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Peak Expiratory Flow: It's Correlation with Age and Anthropometric Parameters in Healthy Pregnant Women in Lubumbashi

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Abstract

Introduction: Peak Expiratory Flow (PEF) is a non-invasive and less expensive method which allows the clinician to have a fair appreciation of the adaptation of the female respiratory system to pregnancy and allows him to make a good development of respiratory pathologies. This study aims to demonstrate the association between age and anthropometric parameters and PEF in pregnant women.

Methods: This is an analytical cross-sectional study that was conducted for 18 months and included 210 pregnant women. The data were analyzed with SPSS 20 software; the parametric comparison tests of 2 means and F of Fisher-Snedecor were used to assess the differences observed between the study parameters. The significance level was set at $p<0.05$.

Results: Of the 210 pregnant women considered in the study, 104 (49.5%) were in the 2nd trimester and 106 (51.5%) in the 3rd trimester. Among the anthropometric parameters considered (BMI, Brachial perimeter, Abdominal perimeter, Weight and Height), only height had a statistically significant correlation with DEP ($p=0.02$). However, it should be noted that gestational age ($p=0.03$) and fundal uterine height ($p=0.035$) showed significant negative correlations with DEP. We did not find a correlation between age and PEF.

Conclusion: To better appreciate the differences in correlation between the different parameters and the PEF in our environment compared to the results found elsewhere, studies in the general population and in pregnant women, including control groups, should be conducted.

Keywords: Peak expiratory flow; Age; Anthropometric parameters; Pregnant

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Introduction

Pregnancy is characterized by major adaptations of the maternal anatomy, physiology and metabolism, which are essential for carrying the pregnancy to term. Hormonal changes alter maternal physiology and persist throughout pregnancy and the postpartum period [1]. With regard to the respiratory system, under the influence of elevated estrogens, the nasopharyngeal mucosa becomes hyperemic and edematous, with hyper secretion of mucus [2]. Mechanical changes occur earlier in pregnancy and consist of an increase in the chest angle, from 68 to 103 degree, the transverse diameter of the chest increases by 2 cm and its circumference, from 5 to 7 cm. With the progression of pregnancy, the diaphragm rises by 4 cm while its depression increases by 1 cm to 2 cm under the action of progesterone on the central chemoreceptors [3]. Pregnant women hyperventilate (increase of 50% to 60%) because of progesterone which decreases the sensitivity of the respiratory centers during pregnancy [4].

Peak Expiratory Flow (PEF) is a maximum speed of the breath during a forced expiration [5]. It is evaluated using the peak flow meter, an instrument invented by Wright in 1959 and which is more advantageous than the pneumometer and the puff meter invented earlier (always for the purpose of measuring PEF). This instrument uses forced expiration alone as a method of assessing ventilatory capacity, which became increasingly popular in the 1950s [5-7]. The measurement of

PEF is a simple and rapid test which objectively assesses the degree of obstruction of the bronchi [7]. It is known that respiratory function varies considerably according to ethnicity and region in addition to age, sex and anthropometric parameters (weight, height and chest circumference) [5-7]. The changes in the rib cage and diaphragm described above induce changes in the pulmonary static volumes [8]. The residual functional capacity decreases by 20% to 30%, itself composed of the volume of expiratory reserve and the residual volume, both, also reduced [9]. This drop is more marked in the sixth month of pregnancy. The volume of inspiratory reserve increases by 5% to 10% so that the total capacity of the lungs composed of the functional residual capacity and the volume of inspiratory reserve remains unchanged or decreases by less than 5% in the long term [10]. Although it is conventionally accepted that the maximum expiratory volume at the first second and the PEF remain unchanged, different studies have observed variable effects on the PEF. Some authors find it lowered (from 6 weeks to postpartum, in supine position) while others find it high [9,11].

The objective of this study is to look for a possible association between PEF and age as well as anthropometric parameters in pregnant women in our environment.

Methods

An analytical cross-sectional study was carried out for 18 months (from April 2016 to October 2017). It included 215 pregnant women recruited during prenatal consultations in 2 health facilities in the city of Lubumbashi (General Reference Hospital of Kamalondo and Polyclinique Shalina) in the Democratic Republic of Congo.

All subjects met the criteria for inclusion in the study: (1) Being pregnant, (2) giving free and informed consent, (3) being able to follow the instructions for the test. Exclusion criteria were as follows: (1) respiratory symptoms less than 3 months old, (2) smoking, as well as a history of (3) chronic respiratory disease, (4) major systemic disease, (5) neurological or otorhinolaryngological disease, (6) taking drugs that may interfere with PEF and (7) deformation of the chest or spine.

