	
40	0	0.00	0	0.00	0	0.00	1	0.15	

Table 7. — *OR for work-related physical exertion among endometrial cancer patients.*

Physical exertion (hours/week)	OR	CI
11–20 hours	0.31	0.12–0,81
20–30 hours	0.80	0.45–1.43
> 30 hours	1.65	0.72–3.79

Moderate (600 - 1500 MET) and vigorous (above 1,500 MET) physical activity during household chores decreases the risk of ovarian cancer and the odds ratio is as follows: OR = 0.35; 95% Cl 0.09 - 1.31 ($p = 0.1179$) and OR = 0.23; 95% Cl 0.07 - 0.80 ($p = 0.0208$), when compared to low-intensity physical exertion.

Women who take passive rest are at increased risk of developing ovarian cancer. The odds ratio for 600 - 1500 MET and > 1500 MET was OR = 1.90; 95% CI 1.13 - 3.17 and OR = 2.91; 95% Cl 1.70 - 4.99, respectively. The results are presented in Figure 2.

The impact of work-related physical activity on the growth of the odds ratio was also analyzed. These calculations included the following time periods: up to 10 hours of physical exertion per week, 20-30 hours, and over 30 hours/week. The odds ratio for 11-20 hours and 20-30 hours was OR = 0.52; 95% Cl 0.32 - 0.83 ($p = 0.0058$) and OR = 0.63; 95% CI 0.41 - 0.98 ($p = 0.0399$), respectively as compared to < 10 hours/week. Physical exertion >30 hours/week results in a 1.27-fold increase in the risk of the disease (OR = 1.27; 95% Cl 0.68-2.37; $p = 0.4575$).

In the present study, we alsoexamined the impact of physical activity related to housework, sports activity, passive rest, and work-related exertion on risk increase or decrease of odds ratio of cervical cancer incidence. The following categories of physical activity were distinguished: low (< 600 MET), moderate (600 - 1500 MET) and vigorous (> 1500 MET). Respondents declaring sports activity between 600 and 1,500 MET/day present lower risk of cervical cancer (OR = 0.52; 95% Cl 0.19 - 1.46; $p = 0.2139$), as compared to women with low-intensity physical activity.

Vigorous physical activity during household chores reduces the risk of cervical cancer. The OR = 0.49; 95% Cl 0.21 - 1.17 ($p = 0.1096$), when compared to moderate exertion. Respondents who take passive rest with MET equal 600 - 1,500/day have increased risk of illness. The odds ratio for MET 600-1500 is OR = 1.74; 95% Cl 0.69 - 4.39 ($p = 0.2374$), and for MET >1500 is OR= 1.12; 95% Cl 0.37 - 3.42 ($p = 0.8375$).

Odds ratio of cervical cancer for 11-20 hours and 20-30 hours of physical exertion was OR = 0.38; 95% CI 0.14 - 1.04 ($p = 0.0595$) and OR = 0.22; 95% Cl 0.06 - 0.74 ($p = 0.0146$), respectively as compared to women working < 10 hours/week. Those with physical exertion > 30 hours a week have more than two-fold higher risk of cervical cancer (OR = 2.13; 95% Cl 0.80 - 5.62; $p = 0.1279$).

The impact of work-related physical activity on the increase or decrease in the OR of endometrial cancer was also investigated. These calculations included the following time periods: up to 10 hours of physical activity per week, 11-20 hours, 20-30 hours, and over 30 hours.

Women with 11-20 hours and 20-30 hours of work-related

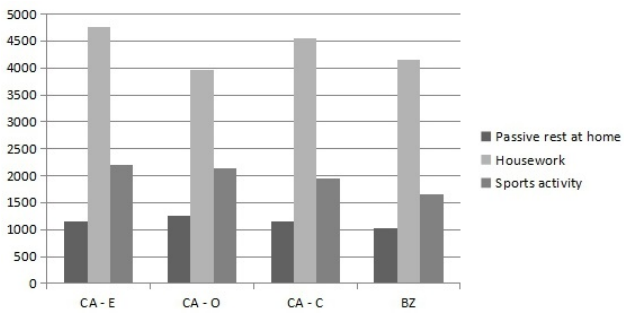

Figure 1. — Physical exertion in the in the study population

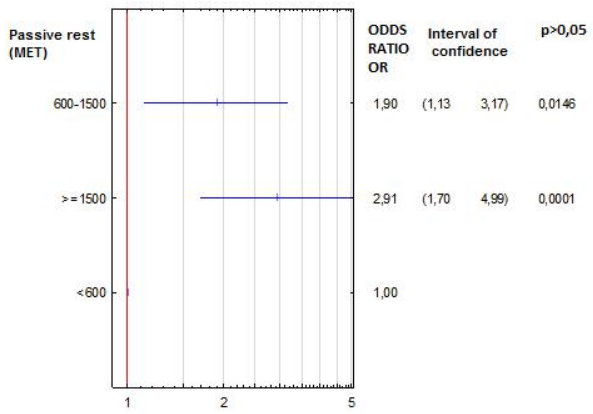

Figure 2. — OR of ovarian cancer incidence versus passive rest.

physical activity per week have the odds ratio of OR = 0.31; 95% CI 0.12 - 0.81, and OR = 0.80; 95% Cl 0.45 - 1.43, respectively as compared to women working <10 hours per week. The results are presented in Table 7.

