CorSalud 2018 Oct-Dec;10(4):274-285

Cuban Society of Cardiology

Original Article

Anthropometric indicators for the characterization of body adiposity in healthy pregnant women at the beginning of pregnancy

Calixto Orozco Muñoz✉, MD, MSc; Nélida L. Sarasa Muñoz, MD, PhD; Danay Hernández Díaz, MD; Oscar Cañizares Luna, MD, PhD; Elizabeth Álvarez-Guerra González, MD; and Alina Artiles Santana, MD

Universidad de Ciencias Médicas de Villa Clara. Santa Clara, Villa Clara, Cuba.

Este artículo también está disponible en español

ARTICLE INFORMATION

Received: June 23, 2018
Accepted: July 21, 2018

Competing interests
The authors declare no competing interests

Acronyms
BMI: body mass index
CAT: computed axial tomography
MRI: magnetic resonance imaging

ABSTRACT
Introduction: Different locations of adipose tissue determine risks for the cardiovascular and metabolic health, without having enough knowledge on how this problem manifests in healthy pregnant at the start of pregnancy.
Objectives: To identify possible groups of healthy pregnant women with body adiposity and to evaluate the diagnostic capability of the indicators used.
Method: Cross-sectional observational study in 1305 pregnant women in a health area of Santa Clara, from 2012 to 2016. Frequency distributions and central tendency and dispersion measures were developed, as well as clustering techniques and ROC curves (Receiver Operating Characteristic). The general and central adiposity, and the components of corporal and abdominal adiposity were studied.
Results: Three clusters of general adiposity and two of central adiposity were identified. The highest average values of body mass index and body fat percentage were in the high cluster of general adiposity (33.5 kg/m^2 y 41.6%), whereas for the central adiposity indicators, these values manifested in the group of high central adiposity. The sum of the tricipital and subscapular skinfolds had the largest area under the curve, both for general (0.752) and central body adiposity (0.934); while for the abdominal adiposity corresponded to visceral (0.697) and preperitoneal (0.822) fat.
Conclusions: The indicators used identified groups of pregnant women with different levels of general and central adiposity, with more diagnostic capability for the sum of subscapular and tricipital skinfolds.
Keywords: *Adiposity, Pregnant women, Body mass index, Cluster analysis, Health status indicators, Cuba*

Indicadores antropométricos para la caracterización de la adiposidad corporal en gestantes sanas al inicio del embarazo

RESUMEN
Introducción: Localizaciones distintas de tejido adiposo determinan riesgos para la salud cardiovascular y metabólica, sin que se conozca lo suficiente cómo se manifiesta esta problemática en gestantes sanas al inicio de la gestación.
Objetivo: Identificar posibles agrupaciones de gestantes sanas con adiposidad corporal y evaluar la capacidad diagnóstica de los indicadores utilizados.
Método: Estudio observacional transversal en 1305 gestantes de un área de salud

✉ *C Orozco Muñoz*
Calle Cuarta Nº 161, e/ C y D.
Reparto Vigía. Santa Clara 50200.
Villa Clara, Cuba. E-mail address:
calixtoom@infomed.sld.cu

de Santa Clara, desde 2012 al 2016. Se realizaron distribuciones de frecuencias y medidas de tendencia central y de dispersión, se aplicaron técnicas de conglomerados y curvas ROC (receiver operating characteristic). Se estudió la adiposidad general, central, y los componentes de adiposidad corporal y abdominal.
Resultados: *Se identificaron tres conglomerados de adiposidad general y dos de la central. Los valores medios más elevados del índice de masa corporal y el porcentaje de grasa corporal estuvieron en el conglomerado de adiposidad general alto (33,5 kg/m^2 y 41,6%) y en el de adiposidad central alta. La suma de los pliegues cutáneos tricipital y subescapular tuvo la mayor área bajo la curva, tanto para la adiposidad corporal general (0,752) como central (0,934); mientras que para la adiposidad abdominal correspondió a la grasa visceral (0,697) y la preperitoneal (0,822).*
Conclusiones: *Los indicadores utilizados identificaron agrupaciones de gestantes con diferentes niveles de adiposidad general y central, con mayor capacidad diagnóstica para la suma de los pliegues cutáneos subescapular y tricipital.*
Palabras clave: *Adiposidad, Mujeres embarazadas, Índice de masa corporal, Análisis por conglomerados, Indicadores de salud, Cuba*

INTRODUCTION

The excessive accumulation of adipose tissue in the body, either selectively or not, can have diverse effects on the metabolism and health of people; as a biological phenomenon, although it can be studied as general adiposity, its study by regions is of greater interest.

