Gynecology & Obstetrics
ISSN: 2161-0932

Yessoufou et al., Gynecol Obstet (Sunnyvale) 2014, 4:9
DOI; 10.4172/2161-0932.1000241

Research Article Open Access

Study of the Inertial Parameters Segments among 30 Women of Porto/Novo (Benin) by the Application of the Method of Jensen

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Abstract

The present study implements the use of the method of Jensen to analyze the inertial parameters segments (masses and center of mass) among 30 women including 20 in a state of pregnancy. Recruited as of the 1st trimester of pregnancy, these last voluntarily took share with the experimentation. These women all are healthy, and have no apparent handicap, of nationality Beninese and at least 15 years old. They are then divided into three groups: of 10 obese pregnant women, of 10 no obese pregnant women and 10 no pregnant women (reference group). The analysis of variance of the parameters of study obtained by the method of Jensen are compared between them with 12th, 24th and 36th weeks of pregnancy; by the statistical test of Student for matched samples. The values are considered significantly identical to the threshold 5%. Whatever is the group of the pregnant women, the results revealed of significant difference between the three quarters of pregnancy, with regard to the MC, the IMC, the mass, the volume and the mass center of the abdomen. On the other hand, there is no significant difference on the level of the size, then segments: head, neck, four members and top of the trunk; relative with their mass and center of mass. The method used here makes it possible to obviously appreciate the repositioning of the center of mass at a pregnant woman at the various stages of development of the future baby.

Keywords: Method of Jensen; Modeling; Pregnant women; Inertial parameters segments

Introduction

Women can procreate by only one natural means: pregnancy. She can carry a load (the fetus) which increases in mass throughout the pregnancy [1].

The analysis of this biological phenomenon (pregnancy) often worries biomechanics. To study the Inertial Parameters of the Segments (ISP), used the method of photogrammetry to study worse trunk of the pregnant women and their relations to the evils of back [2].

Biomechanics is always with the research of the most effective tools of prediction of the human movement. Such tools would make it possible to include/understand well all the variables, their reports/ratios and their functions in displacements of all the parts of the body [2].

The technological projection of the computers allowed a significant development of the physical models and mathematics which is at the base of the simulation of the movements of the body. Kaufman [3] estimated very remarkable, the use potential of the biomechanical models designed by computer.

Leboucher et al. [4], report that the method of Jensen with his software Slicer Project (via computer), is a means which facilitates the determination of mass and center of mass on a subject. It makes it possible to obviously locate the positioning of gravity and center of mass [5].

Then this study is carried out with a view to analyze the inertial parameters segments (mass and center of mass) obtained by the method of Jensen among women Beninese with 12th the, 24th one and 36th weeks of pregnancy [6].

Material and Methods

The study is of type transverse, analytical and comparative.

Sample of study

Thirty women, whose twenty enclosures, voluntarily, took share with the experimentation. At least 15 years old, they all are healthy. Those pregnant come from the services of antenatal consultation of the maternity of "Zebou", in the town of Porto/Novo (capital of Benin). They are divided into two groups: group the no obese ones (10) and that of obese (10). Those women are recruited as from the 1st quarter, after having given their assent lit at the time of their antenatal consultation. A reference group of 10 no pregnant women of the same locality (Porto-Novo) made it possible to control the modifications near those pregnant.

Criteria of inclusion: To belong to the sample, it is necessary to be: of nationality Beninese, volunteer, 15 years old and more, healthy (without apparent pathology) and carrying at least a three months pregnancy.

Criteria of no inclusion: Into account the subjects are not taken: of foreign nationality, handicapped, whose age is lower than 15 years and carrying a pregnancy of more than three months.

Criteria of exclusion: Are excluded from the study the subjects which resigned during the experiments and those having carried out less than three tests.

