

# Influence of Number of Pregnancies in Peak Expiratory Flow and Body Composition of Pregnant Women

ORIGINAL

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## Abstract

**Objectives:** To describe and compare the mean values of the body composition and the peak expiratory flow (PEF) in primigravidae and multigravidae and, to determine its correlation with obstetric, anthropometric and body composition variables.

**Method:** It was performed a cross-sectional study of 120 healthy pregnant women at low risk, including 77 primigravidae and 43 multigravidae. The PEF was measured by spirometry and the body composition by multisegmental electrical impedance. The unpaired t test was used to compare the groups and the Pearson correlation test was used to determine the association between PEF and independent variables. A multiple linear regression was used to estimate the relationship between the dependent variable, the PEF and the independent variables.

**Results:** The body composition variables in multigravidae women showed higher values compared to the primigravidae, being statistically significant, except for fat mass. In primigravidae, the PEF was correlated significantly with maternal age and height. In multigravidae, the PEF was correlated with maternal age, height, pre-pregnancy and current weight, total body water, extracellular water, fat mass, lean mass and fat-free mass. A Multiple linear regression analysis showed that, in primigravidae, height and maternal age were associated with

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PEF, being responsible for explaining 14.5% of its variability. The current weight and the maternal age explained 42.3% of peak flow variability in multigravidae.

**Conclusion:** The PEF seemed to be influenced by the number of pregnancies. Changes were observed in relation to the body composition, as it was evidenced in correlation with the PEF in multigravidae women.

**Keywords**

Pregnancy; Spirometry;  
Weight Gain.

## Introduction

The gestational period is marked by various anatomical, physiological and endocrine changes, so that women can cope with an increase in the physical needs and metabolic demands [1-3]. Adjustments in the ribcage occur, aiming to accommodate the expansion of the uterus that moves the diaphragm in cephalic direction in approximately 4cm [4, 5]. It still occurs the expansion of the anteroposterior and transverse diameters of the chest, around 2cm, reflecting in an increase of 5 to 7 cm in the lower chest circumference with elevation of the subcostal angle of the ribcage from 68,5° to 103,5° graus [1-5].

These modifications, along the gravid state, predispose to adjustments in lung volumes and capacities, starting between the eighth and tenth gestational week and peaked around the 37th week [3]. The mechanics of air flow during pregnancy also shows changes with pregnancy [6-9].

The peak expiratory flow (PEF) is characterized by the maximum air flow generated during a forced expiration, starting from the total lung capacity [10]. Studies evaluating PEF behavior in pregnant women have shown divergent results [8, 11-15]. Transverse or longitudinal studies involving pregnant women and non-pregnant group showed no significant reduction of PEF, which can be explained by hormonal

and mechanical adjustments, occurred during the pregnancy cycle [8, 9, 11]. However, other studies suggest a decrease of this flow due to the reduction in muscle contraction strength and anatomical and mechanical adjustments [13, 15].

This parameter was also related to body mass index (BMI), age and maternal height, lying higher flows in pregnant women with higher pre-pregnancy BMI, as well as positive correlation between PEF, age and, height [9]. In view of the factors that can influence the PEF such as sex, age, height, race and BMI [9, 16-18]. It is noted the importance of monitoring changes in pregnancy weight, since the progressive changes in the form and abdomen configuration, diaphragm and ribcage, besides increasing the size of the uterus and fetal growth could compromise pulmonary function during gestation [9, 15, 19].

The maternal body composition undergoes adaptation during the course of pregnancy. The fat mass, the lean body mass and the total body water (TBW) increase as a result of various components, such as the fetus, placenta, amniotic fluid, uterus and breast tissue. Each of these components may vary individually during pregnancy, affecting thereby, the maternal weight gain that is needed for proper growth of the fetus [20, 21].

Utilizing analysis by quadrupole bioelectrical impedance analysis (BIA), changes were evaluated in

maternal composition during the trimesters of pregnancy. A longitudinal study followed 170 pregnant women and observed elevation in body weight, total body water (TBW), extracellular water (ECW) and intracellular water (ICW), confirming that the fat deposition and the increased fluid retention appear to be responsible for gestational weight gain [20]. When comparing primigravidae and multigravidae by the segmental BIA method in the first trimester, it was observed that the mother's average weight, the BMI and the parameters of body composition remain unchanged during early pregnancy, indicating that these changes should start after the first quarter [22].