It is recognized as more important that body adiposity located in the trunk, which is called central or android adiposity and within this, the abdominal adiposity, understood as the increased deposit of adipose tissue in the wall and abdominal viscera[1].

The body adiposity can be expressed clinically as overweight or obesity when the cutoffs of body mass index (BMI) or the body fat percentage established for these categories of nutritional state –but not necessarily –– are exceeded; it is known that there are excessive regional accumulations of adipose tissue that are not identifiable by the BMI or fat percentage; these findings do not rule out their active participation in the etiopathogenesis of cardiovascular and metabolic diseases[2-4].

Adipose cells can change their volume up to 100 times and store widely varying amounts of fat, fact that converts them in a potentially dangerous factor in the pathophysiology of different chronic diseases[5,6].

Different locations of adipose tissue in the body determine different risks, hence, most of the abdominal visceral adipose tissue has the greatest association with risk of cardiovascular disease, type 2 diabetes mellitus and cancer, etc.[7,8].

The BMI is an indicator of utility in studies of morbidity and mortality associated with high levels of adiposity expressed as overweight or obesity; however, it does not discriminate the proportions of body weight corresponding to muscles, bones and body adiposity, and less, the regional or topographic predominance of this latter[9,10]. These characteristics have limited their sensitivity for diagnosing excess of adipose tissue or body fat in people who have been classified by this indicator as normal weight[11].

In the '80s, Ruderman *et al*[12] described a peculiar type of obesity in people that, even classified as normal weight for their BMI, had hyperinsulinemia, insulin resistance, increased incidence of type 2 diabetes mellitus, hypertriglyceridemia and predisposition to cardiovascular diseases[12].

A few years later, De Lorenzo *et al*[13] and Romero *et al*[14] identified individuals with normal body weight according to the BMI, but with a high percentage of body fat and deficient lean tissue, without other ostensible metabolic alterations; while Brazilian researchers observed in the same type of individuals, values of the sum of tricipital and subscapular skinfolds above the 90th percentile[15].

Other authors reported an increase in central adiposity in Chinese menopausal women with normal BMI, but with waist/height index elevation accompanied by typical metabolic disorders[16]. Such evidence can support the recent postulate that obesity should be classified according to the proportions of adipose tissue in the context of total body composition, as well as its distribution, more than according to the body weight or BMI[17].

Other anthropometric indicators, such as skinfolds, waist and hip perimeters, and waist/height, waist/hip, conicity and energy-protein indices have shown effectiveness in body adiposity studies and can be used in combination with the BMI. The measurement of skinfolds has been proposed for its use in pregnant women, folds such as the bicipital, tricipital and the subscapular make it possible to evaluate changes in the adipose tissue of the body[18].

Different metabolic complications associated to the elevation of body fat percentage, the sum of the subscapular and tricipital skinfolds above the 90th percentile and the waist/hip index are indicative of abdominal fat; characteristics that make up the classification described in the bibliography as: obese normal weight phenotype[15].

In the Cuban population, the prevalence of excess of weight (overweight and obesity) has increased with an annual growth of approximately 0.3%, which translates into unhealthy body adiposity levels; this situation does not exclude women of reproductive age. Results of a study conducted by the National Institute of Hygiene, Epidemiology and Microbiology, to evaluate the nutritional status of Cuban pregnant women, reveals 15% of obese pregnant women and 14.2% with overweight at the national level; with a behavior in our province, Villa Clara, of 28.1% for obese and 6 .9% for overweight[19].

Thus, body fat, with or without overweight or obesity, can be part of a general health problem; however, its analysis in pregnant women requires particular evaluations, especially in normal weight pregnant women, as their vulnerability to certain cardiometabolic risks, generated by the excessive accumulation of unidentified adipose tissue in certain body regions, is not sufficiently known.

