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ORIGINAL ARTICLE

Impact of Parity on Cardiac Structure and Function in Apparently Healthy Pregnant Nigerian Women

Impact de la Parité sur la Structure et la Fonction Cardiaques chez des Femmes Nigérianes Enceintes Apparemment en Bonne Santé

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ABSTRACT

BACKGROUND: There are few and conflicting reports in the literature about the relationship between parity and maternal cardiac function. The study aimed to assess the impact of parity on cardiac structure and function in apparently healthy pregnant women in Nigeria.

METHODS: This was a cross-sectional study carried out in 3 tertiary centers in Kano, and 1 in Ile-Ife, Nigeria. 112 apparently healthy pregnant women were consecutively recruited between the 28th and 38th weeks of gestation, and their cardiac structure and function assessed using echocardiography. Left ventricular (LV) systolic dysfunction was defined as LV ejection fraction of below 50%, and diastolic dysfunction was graded using mitral filling and tissue Doppler velocities.

RESULTS: LV systolic dysfunction and diastolic dysfunction were found in 6 (5.4%) subjects and 20 (17.9%) subjects, respectively. Age (p= <0.0001), left atrial (LA) size (P<0.0001), interventricular septal thickness at end diastole (IVSD) (p= 0.005), posterior wall thickness at end diastole (PWTD) (p=0.004) and QRS duration (p= <0.0001) all increased progressively with higher parity, while tricuspid annular systolic excursion (p=0.320) decreased with higher parity. There was significant positive correlation between parity and age (r= 0.475, p= <0.0001), LA size (r=0.332, p= <0.0001), IVSD (r=0.264, p= 0.005) and PWTD (r= 0.343, p= <0.0001). LV systolic function was not significantly associated with parity.

CONCLUSION: Our findings suggested that parity was significantly associated with myocardial remodeling in apparently healthy pregnant women. **WAJM 2022; 39(10): 1057–1061.**

Keywords: Pregnancy, Parity, Cardiac structure, Peace registry.

RÉSUMÉ

CONTEXTE: Il existe peu de données contradictoires dans la littérature sur la relation entre la parité et la fonction cardiaque maternelle. L'étude visait à évaluer l'impact de la parité sur la structure et la fonction cardiaques chez des femmes enceintes apparemment en bonne santé au Nigeria.

METHODES: Il s'agissait d'une étude transversale menée dans 3 centres tertiaires à Kano et 1 à Ile-Ife, au Nigeria. 112 femmes enceintes apparemment en bonne santé ont été recrutées consécutivement entre la 28* et la 38* semaine de gestation, et leur structure et fonction cardiaques ont été évaluées par échocardiographie. La dysfonction systolique du ventricule gauche (VG) a été définie comme une fraction d'éjection du VG inférieure à 50 %, et la dysfonction diastolique a été graduée en utilisant le remplissage mitral et les vitesses Doppler tissulaires.

RESULTATS: Un dysfonctionnement systolique VG et un dysfonctionnement diastolique ont été trouvés chez 6 (5,4 %) sujets et 20 (17,9 %) sujets respectivement. Âge (p=<0,0001), taille de l'oreillette gauche (LA) (P<0,0001), épaisseur du septum interventriculaire en fin de diastole (IVSD) (p=0,005), épaisseur de la paroi postérieure en fin de diastole (PWTD)(p=0,004) et La durée du QRS (p = <0,0001) a augmenté progressivement avec une parité plus élevée, tandis que l'excursion systolique annulaire tricuspide (p = 0,320) a diminué avec une parité plus élevée. Il y avait une corrélation positive significative entre la parité et l'âge (r = 0,475, p = <0,0001), la taille LA (r = 0,332, p = <0,0001), IVSD (r = 0,264, p = 0,005) et PWTD (r = 0,343, p=<0,0001). La fonction systolique VG était associée à la parité.