In a literature review conducted in the databases of PubMed / MEDLINE between the years 1970-2016, we didn't find studies that have evaluated the effect of the number of pregnancies and changes in body composition in PEF in low-risk pregnant women, and there were no reference values for this population.

Thus, this study aims to describe and compare the average values of peak expiratory flow and body composition between primigravidae and multigravidae and to correlate PEF with obstetric, anthropometric and body composition variables.

## Methods

A cross-sectional study examined 120 low-risk pregnant women between the fifth and 40th gestational week. The study was developed in the Physical Evaluation Laboratory at the University Centro Universitário de João Pessoa (UNIPÊ) from November 2015 to May 2016. Women ages between 18-35 years, singletons, and sedentary were included. Those subjects that were unable to undergo the impedance analysis or evaluation of the lung or cardiac function or had been diagnosed with a neuromuscular, a deformity of ribcage or presence of metallic devices, such as cardiac pacemakers and smokers were excluded.

The variables studied were maternal age, height, pre-pregnancy weight and body mass index (BMI), gestational age, fundal height (FH), number of pregnancies, besides the peak expiratory flow (PEF) expressed in liters per second (l/sec).

The body composition was assessed using the following parameters: current weight (kg), current BMI (kg/m<sup>2</sup>), body fat mass, lean mass and fat-free mass expressed in kilograms, total body water (TBW) and extracellular water (ECW) expressed in liters (l).

The height was measured by a stadiometer (Standard Sanny® -ES 2030- Sao Paulo, Brazil). For evaluation, the pregnant woman wore light clothing and was barefoot with heels together and arms relaxed along the body. She was instructed to remain as upright as possible, with the head directed vertically and to take a deep breath at the time of measurement [23].

The assessment of the body composition was done by Bioelectrical impedance analysis (BIA) (In-Body 720®, BSM-230, Seoul, Korea), which uses the direct segmental multi frequency measurement method through the quadrupole electrode system with eight tactile points-two points on each foot and two in each hand. The measurement of the impedance value of each body segment (right and left arms, trunk, left and right legs) uses the frequencies of 1KHz, 5KHz, 50KHz, 250kHz, and 500KHz 1,000 KHz [24].

To perform the test, the environment remained with temperature between 23C° and 25C° and women were told to take a minimum fasting of 4h, to not practice exercise, to wear shorts or Lycra pants with top. It was also required that they used the toilet in order to reduce the volume of urine and faeces, as well as remove all the trappings of metals. At the time of measurement, the volunteer was positioned standing on the basis of equipment and centrally on the electrodes holding the hand-pieces and keeping slightly open and relaxed arms for about 4 minutes [24].

After assessment of the body composition, the pregnant woman was invited to have lunch and wait about 10 minutes to then be submitted to the evaluation of the PEF with a spirometer (KoKo<sup>®</sup> Spirometer, Fleisch-type, Colorado, USA). The assessment took into account the standards guided by the American Thoracic Society (ATS). The spirometer was calibrated before each test and the temperature remained between 23C° and 25C°. The test was repeated at least three times and a maximum of eight times to ensure the understanding of the participant, for which the value of the analyzed parameters could not exceed 10% of each measure accepted and the best of the three curves was selected. The procedures were carefully described in order to avoid leakage around the mouth and furthermore using a nose clip to prevent leakage of air through the nose [25].

For the evaluation, participants remained seated keeping upright chest and the head in a neutral position. After some quiet breathing cycles, it was requested a maximum oral inspiration followed by a brief apnea and, soon after, the maximum sustained huffing up maneuver until the capacity of the pregnant woman for at least six seconds, measuring the forced vital capacity (FVC). From this parameter, the system calculated the PEF. It was given a two minute interval between measurements to provide more rest [10, 25].