Ethical considerations: The collected data are confidential to guarantee the safety and the decency of the subjects which took part in the study. They neither will be identified nor named in any publication or no report/ratio and their photographs will be possibly published that

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Received March 17, 2014; **Accepted** September 08, 2014; **Published** September 12, 2014

Citation: Yessoufou L, Lawani MM, Dumas G (2014) Study of the Inertial Parameters Segments among 30 Women of Porto/Novo (Benin) by the Application of the Method of Jensen. Gynecol Obstet (Sunnyvale) 4: 241. doi:10.4172/2161-0932.1000241

if they give of it the agreement and after having scrambled their face in order to avoid their identification. However, the study received the authorization of the CSS-STAPS representing in the sectorial plan the National Committee of Ethics.

Studied variables: These are body mass, the center of mass, the index of body mass, the length of the segments, the age of the pregnancy and size of the subject.

Materials used

- an electronic bathroom scales of mark "SECA" made it possible to measure the Body Mass (BM) subjects;

- a wall fathom measuring 2.5 meters length and graduated in centimeters allowed to measure the height of the subjects;

- two (2) digital cameras;

- two (2) small circular levels placed on the cameras, to make sure that they are really parallel on the ground;

- one (1) other level to ensure itself of the verticality;

- four (4) rules (wood or plastic) including two suspended (vertical and two horizontal on the ground are used as calibration at the time of the catch of the photographs;

- one (1) meter ribbon;

- thirteen (13) reflective markers.

Positioning of the subject

In the anatomical, the subject is upright on the tilted plan envisaged for this purpose, with the slightly isolated legs so that the thighs are not touched (when that is possible). The feet (parallel) and the hands are pointed towards the objective of the apparatus taking the front view.

The experimental protocol

We realized on the subjects, three times the same recording (test), at different periods. The first time, at the 12th week of pregnancy, the second time, with the 24th then third time, the 36th week of pregnancy. For the no pregnant women (reference group) the test was carried out only once.

At each stage, anthropometric measurements (sizes and weight) are taken, on these pregnant women and this, to follow the evolution of the size, the body mass (BM) and the index of body mass (BMI). Then, there is the catch of the photographs (Jensen), in order to analyze IPS (mass and center of mass) (Table 1).

Because pregnancy is noticed quickly at the woman, from the photo point of view on side, our analyses took into account the modeled sights of profiles. Moreover, for this study, the trunk which constitutes a segment is subdivided into two:

Periods	Subjects		Averages			
Weeks of pregnancy	Pregnant Women	n	Age (years)	Cut (m)	BM (kg)	BMI (kg/m²)
12th	No obese	10	20.24 ± 2.06	1.64 ± 0.06	59.10 ± 3.04	22.20 ± 2.21
	Obese	10	18.05 ± 3.01	1.62 ± 0.04	78.20 ± 8.30	29.79 ± 4.30
24th	No obese	10	20.24 ± 2.06	1.64 ± 0.06	63.08 ± 2.04	23.45 ± 2.30
	Obese	10	18.05 ± 3.01	1.62 ± 0.04	81.06 ± 7.10	30.88 ± 3.14
36th	No obese	10	20.24 ± 2.06	1.64 ± 0.06	67.21 ± 3.04	24.98 ± 2.32
	Obese	10	18.05 ± 3.01	1.62 ± 0.04	85.37 ± 7.31	32.52 ± 6.18

BM: Body Mass; BMI: Index of Body Mass

Table 1: Anthropometric characteristics of the 30 pregnant women.

- Top of the trunk: who is located between the parallel line of the clavicles and that passing by the appendix xiphoid.

- The bottom of the trunk: who leaves the parallel of the appendix xiphoid to the hips.

For each of the three periods of experiments, the same room, the same schedules, the same equipment and material, are respected at each subject.

The average values of the size, the BM and the BMI are calculated on all 30 subjects. Then, the average values of the segment mass obtained by the method of Jensen are taken into account. Lastly, the center of mass of the abdomen is analyzed, in order to follow its repositioning during the pregnancy.

An analysis of the variances and a test T of Student are used to compare the values obtained on various stages and between the categories of pregnant women. The values are considered significantly identical at $p<0.05$.