CONCLUSION: Nos résultats suggèrent que la parité est significativement associée au remodelage du myocarde chez les femmes enceintes apparemment en bonne santé. n'était pas significatif. **WAJM 2022; 39(10): 1057–1061.**

Mots clés: Grossesse, Parité, Structure Cardiaque, Registre peace.

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Abbreviations: AKTH, Aminu Kano Teaching Hospital; **BP,** Blood Pressure; **CO,** Cardiac Output; **DT,** Deceleration Time; **IVSD,** Interventricular Septal Thickness At End Diastole; **LA,** Left Atrium; **LV,** Left Ventricular; **LVEDD,** Left Ventricular End Diastolic Dimension; **LVEDD,** LV End Diastolic Dimension; **LVEF,** Left Ventricular Ejection Fraction; **LVESD,** Left Ventricular End Systolic Dimension; **MAWSH,** Muhammed Abdullahi Wase Specialist Hospital; **MMSH,** Murtala Muhammed Specialist Hospital; **OAUTHC,** Obafemi Awolowo University Teaching Hospitals Complex; **PEACE Registry,** Peripartum Cardiomyopathy in Nigeria Registry; **PWTD,** Posterior Wall Thickness At End Diastole; **TAPSE,** Tricuspid Annular Plane Systolic Excursion; **TDI,** Tissue Doppler Imaging.

INTRODUCTION

During normal pregnancy, the maternal cardiovascular system goes through immense adaptations which are generally believed to undergo involution after delivery.[1] These adaptations include increases in cardiac output, arterial compliance and extracellular fluid volume, and decreases in blood pressure (BP) and total peripheral resistance.[1] Mean BP gradually falls during pregnancy, with the largest decrease typically occurring at 16 to 20 weeks of gestation.[2] Thereafter, the BP begins to rise approaching pre-pregnancy values. In addition, blood flow to various organs increases, to meet increased metabolic needs of the tissues. The cardiac output (CO) therefore gradually increases and is well-established by 5 weeks of gestation, and reaches to about 50% above pre-pregnancy levels by 16 to 20 weeks, then plateaus and remains elevated until term.[3]

The myocardium undergoes reversible physiological hypertrophy with increase in left ventricular (LV) mass by as much as 30–50%, with 5 to 25% of them having an increased LV mass index.[3,4] Hypertrophy can be seen as early as 12 weeks of gestation, while majority occurs in the third trimester.[4–9] LV end diastolic dimension (LVEDD) appears to increase progressively by the end of the second or early third trimester.[10–12] The end systolic dimension changes are less consistent with some studies showing no change and some showing mild increase at term.[10–12] The left atrial (LA) size increases by a maximum of 14–16%, reaching the peak in the third trimester.[10–12] The changes in LVEDD and LA size are thought to reflect the increase in preload due to a large increase in circulating blood volume.[12]

Maternal cardiovascular mal-adaptation strongly correlates with pregnancy outcomes. It has been demonstrated that maternal LV systolic function adapts worse even at the first trimester in pregnancies that suffer from hypertension complications, premature deliveries and lower birth weights.[13]

Impairment of diastolic function of the LV precedes its systolic dysfunction in the development of most cardiac diseases, and might predict the risk of pregnancy cardiac complications.[14] Studies showed that LV diastolic dysfunction might be associated with onset of preeclampsia.[15,16] It is also suggested that suboptimal adaptations to pregnancy were associated with maternal age, parity and other demographic factors such as height, weight, body surface area and ethnicity.[17]

There are few and conflicting reports in the literature about parity and maternal cardiac function.[18–21] In the present study therefore, we aimed to assess the impact of parity on the cardiac structure and function among apparently healthy pregnant Nigerian women.