Data analysis was performed using descriptive statistics with calculation of measurements of central tendency (mean) and dispersion (standard deviation) for the number and proportion variables, categorical variables to characterize obstetric and anthropometric profile of pregnant women. The Kolmogorov-Smirnov test was used to verify the normality of the data. The comparison of means between groups was performed by the unpaired Student's t-test. The Pearson correlation test was used to verify possible correlations between variables. A multiple linear regression model was built to estimate the PEF in primigravidae and multigravidae.

It was considered a 10% significance level for the entry of the variables in the model, withdrawing subsequently all those not persisted associated with a significance level of 5%.

The study was approved by the Human Research Ethics Committee (HREC) of the University UNIPÊ, Paraíba, Brazil under the CAAE: 50141215.9.0000.5176. All pregnant women voluntarily agreed to participate and signed an Informed Consent Form (ICF).

## Results

A hundred and twenty pregnant women were assessed, in which 62.2% (n= 77) were primigravidae and 35.8% (n= 43) multigravidae. The average age of the primigravidae group was 27.1 ± 1.8 and the multigravidae group was 29.1 ± 4.6, differing significantly ( $p= 0.01$ ). There was a significant difference in relation to height ( $p= 0.02$ ) and pre-pregnancy weight ( $p= 0.03$ ). There was no difference between the groups regarding the PEF (**Table 1**).

**Table 1.** Anthropometric, obstetric and respiratory characteristics (mean ± SD) in primigravidae and multigravidae.

Variables	Primigravidae	Multigravidae	p*
	X±SD	X±SD	
Height (cm)	161.3±5.6	163.9±5.9	0.02
Pre-pregnancy weight (Kg)	62.0±11.5	66.9±10.9	0.03
Pre-pregnancy BMI (Kg/m <sup>2</sup> )	23.8±4.0	24.9±3.7	0.16
GA (weeks)	22.2±7.1	24.4±6.7	0.09
PEF	5.52±1.1	5.27±1.3	0.25

BM: Body mass index; GA: gestational age; PEF: peak expiratory flow. X: Mean; SD: Standard deviation.  
\*: Student's t-test.

Regarding the variables of the body composition, multigravidae presented higher average values when compared with primigravidae, being statistically significant, except for fat mass ( $p= 0.15$ ) (**Table 2**).

When correlating PEF with independent variables, there was a significant positive correlation between

**Table 2.** Means of body composition variables between primigravidae and multigravidae.

Variables	Primigravidae	Multigravidae	p*
	X±SD	X±SD	
Current Weight (Kg)	67.3±11.7	73.6±11.7	0.006
Current BMI (Kg/m <sup>2</sup> )	25.8±4.2	27.3±3.8	0.05
TBW (l)	31.1±3.9	34.2±3.9	<0.001
ECW (l)	11.9±1.5	13.2±1.6	<0.001
Fat Mass (Kg)	24.7±7.6	26.8±7.6	0.147
Lean Mass (Kg)	39.9±5.1	43.9±5.1	<0.001
Fat-free mass (Kg)	42.6±5.4	46.7±5.5	<0.001

TBW: Total body water; ECW: Extracellular water. X: Mean; SD: Standard deviation. \*: Student's t-test.

maternal age and height in the group of primigravidae women. In multigravidae, there was a correlation with maternal age, height, pre-pregnancy and current weight, TBW, ECW, fat mass, lean mass and fat-free mass, all positive and statistically significant (Table 3).

**Table 3.** Correlation between peak expiratory flow and independent variables in primigravidae and multigravidae.

Independent Variables	PEF (l/sec)			
	Primigravidae		Multigravidae	
	r	p*	r	p*
Age (years)	0.240	0.04	0.385	0.01
Height (cm)	0.271	0.02	0.363	0.02
Pre-pregnancy Weight(Kg)	0.100	0.39	0.400	0.008
Current Weight (Kg)	-0.020	0.86	0.477	0.001
GA (weeks)	-0.137	0.24	0.072	0.65
TBW (l)	0.146	0.21	0.438	0.003
ECW (l)	0.119	0.30	0.418	0.005
Fat Mass (Kg)	-0.126	0.27	0.413	0.006
Lean Mass (Kg)	0.133	0.25	0.440	0.003
Fat-free mass (Kg)	0.135	0.24	0.442	0.003

PEF: peak expiratory flow; GA: gestational age; TBW: Total body water; ECW: Extracellular water. \*: Pearson's correlation coefficient.