After a complete examination confirming the pregnancy and excluding pathological elements interfering with the results of the PEF, anthropometric parameters were taken. The weight (expressed in kilograms) was taken using a balance, the pregnant women being dressed lightly and barefoot. The height measured by a stadiometer, the pregnant woman standing and barefoot. The abdominal and brachial perimeters as well as the uterine height were taken with a flexible and inelastic tape. The measurement of the fundal uterine height was performed with the pregnant woman in the supine position with uncovered abdomen and lower limbs extended. The initial end of the flexible and inelastic tape was attached to the top edge of the pubic symphysis, passing it between the index and middle fingers until the cubital edge of the hand reaches the fundus of the uterus.

Regarding the PEF, explanations and a clear demonstration were made before the pregnant before they proceed to 3 tests of which only the highest result was retained. For the whole study, we used two Mini-Wright Peak Flow Meter (Standard Eu).

Data were analyzed using SPSS 20 software and presented as means and standard deviations. The possible correlation between the PEF and other variables was tested using the Bravais-Pearson coefficient *r* while the differences in distribution of the variables between trimesters were evaluated by the means comparison test. The significance level was set at $p<0.05$. Linear regression models explaining PEF (dependent variable or to be explained) by other parameters (explanatory variables) were tested by Fisher's F test for the coefficient of determination R^2 at $p<0.05$ and Student's *t* test for the coefficients of the regression model at $p<0.05$.

Results

Characteristics of pregnant women

Of the 215 pregnant women considered in the study, 5 were in the first trimester, 104 in the second trimester and 106 in the third trimester. The 5 pregnant women of the first trimester were eliminated from the study given this small number. The study covers 210 pregnant women, including 104 (49.5%) in the second trimester and 106 (50.5%) in the third trimester.

With regard to demographic and obstetrical characteristics, the distributions of the two trimesters show no significant difference for age, gravidity and parity. However, the difference was significant for gestational age ($p<0.0001$) and fundal uterine height ($p<0.0001$) (Table 1).

Regarding anthropometric parameters, there was no statistically significant difference for the height distribution. On the other hand, for abdominal perimeter ($p<0.0001$), weight ($p<0.001$), body mass index [BMI] ($p<0.001$) and brachial perimeter ($p=0.026$), we noted respectively a very significant statistical difference. Mean values in the second trimester appear to be lower than those recorded in the third trimester. As for mean value of the PEF (in liter by minute) according to the trimesters, it was significantly lower in the third compared to the second (Table 2).

Relationship between PEF and other parameters

In assessing the correlation between demographic, obstetrical and anthropometric characteristics and PEF, only gestational age, height and fundal uterine height showed significant correlations with PEF. However, it should be noted that gestational age and uterine height showed a more pronounced negative correlation with PEF (Table 3).

Table 1: Age and obstetric characteristics of pregnant women by trimester.

Variables	2nd trimester Mean ± SD (n=104)	3rd trimester Mean ± SD (n=106)	p-value
Age (years)	30.1 ± 6.1	28.7 ± 5.8	0.59
Gravidity	4.8 ± 2.9	4.6 ± 2.6	0.65
Parity	3.4 ± 2.7	3.1 ± 2.5	<0.47
Gestational age (weeks)	23.0 ± 3.5	33.7 ± 3.8	<0.0001
Fundal uterine height (cm)	22.1 ± 4.1	30.45 ± 10.5	<0.0001

Table 2: Anthropometric parameters and PEF of pregnant women according by trimester.

Variables	2nd trimester Mean ± SD (n=104)	3rd trimester Mean ± SD (n=106)	p-value
Height (cm)	159.3 ± 6.7	158.7 ± 8.1	0.59
Weight (kg)	63.3 ± 10.9	68.6 ± 11.9	<0.001
Body Mass Index (kg/m^2)	24.8 ± 4.4	27.5 ± 7.6	<0.001
Brachial perimeter (cm)	26.7 ± 3.8	27.5 ± 3.1	0.026
Abdominal perimeter (cm)	90.5 ± 13.1	96.8 ± 10.2	<0.0001
Peak expiratory flow (l/min)	216.0 ± 48.0	200.0 ± 42.0	0.02

Table 3: Coefficients of determination of the relationship between PEF and other parameters.

Variable	PEF	
	r	p-value
Gestational age(weeks)	-0.146	0.0330
Fundal uterine height (cm)	-0.144	0.035
Height (cm)	0.156	0.0221

r: Bravais-Pearson's coefficient

Table 4: Linear regression coefficients of the relationship between PEF and other parameters.

