

# Effects of Prenatal Gymnastics on Spinal Curvatures Study 120 Women of the City of Porto - Novo

Henriette Magali Abessolo<sup>1\*</sup>, Mohamed M Lawani<sup>2</sup>, Barnabé Akplogan<sup>2</sup>, and Gracien Houeto<sup>1</sup>

<sup>1</sup>PhD Student, National Institute for Youth, Physical Education and Sports, University of Abomey Calavi, Benin

<sup>2</sup>Senior lecturer of CAMES (African and Malgache Higher Education), University of Abomey Calavi, Benin

\*Corresponding author: Henriette Magali Abessolo, PhD Student, National Institute for Youth, Physical Education and Sports, 01 BP 169, University of Abomey Calavi, Porto-Novo, Benin, Tel: 00237 699939885; E-mail: magaliha@yahoo.fr

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## Abstract

Woman body undergoes postural changes during pregnancy process. These changes may impact on their physical conditions and lead to some limitations in daily activities. The aim of this research work is to evaluate the effect of a prenatal gymnastics program on changes in spinal curvature in pregnant women at Porto-Novo. Concerning methods, 120 women constituted the sample of the study, comprised of recruited purposive and divided into three groups: 32 pregnant women using antenatal gymnastics twice a week for eight weeks, 48 sedentary pregnant women and 40 sedentary non-pregnant women. The measurement of spinal curvatures took place at the beginning and the end of the study using with flexible ruler of mark Morn sun. The results showed that thoracic kyphosis and lumbar lordosis have increased and are significantly different between the three groups. These results suggest that prenatal gymnastics during pregnancy acts on the curvatures of the spine minimizing their emphasis.

## Summary

During pregnancy, the female body undergoes postural changes. These changes can impact on physical health and lead to limitations during everyday activities. This study evaluated the effect of prenatal gymnastics program on changes in spinal curvature in pregnant women in Porto-Novo. The sample was comprised of 120 women recruited purposive and divided into three groups: 32 pregnant women using antenatal gymnastics twice a week for eight weeks, 48 sedentary pregnant women and 40 non-sedentary pregnant women. The measurement of spinal curvature was carried out at the beginning and end of the study using a flexible rule Morn sun brand. The resultant obtained show that thoracic kyphosis and lumbar lordosis increased and are significantly different between the three groups. These results suggest that prenatal gymnastics during pregnancy acts on the curvatures of the spine minimizing their emphasis.

**Keywords:** Pregnant woman; Spine; Prenatal gymnastics; Benin

## Introduction

Pregnancy is usually accompanied by anatomical and physiological changes in the maternal organism [1]. This provides an environment conducive to the development of the fetus and the mother prepares for childbirth. Raimondi et al. [2] found changes in the sagittal curvature of the spine between the beginning and the end of pregnancy. These changes have consequences: moving the center of gravity forward [2,3], destabilizing the step [4], the accentuation of the lumbar lordosis, the ante version of the pelvis, the sacrum that becomes horizontal [2,5]. The hyperlordotic posture and ligament laxity create a mechanical imbalance that can result in the appearance of muscle tension, especially pain in the lumbar spine and lower back spine [2,6,7]. Given significant postural changes that occur during pregnancy, organizations such as the American College of Obstetricians and Gynecologists (ACOG) [8], the Society of Obstetricians and Gynecologists of Canada (SOGC) [9], advise pregnant women against having no medical contraindications, to perform physical activity (PA) moderate. The PA

allows among others for pregnant women to keep their autonomy and thus maintain self esteem, limit weight gain, decrease the incidence of gestational diabetes in patients of normal weight, overweight or obese, prevent since other benefits are also shown on the delivery quality and the occurrence state of eclampsia [10-12]. Moreover, the benefits of the AP are not limited to general baby's mother during a reasoned practice [13-15]. Despite the benefits of PA identified above prejudice and African myths consider that physical exercise would have a negative impact on the health of the fetus and pregnant women [16,17].

Under postural changes, the effects of exercise on pregnant women and the important role played by women in the social equilibrium, the aim of this study was to evaluate the effect of a prenatal gymnastics on spinal curvatures in pregnant Beninese women of the city of Porto-Novo.

## Materials and Methods

This is an experimental study which took place in the city of Porto- Novo (Republic of Benin). The Laboratory of Biomechanics and Performance of the National Institute of Youth, Physical Education and Sport (INJEPS), the Sport-Health-Service Center (3S), the Zébou health center and clinical Deo-Gracias served as a support framework experiment that lasted six months.