Results

Comparison of the size, the body mass (BM) and the index of body mass (BMI) between the obese and no obese pregnant women

The average values of the sizes measured over various periods of pregnancy are identical at the no obese ones. Whatever is the period and the group, there is no significant difference ($p<0.05$), with regard to the size, during the pregnancy. On the other hand, the average values of the BM and BMI are significantly modified. The results revealed a significant difference with $p<0.05$, the level of the BM and BMI between 12th, 24th and 36th weeks of pregnancy and this, at the two groups (Figures 1 and 2).

Comparison of the masses segment (head, neck, high of the trunk and low of the trunk) over the three quarters of pregnancy

During 12th, 24th and 36th weeks of pregnancy, the average values of the masses head, neck and top of the trunk obtained remained constant.There is no significant difference ($p<0.05$), with regard to the mass of these segments, whatever the period of pregnancy. However, the average values obtained compared to the mass of the bottom of the trunk (the abdomen) knew variations during the three quarters of pregnancy. The results showed a significant difference ($p<0.05$) on the level of the abdomen, with 12th, the 24th one and 36th weeks of pregnancy at the subjects (Figure 3).

Comparison of the segments mass (arm, front arm lever and hand) of the upper limb right, with 12th the, 24th one and 36th weeks of pregnancy

The average values of the segments mass (arm, front armlever and hand) of the upper limb right are similar during three various quarters of pregnancy. There is thus no significant difference ($p<0.05$), with regard to the mass of these segments, whatever the age of the pregnancy (Figure 4).

Comparison of the masses of the segments thigh, leg and foot of the lower limb right, with 12th the, 24th one and 36th weeks of pregnancy

The average values of the masses of the segments thigh, leg and foot (lower limb right), did not vary at the subjects. Whatever the period of

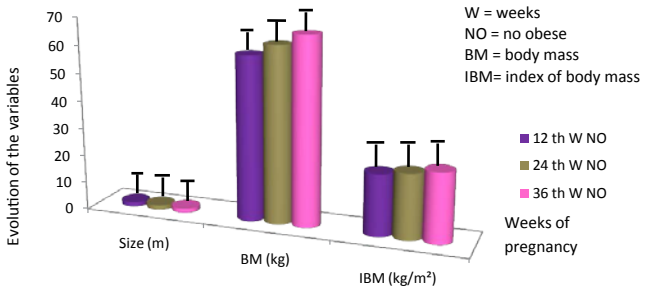

Figure 1: Evolution of the size, body mass and the index of body mass during the pregnancy among no obese women.

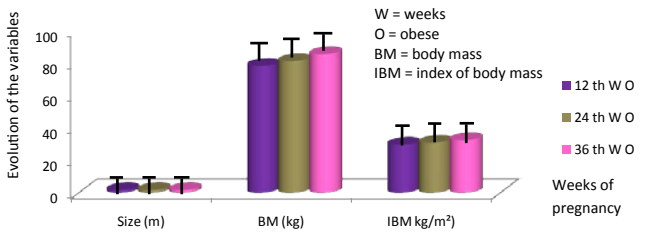

Figure 2: Evolution of the size, body mass and the index of body mass during the pregnancy among obese pregnant women.

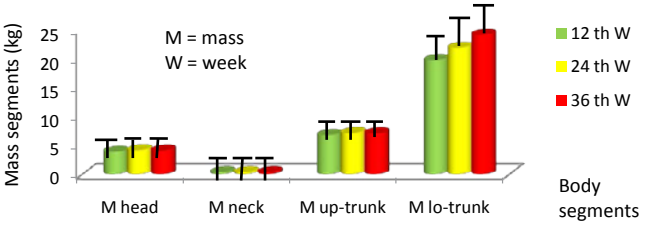

Figure 3: Comparison of the masses of the segments (head, neck, high of the trunk and low of the trunk) by the method of Jensen over the three quarters of pregnancy at the subjects.

