

Lung ventilation and the strength of the respiratory muscles of women in the third trimester of pregnancy in the aspect of physical activity

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Summary

The research concerned assessment of the respiratory function and function of the respiratory muscles of women in the third trimester of pregnancy in terms of the level of their physical activity. Using the ATS/ERS assessment criterion, there was no lung ventilation disorder in the studied groups of women. The results of the study indicate that in women who were more active, the values of all measured functional parameters of the respiratory system were higher. In almost all women, irrespective of the level of physical activity, the strength of the inspiratory muscles was found to decrease. The majority of surveyed women undertook physical activity in the form of walking with varying frequency during the week, but only a few of them had undertaken a more intense physical effort. Pregnant women frequently do not undertake more demanding activities due to concerns about the child.

Key words: Pregnant women; Inspiratory muscle strength; Respiratory function.

Introduction

Changes in the respiratory system are strongly associated with changes in the endocrine system. Increased progesterone secretion during pregnancy raises the sensitivity of the CO₂ respiratory centre and reduces the airway tone, thereby increasing the ventilation of the lungs. This results in a decreased partial pressure of carbon dioxide in the blood and consequently in an increase in PaO [1, 2] respiratory parameters such as residual volume (RV), expiratory reserve volume (ERV) and functional residual capacity (FRC), which are gradually reduced in the second half of pregnancy [2]. The forced vital capacity (FVC) increases significantly over 14–16 weeks of pregnancy, and FVC % is higher in multiparas than in primiparas, suggesting that changes in FVC occurring during pregnancy also continue after delivery [3]. The vital capacity of the lungs remains unchanged, and the total lung capacity decreases gently as a result of the residual volume reduction (RV) [4]. At the same time, the peak expiratory flow rate (PEFR) and forced expiratory volume in 1 second (FEV₁) do not change as they are independent of pregnancy. Pregnant women may also experience a subjective feeling of dyspnoea. Often this is a physiological symptom, usually occurring in the third trimester of pregnancy, which usually appears at rest or during a long conversation. The feeling of breathlessness can be reduced by physical activity [5].

The American College of Obstetricians and Gynecolo-

gists recommends that during pregnancy, women should perform at least 30 minutes of moderate-intensity exercise several times a week [6].

Moreover, according to the literature, exercising by pregnant women increases cardiorespiratory fitness and can potentially correct posture and shorten the time of postnatal regeneration [7, 8]. On the other hand, some people think that physical activity can slow foetal development by reducing the supply of oxygen and metabolic substances necessary for normal foetal growth [9].

A literature review by Tiffany Field (2011) showed that only about 40% of pregnant women exercise. At the same time, up to 92% of pregnant women are encouraged by their doctors to perform exercises. Low-intensity exercises such as aerobics in water reduce lower back pain. The mechanism involving exercises during pregnancy produces positive results in the form of a reduction in the level of cortisol and substance P and also increases serotonin levels, which may result in the reduction of pain. However, there is a need for more controlled studies to formulate recommendations on the type and amount of exercise during pregnancy [10].

Therefore, this study aimed to assess the respiratory function and function of the respiratory muscles of women in the third trimester of pregnancy in terms of the level of their physical activity.

Table 1. — Somatic characteristics in the studied women

Variables	Group I	Group II	<i>p</i>
	Mean ± SD	mean ± SD	
Age [years]	28.67 ± 3.5	30.11 ± 3.18	0.08
Body height [cm]	168.28 ± 6.76	169.89 ± 4.54	0.45
Body weight [kg]	67.42 ± 11.09	75.89 ± 7.11	0.99

Material and Methods

The study included 28 nulliparous female subjects in their third trimester of pregnancy, all participating in child-birth classes. The anthropometric characteristics of the subjects are presented in Table 1. In the studied women, there were no respiratory diseases, and they did not smoke. Participants of the study were divided into two groups in terms of the level of physical activity calculated by the MET, assessed from the IPAQ questionnaire: group I consisted of pregnant women who scored below 2000 MET/week, while group II comprised pregnant women whose physical activity exceeded the value of 2000 MET.