In the identification of different levels of corporal adiposity, the computerized axial tomography (CAT) and nuclear magnetic resonance (NMR) techniques are considered as gold tests to evaluate the distribution of abdominal fat, although they are not feasible for studies at large scale due to its high cost and the risk of radiation, especially the CAT, even less during pregnancy. When it comes to pregnant women it would be advisable to opt for the ultrasound, that is safe and less expensive, and whose results have been validated by the CAT and MRI, as a method to evaluate abdominal fat distribution; without rejecting the use of anthropometric techniques[20,21].

The multivariate technique by clusters has been used to determine anthropometric typologies with different levels of risk of adverse events in pregnancy; with its help, different groups have been found that gather variables such as BMI and arm circumference associated to body fat. These procedures have also allowed, with the use of two or more anthropometric variables, to identify cardiometabolic risk groups, for follow-up and nutritional monitoring[22].

Given the fact, that the description of the distribution of body adiposity in pregnant women of adequate weight is still unsystematic at the local level and that it is not known enough how this problem manifests itself in healthy pregnant women at the beginning of pregnancy, the present work had as objective: to identify possible groups of healthy pregnant women with adiposity and to evaluate the diagnostic capability of the indicators used.

METHOD

A cross-sectional observational study was carried out on healthy pregnant women from the "Chiqui Gómez Lubián" health area, of the Santa Clara municipality, capital of the Villa Clara province, Cuba, during the period 2012-2016. The initial population consisted of 1787 pregnant women selected before the 14th week of gestation, of which 1305 were selected, taking into consideration the following inclusion criteria: Cuban nationality, the coincidence of the date of the last menstruation with the calculation of the first ultrasound study and their willingness to participate in the research.

Exclusion criteria

The exclusion criteria included chronic conditions such as: diabetes mellitus, high blood pressure, heart diseases, uterine fibroids with higher volume for 2-weeks pregnancy, nephropathies, epilepsy, thyroid dysfunction and psychiatric disorders.

Variables

An anthropometric battery was applied, in which general data of the pregnant woman were included: weight, height, perimeters of the waist, hip and arm; bicipital, tricipital, subscapular and suprailiac skinfolds; as well as the values of abdominal subcutaneous, preperitoneal and visceral fats. The variables studied were:

- General adiposity, through the BMI and the body fat percentage.
- Central adiposity, through waist/height, waist/hip, energy-protein, conicity and arm fat area in

dices.
- Components of body adiposity, through the indicators: sum of skinfolds, chronological age measured in years of age and gynecological age, calculated by the difference between the age of the menarche and the age of the first pregnancy.
- Components of abdominal adiposity, through abdominal subcutaneous, preperitoneal and visceral fats.

Reference values

The normality referents of the indicators used were:
- BMI: For the BMI there are four categories, according to the pregnant's anthropometric tables of the *MINSAP* (after its acronym in Spanish) (2010) in Cuba[23]:
  - Deficient weight: <18.8 kg kg/m^2
  - Suitable weight: 18.8 kg/m^2 up to 25.6 kg/m^2
  - Overweight: > 25.6 kg/m^2 up to 28.6kg/m^2
  - Obesity: > 28.6 kg/m^2
- Body fat percentage[24]:
  - Normal: 20 – 30%
  - Limit: 31 – 33%
  - Obesity: more than 33%
- For the waist/hip index the normal value for interpretation is 0.71 - 0.84[25].
- For the waist/height index the normal value for interpretation is 0.50[26].
- For the conicity index, the normal value for interpretation is 1.500[27].
- For the energy-protein index and fat area of the arm, those found below the third quartile (75%) of the percentile distribution performed were accepted as normal values.

Data processing

The information was stored and processed in the statistical package SPSS version 20.0 for Windows, in correspondence with the objectives of the study.

In order to identify possible groups of general and central adiposity of pregnant women, the multivariate classification method known as "cluster technique" was used, specifically the two-step method[28,29]. For the distinction of groups of pregnant women by their adiposity levels, the average values of the different indicators were taken into account.

Three categories were established for the general adiposity:
- Normal adiposity, when BMI values and the percentage of body fat are among normal values.
- Intermediate adiposity, when BMI values related to overweight and body fat are among the risk values.
- High adiposity, when both, BMI values and body fat percentage reflect obesity.

For the central adiposity:
- Normal adiposity, when their waist/height, waist/hip, conicity, energy-protein and fat arm area indicators are in normal limits.
- High adiposity, when the previous indicators have values above the cutoff points.