Discussion

Regular physical activity contributes to a decrease in the risk of breast, ovarian, and endometrial cancer. In addition, it reduces the risk of recurrence of illness at the same time, prolonging the the affected [12].

Regular physical activity may reduce the risk of breast and an ovarian cancer by the regulation of hormonal levels and increase of the immune system activity. Vigorous physical effort may contribute to delay in menarche, irregular menstruation cycles, and primary or secondary amenorrhea. Furthermore, production of steroid hormone-binding globulins increases, which in turn reduces estrogenic activity [13-17].

Research of Abbott *et al.* [18] analyzed the influence of physical activity among 393 393 women with ovarian cancer and 611 controls. They demonstrated that moderate physical activity results in an increase of ovarian cancer risk and the odds ratio among the respondents in this group was OR = 1.51; 95% CI: 1.03 - 2.23. It was also confirmed by the research of Zhou *et al.* [19] and Huang *et al.* [20].

When analyzing the frequency and type of physical activity, it should be emphasized that 41.3% of the respondents from the CA-O group did not engage in any kind of physical activity at all. Also, 11.9% of the women declared cycling less than once a month, 4.8% - once a week, and 13.8% - several times a week. In addition, the research has shown that the risk of illness is increased, and the odds ratio is OR = 1.96; 95% Cl 1.31 - 2.92 in respondents engaging in physical activity between 600 and 1500 MET as compared to women with poor physical activity.

Various researchers reported that physical activity contributes to the reduction of C-reactive protein (CRP) levels by modulating the function of granulocytes and monocytes. Adiponectin, described for the first time in 1995, secreted by the cells of the adipose tissue, presents anti-inflammatory activity, inhibits inflammatory activity, and inhibits angiogenesis and secretion of TNF-α, IL-1, and IL-6 in macrophages. In addition, long-term exercise may contribute to lowering TNF-α and IL-6 levels. The research of You *et al.* [21] freported reduced concentration of inflammatory cytokines (TNF - α, IL - 6, CRP) in the blood serum of women starting higher physical activity, as compared to women on diet alone. Weight loss was apparent in both groups. Regular and moderate exercise regulates the balance between pro-inflammatory and anti-inflammatory cytokines [22].

Obesity is a proven cause of morbidity and mortality. IIn Western countries, obesity is the second most common risk factor, after smoking, for diabetes, cardiovascular disease and cancer. Over the past few years, the number of obese people has notably increased.

Epidemiological studies demonstrated an association between obesity and an increased risk of colorectal, gall bladder, and hormone-dependent tumors, such as breast, endometrial, ovarian, prostate, and thyroid gland cancer. There is also an increased risk of developing leukemia, multiple myeloma, and non-Hodgkins lymphoma. Considering other factors, including low physical activity, the risk is very high [23, 24].

The association of BMI with cancer risk was demon strated in a Korean population study. According to these authors, obese men were more likely to be diagnosed with malignant tumors of the stomach, colon, liver and bladder. Women with BMI ≥ 30kg/m^2 were more likely to have liver, pancreatic, and postmenopausal cancer of the large intestine, breast, endometrium, and kidney [25, 26].

Much evidence points to the relationship between obesity and endometrial cancer. The risk is two or three times higher in women with BMI > 25 kg/m^2 with abdominal obesity. Adverse effects of obesity on the endometrium involve an increase in estrogen concentration by the aromatization of androgens within the adipose tissue. These

disorders are further exacerbated by type 2 diabetes with hyperinsulinemia and the elevated insulin-like growth factor IGF-1 levels by lowering the production of IGFBP-1.

In the case of endometrial cancer, 20-30% reduction in its incidence has been demonstrated in physically active women, which is related to the hormonal etiology of this cancer [27-29].

In a women participating in clinical – cohort study the Nurses' Health Study (NHS) conducted by Du *et al.* [29] 777 cases of endometrial cancer were identified among 1,235,880 women surveyed between the ages of 30 and 55. Moderate and vigorous physical activity reduced the risk of endometrial cancer, OR = 0.61, 95% Cl 0.48 - 0.78, and OR = 0.73, 95% Cl 0.58 - 0.92.