Functional evaluation of the respiratory system was performed with the MasterScreen Pneumo. Measurement of the flow/volume (intense exhalation test) was performed according to the criteria of the American Thoracic Society and the European Respiratory Society [11].

The following parameters were considered in this study: vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), forced expiratory volume in 1 second % of vital capacity (FEV₁% VC), maximal expiratory flow for 50% FVC (MEF₅₀) and peak expiratory flow (PEF). For the assessment of ventilation disorders, a criterion was adopted where the standard is 75% and more of the FVC and FEV₁. Values below 75% of the FVC indicate the existence of restrictive lung ventilation disorders, while values below 75% of FEV₁ are considered to be obstructive ventilation disorders [12].

Moreover, a measurement of the respiratory muscle strength was performed: maximum inspiratory pressure (PI_{max}) and maximum expiratory pressure (PE_{max}). To assess the strength of the respiratory muscles a special adapter from MasterScreen Pneumo was used. The test was carried out under the ATS/ERS guidelines [11]. The ATS/ERS Statement on Respiratory Muscle Testing (2002) was used to assess the correctness of the inspiratory muscle strength. A PI_{max} greater than or equal to 80 cm H₂O is considered to be the correct value.

To assess the level of physical activity of pregnant women, a short version of the standardised International Physical Activity Questionnaire (IPAQ) was used, and an interview was conducted during pregnancy regarding pain and co-morbidities. The questionnaire evaluated physical activity in the last seven days [12]. By the time the subject performed a physical activity, the MET metabolic equivalent value (minimum/week) was calculated, and the degree of physical activity is determined [13].

Results

The results presented in Table 2 do not show significant differences in functional parameters of the respiratory system between the examined groups, although slightly higher values were noted in women with a higher level of physical activity. The significant differences concerned only the parameters of physical activity, which constituted the criterion of division into two groups.

Using the ATS/ERS assessment criterion, there was no lung ventilation disorder in the studied groups of women. However, when evaluating the work of inspiratory muscles (inspiratory muscle strength), using the ATS/ERS criterion Statement on Respiratory Muscle Testing (2002), in all subjects PI_{max} values below 80 cm H₂O were found.

The relationships between inspiratory and expiratory muscles, somatic and functional parameters of the respiratory system and the level of physical activity were evaluated (Table 3). In the first group with a lower level of physical activity, significant inspiratory muscle correlations concerned only the expiratory volume of the first second and the flow through the small bronchioles. In turn, in relation to expiratory muscles, significant correlations were noted between the flow through small bronchioles, MET value and body height. In addition, the MET value correlated with body height and peak expiratory flow expressed as a percentage, and the amount of time spent during daytime activity in the form of a walk was associated with flow through small bronchioles, as well as with peak expiratory flow expressed as a percentage (Table 3).

In the second group, where women were characterised by a higher level of physical activity, inspiratory muscles significantly correlated only with expiratory muscles. Moreover, expiratory muscles significantly correlated with the height of the body. Also, the value of MET correlated with the amount of time spent during the day walking, while the amount of time spent sitting was related to body weight (Table 3).

Discussion

The results of the study indicate that in more active women, the values of all measured functional parameters of the respiratory system were higher. However, the differences were not statistically significant. Studies have also shown that the subjects do not have pulmonary ventilation abnormalities, but a significant reduction in inspiratory muscle strength was noted. According to the literature, during pregnancy hormones change and progressive

Table 2. — Descriptive characteristics of functional parameters and the significance of differences between groups