A multiple linear regression analysis showed that in primigravidae height and maternal age were independently associated with PEF, which explained 14.5% of its variability reflected by the following equation:  $PFE = -5.776 + 0.058 \times \text{height} + 0.071 \times \text{age}$ . In multigravidae, maternal age and current weight were independently associated with PEF, which explained 42.3% of its variability resulting in the equation:  $PFE = -2.634 + 0.124 \times \text{age} + 0.058 \times \text{current weight}$  (Tables 4 and 5).

**Table 4.** Results of the multiple linear regression model for the peak expiratory flow in primigravidae.

PEF	Final Model*	
	Coefficient	P
Maternal Age	0.071	0.02
Height	0.058	0.007
R <sup>2</sup>	14.5	

\* ANOVA Test: p<0.001.

**Table 5.** Results of the multiple linear regression model for the peak expiratory flow in multigravidae.

PEF	Initial Model*		Final Model*	
	Coefficient	p	Coefficient	p
Maternal Age	0.124	0.001	0.124	0.01
Height	0.120	0.39	-	-
Pre-pregnancy Weight	-0.65	0.05	-	-
Current Weight	0.058	<0.001	0.058	<0.001
TBW	-0.126	0.57	-	-
ECW	-0.154	0.51	-	-
Fat Mass	0.159	0.64	-	-
Lean Mass	-0.122	0.61	-	-
Fat-free Mass	-0.113	0.64	-	-
R <sup>2</sup>	42.3%			

TBW: Total body water; ECW: Extracellular water. \*: ANOVA Test: p<0.001.

## Discussion

This study indicates that there is no difference in PEF when comparing primigravidae and multigravidae.

vidae. However, the variables of body composition (current weight and BMI, TBW, ECW, lean mass and fat-free mass) showed significant increase in multigravidae. In primigravidae, the modifications in PEF are influenced by maternal age and height, as in multigravidae, maternal age and current weight were more decisive.

The PEF mean values showed no difference in pregnant and multigestas ( $p < 0.25$ ). It can be assumed that the results are linked to hormonal changes, such as elevation of progesterone and estrogen that reduce pulmonary resistance, plus anatomical and mechanical changes, as enlargement of the lower chest, elevation of the last ribs and diaphragm, leading to reduction of the angle costophrenic, which provides an adjustment in respiratory function during the gravid cycle [4, 6].

Studies demonstrate that the changes in airway resistance have been discarded, since due to hormonal influences, especially progesterone and relaxin, there are adaptations in the connective tissue and in the smooth muscle due to pregnancy status, increasing the conductance of the airways, thus keeping its functionality [3, 5, 26].

In the current research, the multigravidae women presented higher chronological age, height and pre-pregnancy weight than the primigravidae, with no significant difference in the mean values of PEF. However, another study revealed that in women with higher height and pre-pregnancy BMI presented greater expiratory flows [9]. Within this finding, even with similar demographics, there is a difference in the results. It is believed that this distinction may be related to the type of study, the sample size and, the influence of the number of pregnancies, result that we found in this study, leading us to believe that the mechanical and hormonal adjustments occur regardless of the number of pregnancies.

Corroborating the study in scene, a cohort of 100 pregnant women was accompanied during the trimesters of pregnancy and six months after the delivery. The PEF was decreased when comparing its

values during pregnancy and after delivery. However, there was no difference when comparing multigravidae and primigravidae, thus, no difference was found by relating the pre-pregnancy weight and the weight gain [14]. In this sense, it is suggested that the number of births also does not influence the PEF values, which may be related to the changes imposed by pregnancy as a result of the hormonal changes, such as elevation of progesterone and estrogen, in addition to mechanical changes as enlargement of the lower chest, elevation of the last ribs and diaphragm, allowing an adjustment of the respiratory function to meet the demands of the mother and fetus without causing repercussions during the gravid state.