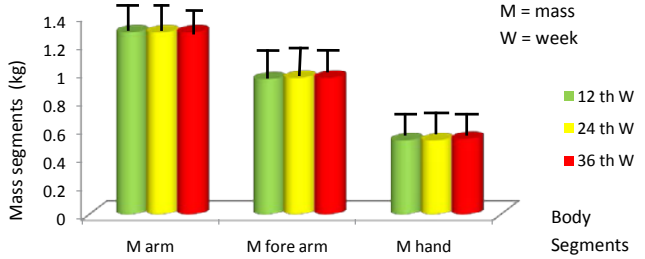

Figure 4: Comparison of the masses of the segments (arm, front armlever and hand) of the upper limb right, by the method of Jensen during 12th the, 24th one and 36th week of pregnancy at the subjects.

pregnancy, there is thus no significant difference, with regard to the masses of these segments (Figure 5).

It is announced that on the level of the members (higher and lower), we dwelt too long in this study on the right side; since according to Jensen [5], these segments are symmetrical.

Moreover, we analyzed on the photographs of modeling (Jensen) of the subjects, the position of the centre of mass of the low trunk and that of the centre of gravity of the whole body. This analysis was made by comparing 12th the, 24th one and 36th week of pregnancy, the studied women.

The choice of the abdomen for this analysis is due to the fact that it is the only part of the body, whose mass and volume increase significantly during the pregnancy [6].

Analysis of the positions of the centre of mass of the abdomen and the centre of gravity of the reference group (no pregnant women)

The center of mass of the abdomen is easy to identify on Figure 6 of face (on the left). It is the point (yellow) located at the level of the belly (green color). But on that of profiles (on the right), the center of mass of the belly is the yellow point, located near to the elbow i.e., with the intersection of the colors red and black.

Whatever the wife of this group, the centre of mass of the belly is located in the leaving prolongation of the straight line, the center of mass of up trunk in the center of gravity. This is quite remarkable on the two photographs of face and of profiles, modeled (Figure 6).

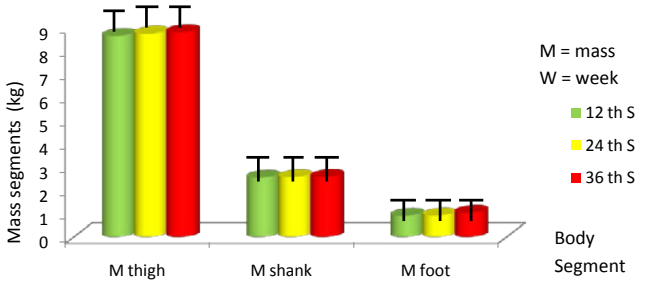

Figure 5: Comparison of the masses of the segments (thigh, leg and foot) of the lower limb right by the method of Jensen, during the evolution of the pregnancy at the subjects.

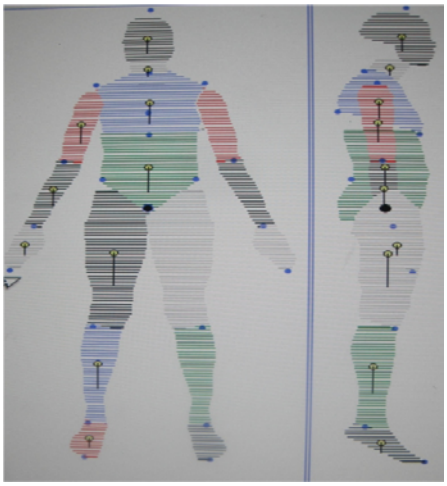

Figure 6: Positions of the center of mass of the abdomen (on the level of the belly) and of the center of gravity (level basin) of a nopregnant woman.

Caption

* **the blue** pointsdelimit by color the modelled segments,

* **the yellow** points represent the center of mass of each segment,

* and **the black** spot on the level of the basin represents the center of gravity or the center of mass of the body

Comparison of the positions of the no pregnant woman, gravity and center of mass of the abdomen and those in the 1st quarter of pregnancy

At the women, at the 12th week of pregnancy, the volume and the mass of the belly increased. On Figure 7, one note that the straight line which crosses the center of mass the top of the trunk (not yellow on the level of the muscle deltoid compared to the modeled sight on side) and it center of gravity, does not take into account the center of mass of the belly. It is found slightly in front of this line. The change of position of the center of mass of the low trunk is observable (Figure 7).