Variables	Group I Mean ± SD	Group II mean ± SD	<i>p</i>
VC [l]	3.46 ± 0.54	3.57 ± 0.46	0.65
VC %	89.73 ± 11.56	91.23 ± 11.39	0.78
FVC [l]	3.39 ± 0.55	3.5 ± 0.5	0.67
FVC %	89.48 ± 12.38	90.89 ± 12.16	0.81
FEV ₁ [l]	2.99 ± 0.47	3.08 ± 0.55	0.69
FEV ₁ [%]	90.27 ± 11.83	91.76 ± 15.59	0.82
PI _{max} [kPa]	3.89 ± 2.7	4.18 ± 1.14	0.76
PI _{max} [%]	35.17 ± 24.3	37.79 ± 10.5	0.77
PE _{max} [kPa]	3.7 ± 1.66	3.71 ± 2.54	0.99
PE _{max} [%]	41.89 ± 18.78	42.37 ± 28.92	0.97
FEV ₁ % VC _{max} %	88.66 ± 11.19	85.97 ± 5.8	0.38
MEF ₅₀ [L/s]	12.73 ± 25.77	4.39 ± 1.42	0.86
MEF ₅₀ [%]	81.65 ± 38.96	96.03 ± 30.8	0.79
PEF [l/s]	13.56 ± 24.14	5.49 ± 1.5	0.72
PEF [%]	67.93 ± 28.3	74.94 ± 20.85	0.38
Assessment of physical activity	1.56 ± 0.53	2.67 ± 0.5	0.96
MET [min./week]	850.5 ± 292.10	3884.44 ± 1207.35	0.00
Walking [days]	5.22 ± 1.79	6.78 ± 0.67	0.04
Walking [h]	0.88 ± 0.49	2.78 ± 0.97	0.00
Sitting [h]	6.39 ± 2.42	5.67 ± 2.69	0.53
Activity before pregnancy	0.44 ± 0.53	0.78 ± 0.44	0.00

abdominal volume grows, which may have a mechanical and functional effect on the respiratory function. However, the increased lateral diameter of the chest, resulting from a wider subvertebral angle, opposes the effect of enlarging the pregnant uterus and elevated diaphragm, leaving the function of the lungs changed, but undisturbed, during pregnancy [14]. This statement may explain the attainment of correct values of lung ventilation parameters by the examined women. The results of the research by Grindheim *et al.* (2012) indicate that during pregnancy, respiratory parameters are within the normal range of predicted values, and in subsequent trimesters, the values of intensive life capacity of the lungs and peak respiratory flow even increase [3]. Other authors also point to the proper ventilation function of the lungs during pregnancy [15].

Lemos *et al.* (2010), in studies on pregnant women, showed no significant difference between PI_{max} and PE_{max} in individual trimesters of pregnancy. All of the 120 women tested were in their first pregnancy, their average age was 23 and the gestational age was between 5 and 40 weeks. The authors divided subjects into three groups indicating the trimester they were currently in. They assessed the strength of inspiratory and expiratory muscles. Additionally, to determine the level of physical activity, they used the IPAQ questionnaire. After analysing the responses, they determined that over half of the women had low levels of physical activity, a third had moderate levels and only a few women had a high level of physical activity. The low physical activity level among these pregnant

women coincides with the results of their research, especially in the first group. The researchers showed the dependence of the level of physical activity with the PI_{max} and PE_{max} values [16]. In this study, in the first group, correlations between the level of physical activity and the strength of the expiratory muscles were also noted – PE_{max}. The difference between the tests assessing the significant relationship between the state of the respiratory system and the level of physical activity may be due to the fact that Lemos *et al.* compared the strength of respiratory muscles at various stages of pregnancy. In this study, they were performed only on a group of women in the third trimester of pregnancy, which was much smaller than the one from the compared study. Other results were obtained by Pinto *et al.* (2015), who found that the strength of respiratory muscles and chest mobility decrease with the advancement of pregnancy [17].