### Population and Sample of the Study

This study involved a group of 120 sedentary women, all from the town of Porto-Novo, recruited by the technique of reasoned choice. The workforce has been left in three groups distinguished by the practice or not of antenatal gymnastics and distributed as follows:

- A group of 32 pregnant women in the 2<sup>nd</sup> and 3<sup>rd</sup> trimester subjected to a program of moderate physical exercise for eight weeks.
- A group of 48 pregnant women in the 2<sup>nd</sup> and 3<sup>rd</sup> trimester of pregnancy undergoing any program.
- A group of 40 non-pregnant women not undergoing any program.

**Criteria for Inclusion of Pregnant Women:** Being sedentary and reside Benin in Porto Novo, have a pregnancy showing no complications (favorable opinion of the treating physician is required for the practice of prenatal gymnastics), having reached the second trimester of pregnancy.

**Inclusion Criteria of Non-Pregnant Women:** Being sedentary and reside Benin in Porto Novo.

**Exclusion Criteria:** Not having undergone all the tests at the beginning and end of the experiment, three successive missed workouts, do not support the exercise, having a twin pregnancy after the 28<sup>th</sup> week.

**Non-Inclusion Criteria:** Having a disease or physical trauma affecting or having affected the spine, engage in activities that could influence spinal curvatures (charging port, to split wood), have a history of preterm deliveries and spontaneous abortions.

**Ethical Considerations:** Before participating in the study, subjects were made aware of the goals and interests of the study. For one, written informed consent was obtained from each subject to express participation agreement; secondly, the approval of the sectoral Scientific Committee of Science and Technology of Physical and Sporting Activities of Abomey University was obtained. No invasive method was used to collect data.

**Variables Studied:** The cervical lordosis, thoracic kyphosis, lumbar lordosis and prenatal gymnastics program.

## Equipment and Technical Data Collection

- A questionnaire adapted from X-AAP [18] for pregnant women has collected information on sociodemographic data subjects
- Scales brand Hanna range Max 150 kg and precision 0.1% was used to evaluate the body mass of the subjects
- A graduated measuring rod of 0-200 cm was measured to the nearest millimeter size matters
- Small material for animation workouts (mats, gym balls, a sound equipment)
- A timer for the registration of working sequences
- A flexible rule 90 centimeters in length, Morn sun mark, was cast on the subject's back in order to reproduce the shape of the spine to measure angles of the curvatures of the spine on the sagittal plane. Reliability and reproducibility within and between evaluators validated by several studies [14,19-21].

### Experimental Protocol

The measurements were taken on all pregnant women selected for the study and before the end of the training program. These measurements are made using the flexible rule, which was used to measure the angles of curvature of the spine according to the procedure described by Hart et al. [19] for the lumbar lordosis; Harrison et al. [20] for the cervical lordosis; Teixeira et al. [21] for the thoracic kyphosis. Rather the subject is standing barefoot back out; the investigator feels and marks each spinous process of C1, C7, D1, D12, L1, L5 and S1. The flexible rule is then molded along the spine covering the spinous processes. Then, the marked rule is removed and placed on a piece of graph paper or white paper sketch curves. The angles are obtained using the formula:

$\theta = 4 \text{Arc tan } 2H / L$  ( $\theta$ = amplitude of the curve; L= straight line between the beginning and end of the curve; H= line perpendicular to L) [19].

**Response:** Discussed perform prenatal gymnastics after a prenatal gymnastics program adapted Lawani et al. [15] from 4<sup>th</sup> to 9<sup>th</sup> months of pregnancy. Prenatal gymnastics has aimed the maintenance of sagittal balance of the spine and the well being of pregnant women by reducing pain, improving lombopelvic flexibility, capacity paraspinal muscles, back injury. The experiment lasted six months; each subject of the experimental group underwent an 8- week training program; in 2 sessions per week.

### Statistical Analysis

The collected data was performed using the statistical software Statistical (Version 5.97). The Wilcoxon rank test was adopted for the comparison of variables in a group at the beginning and end of the study. The Mann-Whitney test enabled appreciates binary intergroup variations in case the Kruskal-Wallis test was significant. The significance level was set at  $p < 0.05$ .

## Results

### Demographic Data by Groups

Analysis of Table 1 shows that the NPSW group includes older women ( $29.35 \pm 6.45$  years) compared to SPW group ( $27.29 \pm 4.39$  years) and PWTPG ( $25.87 \pm 5.36$  years). Only the age difference between PWTPG and NPSW is significant ( $p = 0.024$ ).