Comparison of the positions of the gravity and centers of mass of the abdomen among women with 1st then with the 2nd quarter of pregnancy

During the 24th week of pregnancy, volume as well as the mass of the belly of the woman, increases more. This modification is much more significant in this quarter than with the precedent. On Figure 8, one notes that the straight line leaving the center of mass the top of the trunk (not yellow on the level of the muscle deltoid compared to the modeled sight on side) in the center of gravity, does not cross the center of mass of the belly. There is a significant difference of the positioning of the abdominal center of mass, with 1st then with the 2nd quarter of pregnancy at the subjects.

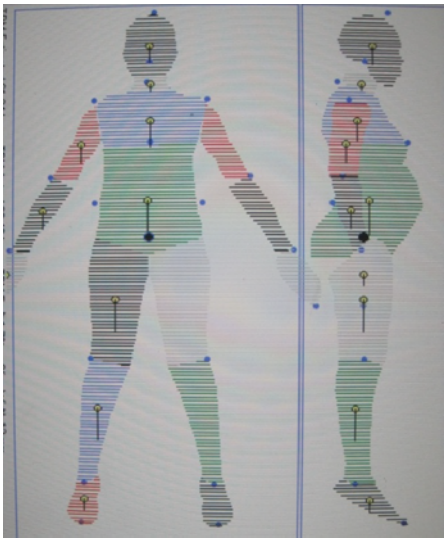

Figure 7: Positions of the center of mass of the abdomen (on the level of the belly) and of the center of gravity (level basin) of a woman in the 1st quarter of pregnancy.

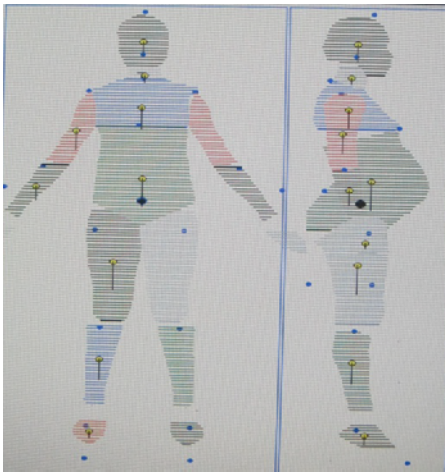

Figure 8: Positions of the center of mass of the abdomen (on the level of the belly) and of the center of gravity (level basin) of a woman to the 2nd quarter of pregnancy.

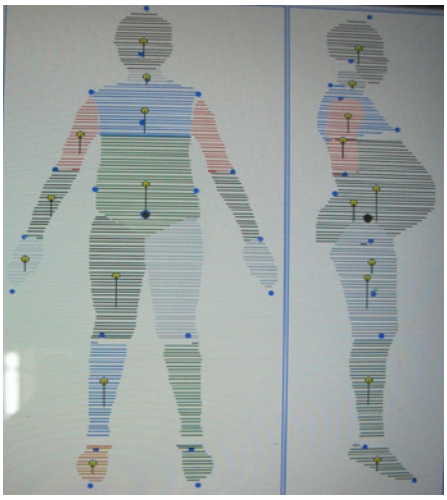

Figure 9: Positions of the center of mass of the abdomen (on the level of the belly) and of the center of gravity (level basin) of a woman, in the 3rd quarter of pregnancy.

Comparison of the positions of and the gravity centers of mass of the women to 1st, the 2nd then in the 3rd quarter of pregnancy

Compared to the two preceding quarters of pregnancy, the volume and the mass of the belly increase considerably. Figure 9, shows that the straight line leaving the center of mass the top of the trunk (not yellow on the level of the muscle deltoid compared to the modeled sight on side) in the center of gravity, does not cross the center of mass of the belly. There is then a significant difference of the positioning of the abdominal center of mass, between 1st, the 2nd and the 3rd quarter of pregnancy at the subjects.