The results of own tests of respiratory muscle strength confirm this trend, in almost all women, irrespective of the level of physical activity undertaken, the strength of the inspiratory muscles has been found to decrease. In other studies, there was no reduction in respiratory parameters during pregnancy [16]. It is possible that the age of pregnant women does play a role, in our studies the average age of the respondents was 29 years, while the oldest woman was 38 years old. In their studies, Lemos *et al.* [16] placed special emphasis on women not older than 30 because after this the respiratory system functions significantly decrease, which has a significant impact on the PI_{max} and PE_{max} values

Table 3. — Correlation of measured parameters in group 1 and group 2

Variables	Correlation of Spearman's rank order					
	Marked correlation coefficients are significant from $p < 0.05$					
	Group I			Group II		
	PI _{max} (mmHg)	PE _{max} (mmHg)	MET-min./week	PI _{max} (mmHg)	PE _{max} (mmHg)	MET-min./week.
Age	0.44	-0.26	-0.53	-0.57	-0.56	-0.18
Body height [cm]	0.1	0.83	0.78	-0.59	-0.83	-0.23
Body weight [kg]	0.23	0.02	-0.18	-0.1	-0.42	-0.07
PI _{max} [mmHg]	1.00	0.42	-0.1	1.00	0.87	-0.29
PI _{max} [%]	1.00	0.42	-0.1	1.00	0.87	-0.29
PE _{max} [mmHg]	0.417	1.00	0.71	0.87	1.00	-0.08
PE _{max} [%]	0.47	0.97	0.76	0.87	1.00	-0.08
VC _{max} [l]	0.53	0.33	-0.05	-0.17	-0.02	-0.05
VC _{max} [%]	0.62	0.05	-0.4	0.08	0.35	0.05
FEV ₁ [l]	0.55	0.63	0.36	0.07	0.13	-0.24
FEV ₁ [%]	0.83	0.25	-0.18	0.02	0.22	-0.08
FVC [l]	0.45	0.37	0.08	-0.1	0.04	-0.07
FVC [%]	0.58	-0.02	-0.42	0.08	0.28	-0.09
FEV ₁ % VC _{max}	0.28	0.37	0.38	0.17	0.00	0.2
MEF ₅₀ [l/s]	0.6	0.6	0.21	0.32	0.28	-0.07
MEF ₅₀ [%]	0.67	0.02	-0.24	0.48	0.53	-0.08
PEF [l/s]	0.33	0.38	-0.11	0.23	0.35	0.25
PEF [%]	0.43	-0.33	-0.73	0.43	0.55	0.13

[18].

Despite the lack of reference values of the PI_{max} and PE_{max} of pregnant women, the results can be compared to the criterion according to ATS/ETS (2002), which was used in this work.

The short version of the standardised international IPAQ questionnaire was used to assess the level of physical activity of pregnant women due to its quick and accessible form.

In the interview conducted with respondents regarding pre-pregnancy sports, more than half of the women responded affirmatively, but after conducting the IPAQ questionnaire, it turned out that during pregnancy the level of physical activity was much lower. A similar relationship was demonstrated by Brzęk *et al.* (2016), who stated that the level of physical activity decreased significantly in pregnant women who previously practised sport [19].

In this study, the majority of the surveyed women undertook physical activity in the form of walking with varying frequency during the week. Only a few primiparas decided to undertake more intense physical exercise. For this reason, only the IPAQ results relating to walking and sitting are included in this paper. Women very often do not undertake more demanding activities for the cardiovascular system due to concerns about the child.

Conclusions

- i. There were no lung ventilation disorders in the studied groups of women.
- ii. The inspiratory muscle strength in women in the third

trimester of pregnancy was reduced.

iii. There was no relationship between the condition of the respiratory system and the level of physical activity in women in the third trimester of pregnancy. Only in the group of less active women in the third trimester of pregnancy was there a significant dependence of the peak inspiratory flow and exhaust muscle strength with the energy expenditure of MET.

iv. The most commonly undertaken form of physical activity by pregnant women was walking; they sporadically made a moderate and intense effort.

Conflict of Interest

The authors declare no competing interests.

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