In the NIH – AARP Diet and Health Study [30], among 109,621 women the endometrial cancer was diagnosed in 1,052 women. Physical activity 5 times a week results in reduced risk of this type of cancer (OR = 0.77; 95% Cl 0.63 - 0.95) as compared to non-physically active women. It was also confirmed in a study by Friedenreich et al. (2010), who reported the following odds ratio for recreation, occupational and household activities: OR = 0.81; 95% Cl 0.59 - 1.12, OR = 0.81; 95% Cl 0.60 - 1.11 and OR = 1.26; 95% Cl 0.85 - 1.86, respectively.

In our study, 11-20 hours and 20-30 hours of work-related physical activity reduced the risk of endometrial cancer (OR = 0.31; 95% Cl 0.12 - 0.81 and OR = 0.80; 95% Cl 0.45 - 1.43, respectively) as compared to women who worked <10 hours a week.

For prevention purposes, even three 30-minute vigorous training units per week will be enough to reduce the risk of cancer by half. In addition, modification of lifestyle through taking up physical activity, as well as limiting or eliminating alcohol and tobacco use, can help to reduce the risk of developing malignant neoplasms of the reproductive organs.

Conclusions

Based on our findings and the analyses of other authors, it seems safe to conclude that: physical effort between 600-1500 MET, which is equivalent to 3 hours of walking/week or 1.5 hours of recreational cycling/week, should be undertaken in order to decrease the risk of malignant gynecological cancer in women, moderate and vigorous physical activity related to household chores reduces the risk of developing cancer of the female reproductive organs.

References

[1] Bergier B., Bergier J., Paprzycki P.: "Level and determinants of physical activity among school adolescents in Poland". *Ann. Agric. Environ. Med.,* 2014, *21*, 75.

[2] Bergier B., Bergier J., Wojtyła A.: "Various aspects of physical activity among Lithuanian adolescents". *Ann. Agric. Environ. Med.,* 2012, *19*, 775.

[3] Patel A.V., Rodriguez C., Bernstein L., Chao A., Thun M. J., Calle E. E.: "Obesity, recreational physical activity, and risk of pancreatic cancer in a large US Cohort". *Cancer Epidemiol. Biomarkers Prev.,* 2005, *14*, 459.

[4] Plagens–Rotman K., Żak E., Pieta B.: "Odds ratio analysis in women with endometrial cancer". *Menopause Rev.,* 2016, *1*, 12.

[5] Kushi L.H., Byers T., Doyle C., McCullough M., Rock C.L., Demark-Wahnefried W., Bandera E.V., *et al.*: "American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity". *CA Cancer J. Clin.*, 2012, *1*, 30.

[6] Neilson H.K., Friedenreich Ch.M., Brockton N.T. Brockton N. T., Millikan R. C.: "Physical activity and postmenopausal breast cancer: Proposed biologic mechanisms and areas for future research. Cancer Epidemiol". *Biomarkers Prev.* 2009; 1, 12.

[7] Eliassen A.H., Missmer S.A., Tworoger S.S. Hankinson S. E.: "Endogenous steroid hormone concentrations and risk of breast cancer: does the association vary by a woman's predicted breast cancer risk?" *J. Clin. Oncol.,* 2006, *24*, 1823.

[8] Friedenreich C.M., Woolcott C.G., McTiernan A., Ballard-Barbash R., Brant R.F., Stanczyk F.Z., *et al.*: "Alberta physical activity and breast cancer prevention trial: Sex hormone changes in a year – long exercise intervention among postmenopausal women". *J. Clin. Oncol.,* 2010, *28*, 1458.

[9] Rolls B.J., Drewnowski A., Ledikwe J.H.: "Changing the energy density of the diet as a strategy for weight management". *J. Am. Diet. Assoc.,* 2005, *105*, S98.

[10] Ainsworth B.E., Haskell W.L., Whitt M.C. Irwin M.L., Swartz A.M., Strath S.J., *et al.*: "Compedium of physical activities: an update of activity codes and MET intensities". *Med. Sci Sports Exerc.*, 2000, *32*, S498.

[11] Friedenreich C.M., Courneya K.S., Bryant H.E.: "The lifetime totoal physical activity questionnaire: development and reliability". *Med. Sci. Sports Exerc.,* 1998, *30*, 266.

[12] Litwiniuk M., Kara I.: "Physical activity and cancer". *Onco. Review,* 2012, *4*, 228.

[13] Moorman PG., Jones LW., Akushevich L., Schildkraut JM.: "Recreational physical activity and ovarian cancer risk and survival". *Ann. Epidemiol.,* 2011, *21*, 178.