There is no significant difference in size between the three study groups ( $p > 0.05$ ).

Body weight and body mass index (BMI) increased significantly from the beginning to the end of the experiment in pregnant women using prenatal gymnastics, as well as in sedentary pregnant women. The increase in body weight and BMI of 2.97% in PWTPG, against 5.58% for the SPW.

Although groups of pregnant women are all in the 2nd trimester of pregnancy, there is a significant difference of childbearing age between the groups ( $p = 0.03$ ).

Table 1: Demographic data of the topics of the survey

Variables	Age (Years)	Size (M)	BW (Kg)	BMI (Kg/M2)	Week of Amenorrhoea
PWTPG V1 N1= 32 V2	$5.87 \pm 5.36$	$1.63 \pm 0.06$	$64.06 \pm 9.65$ $65.97 \pm 9.64^{***}$	$24.12 \pm 2.69$ $24.83 \pm 2.59^{***}$	$24.40 \pm 5.66$
SPW V1 N2= 48 V2	$27.29 \pm 4.39$	$1.59 \pm 0.07$	$62.00 \pm 9.78$ $65.46 \pm 9.48^{***}$	$24.31 \pm 3.19$ $25.68 \pm 3.07^{***}$	$26.89 \pm 4.70 \dagger$
NPSW V1 N3= 40 V2	$29.35 \pm 6.45 \ddagger$	$1.61 \pm 0.06$	$66.87 \pm 8.8$ $66.87 \pm 8.8$	$25.81 \pm 3.24$ $25.81 \pm 3.24$	//

PWTPG: Pregnant Women Trained in Prenatal Gymnastics; SPW: Sedentary Pregnant Women; NPSW: Non Pregnant Sedentary Women; N1: Effective of Pregnant Women using Antenatal Gymnastics; N2: Effective of sedentary pregnant women; N3: Effective non pregnant sedentary women; V1: Initial Value; V2: Value at the end of the experiment ; BW: Body Weight; BMI: Body Mass Index; WA: Week of Amenorrhoea; \*\*\* : significant difference between V1 and V2 ( $p < 0.001$ );  $\ddagger$  : significant difference between PWTPG and NPSW ( $p < 0.05$ );  $\dagger$  : significant difference between PWTPG and SPW ( $p < 0.05$ )

### Comparison of the Average Values of the Angles of Spinal Curvatures (Figures 1,2)

The average angle of cervical lordosis from beginning to end of the study showed no difference significant within SPW ( $p = 0.025$ ).

The average angle of dorsal kyphosis meanwhile, shows a significant increase from the beginning to the end of the study in PWTPG and SPW groups. However, the increase of the bending angle in PWTPG is of 4.53% against 8.19 % for the SPW. The average values of NPSW group show no significant differences ( $p > 0.05$ ).

The mean angle of lumbar lordosis increases significantly with  $p = 0.031$  (PWTPG) and  $p = 0.000$  (FES). The percentage increase is 3.82% in the PWTPG group and 11.74% in the SPW group. The NPSW group showed no significant difference ( $p > 0.05$ ).



Figure 1: Comparison of Average values of Dorsal Kyphosis Intra Groups

PWTPG: Pregnant Women trained in Prenatal Gymnastics

SPW: Sedentary Pregnant Women

NPSW: Non Pregnant Sedentary Women

\*: Significant difference between initial value and final value ( $p < 0.05$ )



Figure 2: Comparison of Average values of Lumbar Lordosis Intra Groups

PWTPG: Pregnant Women Trained in Prenatal Gymnastics

SPW: Sedentary Pregnant Women

NPSW: Non Pregnant Sedentary Women

\*: Significant difference between initial value and final value ( $p < 0.05$ )



Figure 3  
**Comparison of Average Values of the Angles Spinal Curvatures between the Study Groups at the Beginning and the End of the Experiment (Table 2)**

At the beginning of the study, the dorsal kyphosis NPSW of the group is lower than that of pregnant women. There are significant differences ( $p < 0.05$ ) between the group and that of SPW NPSW and between the PWTPG and NPSW. No significant difference in the angle of the dorsal kyphosis was noted between the groups of subjects PWTPG and SPW. At the end of the experiment, there are significant differences between the groups SPW

/ NPSW and between PWTPG/NPSW. Although the difference between FEGP and SPW is not significant, it is noticed an increase in the average angle of dorsal kyphosis of 8.19% for SPW, against only 4.53% for PWTPG.