In this study, the body composition showed higher average values in multigravidae than in primigravidae, which presented significantly different findings, suggesting that the number of pregnancies may influence weight gain during the gravid state. Additionally, the multigravidae volunteers exhibited higher age and pre-pregnancy weight. These findings corroborate with other studies that demonstrate the influence of pre-pregnancy weight and the number of children in excessive weight gain during pregnancy [27-28]. It is believed that these findings may occur due to physiological changes associated with pregnancy, besides the changes in life habits of mothers for taking the time to care for their children.

A retrospective cohort study followed 27,771 women in their first and second pregnancies. It was observed, by BMI measurement that, women with excessive weight gain in the first pregnancy are 2.6 times more likely to gain weight inappropriately in the second pregnancy [29]. Even using different methodology as the study design and the method of assessment of body composition, the results of the survey are similar, emphasizing the influence of pre-pregnancy weight in excessive weight gain during pregnancy. Therefore, it is seen the need for the health professional to act preventively through

health education, preventing harm to the pregnant woman.

Another study evaluated 1,000 caucasian women in the first trimester, 49.2% primigravidae and 52.8% multigravidae. It was observed that the mother's average weight, BMI and body composition parameters were unchanged during early pregnancy, indicating that changes had begun after the first quarter [22]. In our study, we observed a significant increase in the mean values of body composition in multigravidae when compared to primigravidae. It is pointed that these women could be in any trimester, thus differing from the study cited above. Besides that, it is emphasized that the changes in body composition occur during pregnancy, in which the woman's body passes through adaptive changes. The growing fetus, the placenta, the amniotic fluid, the increasing of the uterus and breast tissue as well as the expansion of blood volume are aspects that favor the elevation of body compartments to suit the demands of pregnancy [21].

Anthropometric and body composition variables showed correlation with the PEF, corroborating with the results of several other studies [9, 16, 19, 30, 31]. The results of our research elucidated that maternal age and height were positively related to the PEF in primigravidae. In multigravidae, a positive correlation was seen between maternal age, height, pre-pregnancy and current weight, TBW, ECW, fat mass, lean mass and fat-free mass, noting that in multigestas in addition to age and height, the usual parameters that influence lung function, the variables of body composition also have association, contributing to a major change in PEF.

A multiple linear regression analysis showed that height and maternal age were associated with PEF in primigravidae, being responsible for explaining 14.5% of its variability. In multigravidae, maternal age and current weight were independently associated with PEF, explaining 42.3% of its variability.

These findings increase the importance of weight control during pregnancy, since weight gain may

influence the changes in PEF, predisposing to clinical implications in the follow-up of pregnant women with respiratory diseases, which may be exacerbated by inadequate weight gain. It also draws attention to important points related to weight gain during pregnancy, since the balance of caloric intake to physical activity, involving multi factorial aspects such as socio-cultural conditions, metabolic and genetic issues that produce maternal and neonatal effects, as well as long term consequences in women's health [28].

In the face of what has been exposed, the research emphasizes the existence of divergences in the results available on the PEF study in pregnant women, perhaps for lack of a better sample delineation or the adoption of different methodologies. In addition, the studies were limited to pregnant women approach in the three quarters and only one study compares the PEF behavior in nulliparous and primiparous.

Furthermore, the current study is important in regard to the comparison of PEF in pregnant women considering the number of pregnancies. Another contribution refers to the fact that the influence of the variables of body composition (current weight, TBW, ECW, lean mass, fat mass and fat-free mass) was addressed in the PEF, as the other published articles only relate BMI and weight in changes of lung function during pregnancy.

Whereas there are no studies with healthy pregnant women taking into account the number of pregnancies or the influence of the variables of body composition using the assessment by bioimpedance technology in changes of PEF, it is suggested the continuity of the study including the longitudinal follow-up of pregnant women to better evaluate the changes in body composition, as well as other obstetric characteristics that may influence lung function.

Moreover, it is believed that with a detailed study of body composition, which can adequately characterize pregnant women about the nutritional sta-

tus, it envisions the possibility of a conception of normal standards for PEF in the studied population taking into account the nutritional status of these individuals to provide a better monitoring of lung function in women with excessive weight.

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