[14] Plinta R., Olszanecka–Glinianowicz M., Drosdzol–Cop A., Chudek J., Skrzypulec-Plinta V.: "State of nutrition and diet habits versus estradiol level and its changes in the pre – season preparatory period for the league contest match in female handball and basketball players". *Ginekol. Pol.,* 2012, *83*, 674.

[15] Cannioto R.A., Moysich K. B.: "Epithelial ovarian cancer and recreational physical activity: a review of the epidemiological literature and implications for exercise prescription". *Gynecol Oncol.,* 2015, *137*, 559.

[16] Plagens-Rotman K., Chmaj-Wierzchowska K., Pięta B., Bojar I.: "Modifiable lifestyle factors and ovarian cancer incidence in women". *Ann. Agric. Environ. Med.,* 2018, *25*, 36.

[17] Plagens-Rotman K., Piskorz-Szymendera M., Chmaj-Wierzchowska K., Pięta B.: "Breast cancer - Analysis of the selected risk factors". *Eur. J. Gynaecol. Oncol.*, 2017, *38*, 425.

[18] Abbott S.E., Bandera E.V., Qin B.: "Recreational physical activity and ovarian cancer risk in American American women". Cancer Med., 2016, *5*, 1319.

[19] Zhou Y., Chlebowski R., La Monte M.J., Bea J.W., Qi L., Wallace R., *et al.*: "Body mass index, physical activity, and mortality in women diagnosed with ovarian cancer: results from the Women's Health Initiative". *Gynecol. Oncol.*, 2014, *1*, 4.

[20] Huang T., Eliassen A.H., Hankinson S.E. Okereke O.I., Kubzansky L.D., Wang M., *et al.*: "A prospective study of leisure-time physical activity and risk of incident epithelial ovarian cancer: Impact by menopausal status". *Int. J. Cancer*, 2016, *4*, 843.

[21] You T., Berman D.M., Ryan A.S., Nicklas B.J.: "Effects of hypocaloric diet and exercise training on inflammation and adipocyte lipolysis in obese postmenopausal women". *J. Clin. Endocrinol. Metab.,* 2004, *89*, 1739.
[22] Neilson H.K., Friedenreich Ch.M., Brockton N.T, Millikan R.C.: "Physical activity and postmenopausal breast cancer: Proposed biologic mechanisms and areas for future research". *Cancer Epidemiol. Biomarkers Prev.,* 2009, *1*, 12.
[23] Hjartaker A., Langseth H., Weiderprass E.: "Obesity and diabetes epidemics: cancer repercussions". *Adv. Exp. Med. Biol.,* 2008, *630*, 72.
[24] Renehan A.G., Roberts D.L., Dive C.: "Obesity and cancer: pathophysiological and biological mechanisms". *Arch. Physiol. Biochem.,* 2008, *114*, 71.
[25] Jee S.H., Yun J.E., Park E.J., Cho E.R., Park I.S., Sull JW., Ohrr H., Samet J.M.: "Body mass index and cancer risk in Korean men and women". *Int. J. Cancer,* 2008, *123*, 1892.
[26] Song Y.M., Sung J., Ha M.: "Obesity and risk of cancer in postmenopausal Korean women". *J. Clin. Oncol.,* 2008, *26*, 339.
[27] Moore S.C., Gierach G.L., Schatzkin A. Matthews C.E.: "Physical activity, sedentary behaviours, and the prevention of endometrial cancer". *Br. J. Cancer,* 2010, *103*, 933.
[28] Cust A.E., Armstrong B.K., Friedenreich C.M., Slimani N., Bauman A.: "Physical activity and endometrial cancer risk: a review of the current evidence, biologic mechanisms and the quality of physical activity assessment methods". *Cancer Causes Control,* 2007, *18*, 243.
[29] Du M., Kraft P., Eliassen A.H., Giovannucci E., Hankinson S.E., De Vivo I.: "Physical activity and risk of endometrial adenocarcinoma in the Nurses' Health Study". *Int. J. Cancer*, 2014, *11*, 2707.
[30] Gierach G.L., Chang S.C., Brinton L.A., Lacey J.V. Jr, Hollenbeck A.R., Schatzkin A., Leitzmann M.F.: "Physical activity, sedentary behavior, and endometrial cancer risk in the NIH – AARP Diet and Health Study". *Int. J. Cancer*, 2009, *9*, 2139.
[31] Friedenreich C.M., Cook.LS., Magliocco A.M., Duggan M.A., Courneya K.S.: "Case – control study of lifetime total physical activity and endometrial cancer risk". *Cancer Causes Control*, 2010, *7*, 1105.

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