Variables	Coefficient	Standard error	t	p-value
Constant	84.960	67.395	1.261	0.209
Gestational (weeks)	-0.677	0.538	-1.258	0.210
Height (cm)	0.966	0.416	2.320	0.021
Fundal uterine height (cm)	-0.432	0.404	-1.069	0.286

Considering the relationship between PEF and parameters which are significantly correlated to it (Table 3), a first equation to explain the PEF as a function of the Gestational Age (GA), the height and the Fundal Uterine Height (FUH) is presented as follows: PEF= 84,96 – 0,677 × GA+0,966 × Height – 0,432 × FUH.

This model is globally significant (p=0.011) for the R^2 as coefficient of determination. By then testing the share of each of the parameters in the explanation of the PEF as a function of the regression coefficients (Student's *t* test), we had the results shown below (Table 4).

Only the height is significant and explains the PEF (p=0.021). Since there is a large correlation between GA and FUH (r=0.55, p<0.0001), by eliminating one of the two non-significant parameters (GA or FUH), we will have two following possibilities:

- PEF = 80.108 + 0.981 × Height – 0.992 × GA*[significant model (p=0.007)]*

Both parameters become significant both (p_{Height} =0.019 and p_{GA} =0.03).

- PEF = 75.76 + 0.95 × Height – 0.71 × FUH*[significant model (p=0.008)]*

Discussion

The results of our study show that among the anthropometric parameters considered (BMI, Abdominal Perimeter, Brachial Perimeter, Weight and Height), only height has a statistically significant correlation with peak expiratory flow. This observation is in line with those of a few studies where a statistically significant relationship has been demonstrated between height of pregnant women and PEF [12,13]. In India, a case-control study found no statistically significant association between PEF and BMI [6]. Several other studies have noted a correlation between anthropometric parameters and PEF in pregnant women [13]. Nevertheless, height and pre-gestational BMI remain the most correlated elements, as demonstrated in a Brazilian study [14]. The difference in the influence of BMI could be explained by the variation in constitution according to the study populations. A different type of study, including a control group, can provide enough evidence regarding this difference.

Our series found a significant difference between the mean values of PEF in the last two trimesters of pregnancy, with PEF being slightly lowered in the third trimester. These results are corroborated by several authors [14,15].

Patnaik and Mohanty found a statistically significant variation in PEF in the different trimesters, but higher in the first trimester [15]. The fact that this difference is higher in the first trimester could be explained by the fact that progesterone being one of the means implemented, and its rate being greater in the last two trimesters. Other authors have mentioned no difference in different trimesters [13]. We believe that the lack of difference in different trimesters would be justified by the fact that the respiratory adaptation to pregnancy is sufficient to meet maternal and fetal needs without causing repercussions on respiratory functions.

The mean PEF values observed by trimesters in our study are relatively lower than those reported by other authors [6,12,13,15,16]. These differences may be linked to the differences in environments as demonstrated in a study which evaluated pulmonary function tests in pregnant women in rural and urban environments [17]. A case-control study, with non-pregnant women as controls, could help better define this difference.

The results of this study showed a significant negative correlation between gestational age and PEF, that is to say that PEF decreases with the age of pregnancy (the mean value in the third trimester is significantly lower than that observed in the second trimester). Other authors have not found a statistically significant difference on this subject [13,16]. This difference could be related to the type of study and the sample size.

This study did not find a correlation between age and PEF. Despite the fact that age has an immutable influence on PEF in general. Other studies in pregnant women have also not reported a correlation between these two parameters [6,18]. The influence of age on PEF is explained by the contribution of the contraction of the abdominal muscles in the evaluation of PEF which is an effort manoeuvre. During growth, these muscles become more and more powerful and this power decreases with age. Likewise, progressive distension of the abdomen during pregnancy would limit the supply of abdominal muscles by reducing their force of contraction according to Starling's law; which would cause variations in PEF comparable to those related to age.

Indeed, the present study has also highlighted a significant negative correlation between fundal uterine height and PEF. It would therefore be very interesting to assess the PEF in case of hydramnios.

Conclusion

The assessment of respiratory function in general and of PEF in particular, allows us to identify underlying lung pathologies and suboptimal lung function, which are associated with high morbidity in the newborn. We identified height as the only anthropometric parameter with a positive correlation with PEF. Gestational age and fundal uterine height, correlated with each other, were also found to be negatively correlated with PEF.

To better appreciate the differences in correlation between the different parameters and PEF in our environment compared to the results observed elsewhere, studies in the general population and in pregnant women, including control groups, should be conducted.

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