At the beginning of the study, the mean value of the lumbar lordosis of the NPSW group is less than that of pregnant women. The mean angle of lumbar lordosis of the PWTPG group was significantly higher than that of the SPW group and the NPSW group. The end of the experiment showed a significant increase in the average angle of lumbar lordosis in the two groups of pregnant as compared to non-pregnant women. The percentage is also noted that an increase in the average angle of lumbar lordosis is 1.94% in PWTPG against 11.74% in the SPW.

**Comparison of the Mean Value of Angles in Exchange Entre Spinal Curvatures and SPW PWTPG Groups (Table 3)**

No significant difference was observed for the mean value of variation of the angle of the cervical lordosis.

The average value of variation in the angle of the dorsal kyphosis shows a significant difference entre les PWTPG groups and the SPW.

The average value of variation of the angle of lumbar lordosis in turn, shows an Increase in the corner of the SPW group Compared to PWTPG.

Table 2: Comparison of average values of the angles spinal curvatures between the study groups

Variables	V1			V2		
	PWTPG N1= 32	SPW N2= 48	NPSW N3= 40	PWTPG N1= 32	SPW N2= 48	NPSW N3= 40
Cervical Lordosis (°)	53.12 ± 18.13	62.04 ± 14.85††	44.94 ± 12.28‡§§§	52.16 ± 17.56	61.86 ± 15.89††	44.94 ± 12.28§§§
Dorsal Kyphosis (°)	39.80 ± 5.11	40.08 ± 5.90	30.70 ± 6.45‡‡‡§§§	41.61 ± 4.98	43.37 ± 6.59	30.70 ± 6.45‡‡‡§§§
Lumbar Lordosis (°)	50.78 ± 8.80	44.01 ± 7.75†††	40.89 ± 8.04‡‡‡	52.72 ± 8.25	49.17 ± 6.68	40.89 ± 8.04‡‡‡§§§

††: significant difference between PWTPG and SPW ( $p < 0.01$ ); †††: significant difference between PWTPG and SPW ( $p < 0.001$ ); ‡: significant difference between PWTPG and NPSW ( $p < 0.05$ ); ‡‡: significant difference between PWTPG and NPSW ( $p < 0.01$ ); ‡‡‡: significant difference between PWTPG and NPSW ( $p < 0.001$ ); §§§: significant difference between SPW and NPSW ( $p < 0.001$ )

Table 3: Comparison of the Variation of the Mean Value of Angles Spinal Curvatures between PWTPG and SPW

Variables	ΔFEGP	ΔFES
	N1= 32	N2= 48
Lordose Cervicale (°)	-0.96 ± 8.76	-0.85 ± 2.56
Cyphose Dorsale (°)	1.45 ± 3.32	3.28 ± 1.86††
Lordose Lombaire (°)	1.94 ± 4.15	5.17 ± 4.14†††

Δ PWTPG: middle values of the variation of the angles of spinal curvature of the pregnant women practicing the prenatal gymnastics; Δ SPW: middle values of the variation of the angles of spinal curvature of the sedentary pregnant women; † significant difference between PWTPG and SPW ( $p < 0.05$ ); ††: significant difference between PWTPG and SPW ( $p < 0.01$ ); †††: significant difference between PWTPG and SPW ( $p < 0.001$ )

## Discussion

### Characteristics of the Study Subjects

The group of non-pregnant women (NPSW) is The Oldest ( $29.35 \pm 6.45$  years) Compared to the group of pregnant women prenatal practicing gymnastics (PWTPG) [ $25.87 \pm 5.36$  years]. The mean age For Each group is Greater than 19 and less than 40 years. Subjects the therefore fully grown morphotype and no degeneration related to age should not be present [22,23]. The Increased BMI pregnant subjects from start to end of the experiment, indicates a weight gain. Indeed, PWTPG and SPW (sedentary pregnant women) has-have significant gain in body mass. The Increase in body weight is one of visible exchange during Pregnancy. Artal et al. [12] reported that the normal weight gain is 10-15kg during Pregnancy. This is due to the Increase in mass of the fetus, placenta, amniotic fluid, the occurrence of edema, storage of fat deposits etc. Pregnant women in the study were practicing prenatal gymnastics taking a lower weight compared with sedentary. Many studies-has showed the practice of PA that reduces the increase in body mass [11,24-25].