METHODS

This was a cross-sectional study carried out in four tertiary centres in Nigeria; three in Kano (Murtala Muhammed Specialist Hospital(MMSH), Aminu Kano Teaching Hospital(AKTH), and Muhammed Abdullahi Wase Specialist Hospital(MAWSH), and one in Ile-Ife (Obafemi Awolowo University Teaching Hospitals Complex(OAUTHC). This is a post- hoc analysis of the Peripartum Cardiomyopathy in Nigeria (PEACE) Registry data, whose study protocol and main results have already been published.[22–24]

In this study, apparently healthy pregnant women attending the antenatal clinics of the study centres were consecutively recruited between 28th and 38th weeks of gestation, after obtaining a written informed consent. Each subject was clinically evaluated and Electro-cardiography and Echocardiography were carried out on each of the patients using standard criteria and methods.[25,26]

A pretested questionnaire was used to collect demographic, clinical and laboratory data. For the purpose of this study, LV systolic dysfunction was defined as LV ejection fraction of below 50%. LV diastolic dysfunction was defined and graded using mitral filling pattern and mitral tissue Doppler imaging (TDI) velocities at the mitral (septal) annular levels as follows:[20]

Normal LV diastolic function: E:A ratio 1–2, deceleration time (DT)160-230 milliseconds (ms) and E/e'<8.

Grade I LVDD (impaired myocardial relaxation in early diastole): E:A<1, DT>240ms.

Grade II LVDD (pseudo-normal pattern): E:A 1–1.5, DT 160–230ms, e'<7cm/s and E/e'>15.0.

Grade III LVDD (restrictive filling pattern): E:A>2.0, DT<120ms, e'<7cm/s, E/e'>15.0.

Ethical approval for the study was obtained from the Ethical Research Committees of the participating centres before the commencement of the study and the study conformed to the ethical guidelines of the Declaration of Helsinki on the principles of medical research involving human subjects.[27]

Data Analysis

Continuous variables were explored for presence of skewness. Proportions, mean with standard deviation, and median with interquartile range were used to summarise subjects' characteristics as appropriate. Chi squared, Fisher's exact, Student's t- and Mann Whitney tests were used to compare continuous and categorical variables, as appropriate.

Relationships between parity and variables of interest were determined using Spearman's correlation coefficient as well as linear regression analyses. P value < 0.05 was used as minimum level of statistical significance. The statistical analysis was carried out using SPSS version 23.0 software.

RESULTS

A total 112 subjects were recruited from the four study sites between June and December 2017. Of these, 53(47.3%) were recruited in AKTH, 24(21.4%) in MMSH, 11(9.8%) in MAWSH and 24(21.4%) in OAUTHC. They were recruited between the 28th and 38th weeks of gestation. Subjects were categorized into four groups based on their parity (para 1, para 2, para 3–4 and para $\geq$5). Comparisons of the baseline clinical and echocardiographic characteristics between the parity groups are presented in Table1.

LV systolic dysfunction and diastolic dysfunction were found in 6(5.4%) subjects and 20(17.9%) subjects, respectively. Age (p= <0.0001), LA size (p= <0.0001), interventricular septal thickness at end diastole (IVSD) (p= 0.005) and posterior wall thickness at end diastole (PWTD)(p=0.004) all increased

Table1: Comparison of the Clinical and Echocardiographic characteristics of the Subjects