Discussion

Comparison of the size, the BM and the IBM, among obese and no obese women enclosure, over various periods

During a pregnancy, the maternal morphological evolution most visible is the catch of weight. The results of this study revealed an increase in the BM, as well at the obese women at those no obese. Whatever the group, the body mass increases significantly (8%) during the pregnancy, as that can appear well in work of Timsit [7].

However, our results showed certain constancy on the level of the values sizes obtained. There is thus no significant difference, when the sizes of the subjects are compared, during three quarters of pregnancy.

In addition, our results also show an increase in the average values of the IMC obtained; what corroborates work of Wilmore and Costill [8].

Comparison of the mass of the segments: head, neck, high of the trunk, low of the trunk and the four members

The values of mass of the abdomen (low of the trunk), reveal a significant increase in the mass of this part of the body, for the period of pregnancy. Where as masses of the segments: head, neck, higher trunk and of the four members of the subjects, remained unchanged, during the development of the future baby.

During the pregnancy, the catch of weight is quite visible with the level of maternal morphology (the abdomen), the explanation related to the growth fetus and placental can be advanced. According to several studies, the placental weight report/ratio on fetus weight varies throughout the pregnancy. Eventually his weight account for approximately 1/6 of the weight of the fetus is 500 g [9].

Comparison of the positions of the abdomen and the gravity centers of mass of the women to 1st, the 2nd then in the 3rd quarter of pregnancy

The application of the method of Jensen to the woman (without overweight, nor obesity) not enclosure, shows an alignment of the centers of mass of the trunk top, the abdomen and the centre of gravity of the body.

Then, the same method (of Jensen) applied to the pregnant women of the two groups (obese and no obese), particularly reveals a modification of the positioning of the centre of mass of the belly. There is a significant difference from the positioning point of view of the abdominal centre of mass, between 1st, the 2nd and the 3rd quarter of pregnancy at the subjects. This repositioning is much more remarkable when one compares the position of the centre of mass of a no pregnant woman (pilot subject) with that of a pregnant woman with the 36th week. It perhaps due to the significant increase in the abdominal volume, by catch of the weight (development of the fetus) at the pregnant woman. This corroborates the data of the literature of Berg et al. [10], which estimated that lordosis is more marked among women in a state of pregnancy. Perkins [11], also, reported that because of the weight of the pregnant uterus, the centre of gravity moves forwards.

The juxtaposition of the whole of the results obtained among women studied in the town of Oporto/Novo, over the three quarters of pregnancy, with regard to the mass and the centre of mass reveals a significant variation of this IPS, by using the method of Jensen.

Conclusion

The presence of significant difference of IPS (mass and centre of mass) between the stages of development (12th, 24th and 36th week) of pregnancy, shows, with regard to pregnant women of the town of Porto/Novo, that modifications are observed, whatever the group (obese and no obese).

This study reveals that in each quarter of pregnancy, the inertial parameters segments (mass and centre of mass) obtained, evolve/move in an identical way, between the groups considered. Moreover, it arises several research tasks, that the method of Jensen is suitable, to model and determine with precision of the Inertial Parameters Segments (IPS), at alive pregnant women. However, the assumption going in the direction, of a change of position of the center of mass (of the abdomen), is quite plausible. In spite of the repositioning of the center of mass of the abdomen, the center of gravity of the body seems not to move. One can in this case, to conclude, that the displacement of the center of mass of a segment, is not enough to reposition the center of gravity of the body to a significant degree. Lastly, we can retain that, at a normal woman, without overweight or obesity, the centers of mass the top of the trunk, of the bottom of the trunk and the center of gravity are aligned. On the other hand at the pregnant woman (as from 3 months), the center of mass of the bottom of the trunk is not found any more on this straight line (seen modeled side).

Acknowledgment

All personnel of the maternity of “Zebou” in general, with the pregnant midwives, assistance-looking after and women, in particular for their participation in this study. All those which brought their contest of some nature that it is within the framework of this study, thank you for your availability, your support and your councils.

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