### Evaluation of Sagittal Balance of the Spine

The results of our study show that only non-pregnant subjects lumbar lordosis close to that of the literature [26]. Subjects pregnancy has higher values. From beginning to end of the study, the values of lumbar lordosis significantly increased by  $50.78^\circ \pm 8.80$  to  $52.72^\circ \pm 8.25$  for PWTPG and  $44.01^\circ \pm 7.75$  to  $49.17^\circ \pm 6.68$  for SPW. This trend is also observed for the angle of the dorsal kyphosis. With values of  $40.08^\circ \pm 5.90$  to  $43.37^\circ \pm 6.59^\circ$  for the SPW and  $39.80^\circ \pm 5.11$  to  $41.61^\circ \pm 4.98$  for PWTPG. The cervical lordosis does not change meaningful way. These results are in agreement with those of Kouhkan et al. [27], who using the flexible rule, has obtained the following values for the three trimesters of pregnancy. At the dorsal kyphosis they get from 1<sup>st</sup> to 3<sup>rd</sup> quarter:  $32.4^\circ \pm 1.8$ ;  $34^\circ \pm 1.6$ ;  $37.9^\circ \pm 1.3$  against  $30^\circ \pm 1.2$  in non-pregnant women. For lumbar lordosis, they get:  $46.9^\circ \pm 2$ ;  $51.7^\circ \pm 2.5$ ;  $54.3^\circ \pm 2.3$  against  $45^\circ \pm 2.8$  in non-pregnant women. These results thus show that there are obvious changes (significant increase) curvatures of the spine during all trimesters of pregnancy.

Comparing the non-sedentary pregnant women group (NPSW) than pregnant women using antenatal gymnastics (PWTPG), it was found that the significant increase of lumbar lordosis of PWTPG from beginning to end of the experiment led a significant difference with NPSW. A concomitant variation was noted at the dorsal kyphosis of PWTPG ( $39.80^\circ \pm 5.11$  to  $41.61^\circ \pm 4.98$ ); significantly higher than that of NPSW ( $30.70^\circ \pm 6.45$ ) and to that reported in the literature [27].

These deviations observed in the PWTPG group were more accentuated by comparing the SPW group than the NPSW. It was noted in the group of SPW a significant increase in lumbar lordosis and thoracic kyphosis, and a significant reduction of the cervical lordosis. Data from pregnant women in the study compared to non-pregnant women, confirm the effect of pregnancy on postural changes.

Under bending angles increase percentages obtained from start to end of the study or between the groups of PWTPG and SPW at thoracic kyphosis (4.53% versus 8.19%) and lumbar lordosis (1.94% versus 11.74%), it is possible that it is the practice of physical activities has reduced postural

changes. This thesis is supported by the average values of changes in the cervical lordosis angles ( $-0.96 \pm 8.76$  versus  $-0.85 \pm 2.56$ ), the dorsal kyphosis ( $1.45 \pm 3.32$  versus  $3.28 \pm 1.86$ ) of lumbar lordosis ( $1.94 \pm 4.15$  versus  $5.17 \pm 4.14$ ) between these two groups. With this in optical Kouhkan et al. [27] encourage pregnant women to have postural care including appropriate exercises to keep their spine in the best positions during pregnancy. In this same vein, further scientific studies indicate that the practice of PA during pregnancy helps the woman to stay healthy and reduce the effects of anatomical changes, such as increased range of motion (especially at the trunk), the increase in body mass, hormonal disorders that reduce laxity of joints, musculoskeletal disorders, back pain and leg edema [28,29]. In contrast, other research reported no detectable effect on AP lumbar lordosis [14,30].

### Conclusion

In our survey it was question to measure and to compare the spinal curvature between a group of pregnant women submitted to the prenatal gymnastic program and others group of pregnant women and sedentary non pregnant women. At the end of our investigation we have found a real augmentation of the angle of the lumbar lordosis and the dorsal kyphosis and also a light decrease of the cervical lordosis in all pregnant women. The comparison of the values of the middle values of the angles of spinal curvature between our different groups of study has shown significative differences between pregnant women groups and non pregnant women group at the end of our experimentation. The variations of the angles of spinal curvatures between the pregnant women group submitted to prenatal gymnastic and the sedentary pregnant women group, in this case of the angle of cervical lordosis, those of the dorsal kyphosis and the lumbar lordosis, show that the prenatal gymnastic program has an effect on the curvature of spine while minimizing their accentuations. Taking look at the evolution of the curvature of the spine of pregnant women compare to those of non pregnant women we notice that sagittal balance is not always maintained.

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