Variables	All Subjects n = 112	Para 1 n = 34	Para 2 n = 24	Para 3–4 n = 22	Para ≥ 5 n = 32	p-value
	Demographic and Clinical Characteristics					
Age, years	29.4±5.3	26.9 ± 4.6	26.8 ± 5.5	31.5± 4.2	32.8± 4.3	<0.001*
EGA, months	26.1±10.6	20.6 ± 12.2	25.0± 10.8	26.1 ± 10.1	32.4 ± 4.3	<0.001*
Unemployment	41(36.6%)	10(24.4%)	11(26.6%)	7(17.1%)	13(31.7%)	0.556
No formal education	9(8.0%)	0(0%)	0(0%)	1(11.1%)	8(88.9%)	<0.001*
HR, bpm	91.6±13.0	93.1 ± 12.7	95.8 ± 14.1	89.7 ± 10.6	88.3 ± 12.9	0.151
SBP, mmHg	114.4±10.2	115.6 ± 7.4	114.2 ± 12.0	113.4 ± 11.2	114.4 ± 10.2	0.911
DBP, mmHg	72.4±5.0	71.8 ± 7.57	73.6 ± 7.58	71.9 ± 10.3	72.3 ± 8.58	0.907
Echocardiogram						
LA size, mm	36.7±4.9	34.9 ± 4.2	35.5 ± 5.2	37.7 ± 5.6	38.7 ± 7.6	0.005*
LVEDD, mm	48.6±8.6	48.7 ± 3.9	47.9 ± 5.7	48.8± 5.8	48.9 ± 5.1	0.886
IVSD, mm	7.4±2.1	6.8 ± 1.9	7.3± 2.1	7.9 ± 2.0	7.9 ± 2.3	0.123
PWTD, mm	7.4±2.4	6.7 ± 2.1	6.7 ± 1.92	7.4± 2.35	8.6 ± 2.38	0.004*
LVEF, %	61.8±6.7	63.6 ± 5.5	60.00 ± 6.9	59.7 ± 6.8	62.6 ± 7.2	0.072
Mitral e', cm/s	10.5±3.9	10.3± 2.81	10.4± 1.93	9.6±0.45	13.6± 10.6	0.144
LVDD	28(25%)	9(32.1%)	9(32.1%)	3(7.14%)	7(25.0%)	0.002*
TAPSE, mm	22.8±6.7	25.9 ± 8.8	24.3 ± 5.5	24.1 ± 6.8	21.0± 2.9	0.320
Electrocardiogram						
PR interval, ms	143.3±20.2	145.9± 20.4	136.8± 21.7	146.4± 22.8	143.6± 17.5	0.455
QRS duration, ms	86.1±15.2	77.6± 6.47	76.0± 8.37	91.2± 17.9	95.4± 16.1	<0.001*
QTc, ms	427.1±23.2	428.2± 27.6	433.7± 21.5	428.4± 15.9	421.6± 23.1	0.358

*EGA, Estimated Gestational Age; HR, Heart Rate; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; LA, Left Atrium; LVEED, Left Ventricular End-Diastolic Dimension; IVSD, Interventricular Septal Thickness at End-Diastole; PWTD, Posterior Wall Thickness at End-Diastole; LVEF, Left Ventricular Ejection Fraction; LVDD, Left Ventricular Diastolic Dysfunction; TAPSE, Tricuspid Annular Plane Systolic Excursion. *P value Statistically Significant.*

progressively with higher parity, while TAPSE progressively decreased with higher parity (Table1).

There was significant positive correlation between parity and age (r = 0.475, p <0.0001), LA size (r = 0.332, p <0.0001), IVSD (r = 0.264, p = 0.005) and PWD (r = 0.343, p = <0.0001). However, LV end-diastolic dimension (LVEDD) (r = 0.024, p = 0.806) and LV ejection fraction(LVEF)(r = –0.105, p = 0.275) were not significantly associated with parity among the subjects.

All subjects were in sinus rhythm. There was progressive increase in QRS duration as parity increased, but other ECG indices did not significantly relate with parity (Table1). Linear regression analysis further showed that the progressive increase in QRS duration was determined by the LA size(R^2 = 0.132, p = <0.001), IVSD(R^2 = 0.069, p = 0.014), PWTD(R^2 = 0.241, p <0.001) and TAPSE(R^2 = 0.076, p = 0.01). In addition, the model comprising these four variables could explain 47.0% of the variability of QRS duration of the subjects.

DISCUSSION

In this post-hoc analysis of PEACE registry results, we aimed to determine the impact of parity on cardiac structure and function of apparently healthy pregnant Nigerian women. Firstly, our results showed LV systolic and diastolic dysfunction were uncommon in the apparently healthy pregnant women. Secondly, we found significant positive correlations between parity and age, LA size, IVSD and PWT, and no significant relationship with LV systolic function.

