SUMMARY
Pregnancy imposes adaptations on abdominal muscles morphology and function. One of the muscles thought to undergo change in pregnancy is the rectus abdominis (RA). However, a few studies are available about abdominal muscles changes and the risk factors involved on common abdominal-strengthening exercises, during pregnancy and the post-partum period. Thus, a case study was developed in order to identify and discuss the relevant parameters to use on the description of the morphologic changes, namely on RA muscles, during pregnancy. Ultrasound images (USI) from the superficial abdominal musculature were collect from a 31 years old healthy pregnant woman between 18th to 28th gestational weeks. Ultrasonographic parameters include the inter-recti distance (IRD) and the linea-alba thickness (LAT). Additionally, anthropometric measurements were taken and related with USI. The results showed that the IRD increased gradually while LAT reduce. It was noticed that close to the edge of both RA the LAT decrease more than on the middle portion of linea-alba. The uterine weight was the anthropometric parameters that showed a better agreement with ultrasound parameters. The results are referring to a preliminary study limited to the firsts two trimesters of pregnancy. Further information is required about the last trimester and the post-partum period.

INTRODUCTION
During pregnancy, substantial morphological changes occur at the abdominal muscles which could have implications on functional capacity of women during the postpartum period. A muscle that undergoes changes during pregnancy is the rectus abdominis (RA) which extends along the entire length of the anterior abdomen, from the xipoid process to the pubic symphysis. As the fetus grows the two muscle bellies of the RA, connected by a fascia tendon, the linea alba, elongates and curve round as the abdominal wall expands, with most separation occurring at the umbilicus [1-3]. This gap, the inter-recti distance (IRD), may vary from 2 to 3 cm wide and 2 to 5 cm long to 20 cm wide and involving the whole length of RA [4]. The increased IRD, often referred to as a diastasis abdominis (DRA), is described as a change in the abdominal muscles with onset in the last trimester of pregnancy and whose peak of incidence occurs immediately after birth and the first weeks of the postpartum period [1, 4]. Many women continue abdominal exercise programs during their pregnancies and mostly of postnatal women are encouraged to resume abdominal exercises shortly after delivery, to restore their abdominal figure and fitness. The abdominal-strengthening exercises programs prescriptions are not based on evidence and very little literature about abdominal muscles morphological changes during and after pregnancy is available. Ultrasound imaging (USI) has recently been used to assess muscular geometry and as an indirect measure of muscle activation via changes in muscle thickness and other characteristics of muscle function [5][6]. On the cross-sectional and partial longitudinal study of Coldron et al. [4] USI was used on the characterization of RA changes on the first year postpartum. However no data is available with respect to the ultrasound parameters used on the characterization of changes on women abdominal muscles during pregnancy. Thus, a case study was developed in order to discuss the relevant USI parameters to use on the description of the morphologic changes on the abdominal wall, namely on RA muscles, during pregnancy. Morphological analysis was completed by a set of anthropometric data that was collected and related with the ultrasonographic parameter.

METHODS
A 31 years old healthy pregnant woman participated in this study between the 18th and the 28th gestational weeks. Ultrasound images from superficial abdominal musculature, including RA and linea alba, were obtained by means of an ultrasound diagnostic scanner (Hitachi EUB-7500) with a 108 mm linear array transducer at 7.5 MHz. With the subject in supine and knees bent at 90º measurements were taken of resting abdominal musculature. The bottom edge of the probe was placed centrally in a transverse plane of linea alba on three locations on the abdominal wall: a location just distal to the umbilicus and two locations cephalic to the umbilicus. Locations were determined based on two pre-defined distances from the umbilicus: the 2PDD (2 cm) and 5 PDD (5 cm) distances. As the umbilicus position is affected by the subject stature, the 2PDD and 5PDD locations were estimated in function of subject height, according to the ISAK [7] formula PDD x (height/170,18). This means that in this study, the 2PDD was 1,95 cm and the 5PDD was 4,88 cm. The distance of 5 cm from the umbilicus was chosen based on the distance defined by ISAK [7]. An anthropometric tape was used to estimate the three locations for the probe/transducer, assuming the center of the umbilicus as a reference for the linear distance. The bottom edge of the probe was then placed on each location, 2PDD below the umbilicus, 2PDD and 5PDD above the umbilicus. On each location, the probe was moved laterally until the internal edge of both RA muscles was obtained. The angle of the probe was then adjusted to optimize
visualization of the image. Particular attention was taken about pressure imposed to the probe in order to avoid reflexive response from mother’s musculature and/or from fetus. Between 18th and the 28th gestational weeks a set of 10 ultrasounds measurements were collected, with intervals of approximately 10 days (recording moments). During this period, anthropometric measurements were taken in three occasions: 18th, 23rd and 28th gestational weeks. Anthropometric assessment follows a standardized measurement protocol women thorax and abdomen length, diameter and perimeter, as well as abdominal skinfolds. Anthropometric parameters included the body mass (Kg), the biliocristale diameter (cm), the hip perimeter (cm), the abdominal perimeter (cm), the thoracic diameter (cm) and the uterine height (cm). The first three were taken in accordance with ISAK protocols (Marfell-Jones M, 2006 #266). Anthropometric measurements were obtained using portable measurement devices (DKSH, Switzerland) and a calibrated precision scale (Seca Vogel & Halke, model 761 7019009, Germany), and an anthropometric tape (Rosscraft Innovations, Vancouver, Canada). Ultrasonographic parameters include the IRD and the linea-alba thickness (LAT), which were estimated with help of specific software (ImageJ, Image Processing Analysis in Java) and expressed as a percentage of increment across all recording moments. For IRD estimation, the linear distance between both edges of the RA muscle was recorded from a single frame obtained on each PDD probe locations. The LAT was measured on on three locations: at the middle part of the linea alba and close to both edge of the RA muscles. The LAT correspond to the linear distance between the top and bottom edge of the linea alba. Descriptive statistics were calculated to summarize data.

RESULTS AND DISCUSSION

The results showed that the IRD increased gradually while LAT reduce (Figure 1). It was noticed that close to the edge of both RA the LAT decrease more than on the middle portion of linea-alba.

The uterine weight was the anthropometric parameters that showed a better agreement with ultrasound parameters. The results are referring to a preliminary study limited to the firsts two trimesters of pregnancy. Further information is required about the last trimester and the post-partum period. The results showed that the IRD increased gradually from the first moment at 18th gestational week of measurement (Figure 1), while at 5 cm above umbilicus (SPDD location) the IRD almost duplicates after 71 days. The LAT is decreasing gradually as the rectus separates from the middle line and comparing the first and the last moment of measurements there is -30,46%, -21,54% and -31,98% for the same previous locations. The anthropometric measurements are all increasing gradually also, as expected for this period.

Figure 2: Anthropometric data. (35 days =23rd week; 71 days=28th week)

CONCLUSIONS

The results showed that the IRD increased gradually while LAT reduce. It was noticed that close to the edge of both RA the LAT decrease more than on the middle portion of linea-alba. The uterine weight was the anthropometric parameters that showed a better agreement with ultrasound parameters. The results are referring to a preliminary study limited to the firsts two trimesters of pregnancy. Further information is required about the last trimester and the post-partum period.

REFERENCES