This study has confirmed the previously described hemodynamic and cardiac changes that occur during uneventful pregnancy.[4,17,28–30] There are however, few and conflicting reports on the effect of parity on cardiac structure and function.[29–32] Although pregnancy related physiological changes mostly resolve after delivery, each parity may have an additive effect on these changes. Clapp, *et al* reported that vascular remodeling begins early in pregnancy, persist for at least a year after delivery, and is accentuated by subsequent pregnancy.[18] Our results are aligned in some aspects to those of Parikh, *et al,* who reported a progressive increase in LV mass, LVEDD, LVESD and a decline in LVEF, with increased parity.[31] Although we reported a higher mean LVEF among the primigravida, there was no statistically significant difference among the groups. In addition, we found a progressive increase LA size, IVSD and PWTD with parity. The differences in cardiac function between nulliparous and multiparous women could represent an exaggerated response to the stimuli that lead to maternal reduction in peripheral resistance and increase in cardiac output in early pregnancy. It could be from adaptational mechanisms or remodeling of the heart from previous pregnancies. In normal pregnancy, regression of cardiac changes takes atleast 6months and up to one year postpartum.[18,31]

However, it may even take decades before the changes return to their original values.[31] In contrast, Sadaniantz, *et al* found no significant differences in chamber dimensions, systolic and diastolic function, valvular incompetence and heart rate between 20 multiparous and aged-matched nulliparous women.[32] This suggests that the recurrent volume loading and hormonal changes associated with multiple pregnancies had no significant cumulative effect on heart size and function in this cohort.[32]

Similar to previous reports, the prevalence of LV diastolic dysfunction was low in this study, 17.9%, with no statistically significant difference between the parity groups.[29,30] Melchiorre et al, however, described a much higher prevalence of LV diastolic dysfunction of 46.3% among nulliparous apparently healthy pregnant women in London.[29] In the later study, there was full recovery of cardiac function at one year postpartum. Longitudinal studies are therefore needed to determine whether full recovery would be observed among multiparous pregnant women postpartum.

The electrocardiogram during normal pregnancy may show a wide variation from the normal. Most of the changes that occur can be explained by the physiologic adaptations in response to pregnancy. They may also be due to changed electrical properties of the myocardium due to changes in both the sympathetic and hormonal variations during pregnancy. ECG changes such as reduction in QRS axis, T wave inversion in Leads III and V1-V2, prolongation of QTc and rhythm abnormalities were observed in pregnant women.[33–37] There is paucity of data on the effect the of parity on these changes. In the present study, all the subjects were in sinus rhythm. There was progressive increase in QRS duration as parity increased, but other ECG indices did not significantly relate with parity. An increase in QRS duration could be linked to changes in ventricular depolarization patterns during pregnancy, which may be pronounced with increasing parity.[37] Further longitudinal studies are therefore recommended to provide more information on the changes that take place with increase in parity and their reversal postpartum.

Limitations

The study had some limitations. First, this was a hospital-based study involving women receiving antenatal care. Therefore, our results may not be generalizable to populations of women who have not received antenatal care. Secondly, we did not screen the subjects prior to pregnancy to exclude any occult cardiac disease. We therefore relied on the absence of symptoms and cardiovascular disease risk factors among all the subjects at recruitment. In any case, our focus was on determining the relationship between parity and cardiac structural and functional changes among the subgroups. We appreciate that large population-based longitudinal studies, which is beyond the scope of PEACE Registry at the moment, would be needed to fully appreciate the impact of parity on cardiac structure and function.

CONCLUSION

In this post-hoc analysis of the PEACE registry results, we showed that systolic and diastolic dysfunctions were uncommon in apparently healthy pregnant women, with no significant positive correlations with parity. We also reported significant positive correlations between parity and age, LA size, IVSD and PWT during apparently healthy pregnancy. In addition, there was progressive increase in QRS duration as parity increased, but the other ECG indices did not significantly relate with parity. These findings should therefore be taken in to consideration while interpreting echocardiograms and electrocardiograms of apparently healthy pregnant women. However, subjects with cardiovascular dysfunction deserves further investigations to rule out cardiovascular pregnancy complications.

Declarations of Interest

The authors declare no conflicts of interest.

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