In order to evaluate the diagnostic capability of other variables involved in body adiposity (general, central and abdominal) in healthy pregnant women, we used the ROC (receiver operating characteristic) curve analysis; from the intermediate and the high categories for the general and central adiposity groups, respectively. Variables with diagnostic possibilities included those that are known to be independently related to the conformation of the body's adiposity: sum of the tricipital and subscapular skinfolds, gynecological age, subcutaneous abdominal, preperitoneal and visceral fats. The same groups of pregnant women were used for verifying the diagnostic capability of these variables.

The areas under the curves and their confidence intervals were analyzed. An alpha significance value of 0.05 was prefixed, for the statistical decision-making.

Ethical considerations

This research was determined by the ethical principles that guide medical research with human beings, embodied in the Declaration of Helsinki in 2008[30], expressed through the informed consent of the pregnant women and the endorsement of the research ethics committee belonging to the Biomedical Research Unit of the Universidad de Ciencias Médicas Dr. Serafín Ruiz de Zárate Ruiz of Villa Clara.

RESULTS

Healthy pregnant women, according to their general body adiposity and studied through the BMI variables and body fat percentage, were grouped into three clusters: one with 529 pregnant women (40.5%); another with 651 (49.9%) and a third with 125 pregnant women, who represented 9.6%. Due to

Table 1. Anthropometric indicators according to clusters of general adiposity.

Anthropometric indicators of general adiposity	Anthropometric clusters of central adiposity					
	1		2		3	
	Mean ± SD	CV	Mean ± SD	CV	Mean ± SD	CV
Body mass index	20.4 ± 1.9	9.3%	25.7 ± 2.1	8.2%	33.5 ± 3.8	11.3%
Body fat percentage	23.7 ± 3.5	14.8%	31.5 ± 2.7	8.6%	41.6 ± 4.6	11.1%

SD, standard deviation; CV, coefficient of variation

the similarity of the central adiposity's distribution variables, the pregnant women were grouped into two clusters: one with 703 (53.9%) and another, with 602 pregnant women (46.1%).

In **table 1** are presented the indicators of general and central adiposity for different clusters. For the general adiposity, in cluster 1 was observed that both, the BMI and the percentage of body fat, had values of the mean that are between the limits of the normal weight category (20.4kg/m^2 and 23.7% of fat, respectively). In cluster 2, although the BMI is in the lower limit of the overweight category (25.7 kg/m^2), the value of body fat percentage is in the limit category (31.5%). On the other hand, in cluster 3, both, the BMI value (33.5 kg/m^2) and the body fat percentage (41.6%) placed the pregnant women in the obesity category. In cluster 1 of general adiposity the percentage of body fat had greater dispersion of its average values than the BMI; nevertheless, at 2 and 3, dispersions was negligible. These results allowed us to classify the groups into: normal adiposity (cluster 1), intermediate (cluster 2) and high (cluster 3).

The mean values of the anthropometric indicators of central adiposity (**Table 2**), in cluster 1 were lower than those of 2, with the greatest differences in the fat area of the arm. Being the indicator values in cluster 1 near to normal referents, hereinafter, these pregnant women were considered with normal central adiposity; while those of 2, whose values markedly exceeded normality, were considered with high central adiposity.

In **table 3** are shown the mean values of anthropometric variables related to general and central adiposity by categories and clusters. All the mean values of the variables increased in correspondence with a greater adiposity, both general and central.

In **table 4** is shown how the cluster of normal central adiposity included pregnant women that in the general adiposity cluster had been classified as intermediate adiposity (222 out of 651, for 34.1%); while in the category of high adiposity were included almost all pregnant women who had been placed in the intermediate (429; 65.9%) and high (124; 99.2%) clusters of general adiposity.

The graphics of the **figure**, where the results of the analysis of the ROC curves for the different variables appear, showing the diagnostic capability of the variables independently, are known to influence the adipose body composition for discriminating high and intermediate categories of clusters of general (a and b) and central (c and d) adiposities, respectively. It was observed, that all the variables discriminated, statistically significant, each category, but the largest area drawn was by the sum of the tricipital and subscapular skinfolds for the high category of central adiposity (c) with an area under the curve of 9.340 (CI 0.920 to 0.947), just as the preperi-

Table 2. Anthropometric indicators according to clusters of central adiposity.

Anthropometric indicators of central adiposity	Anthropometric clusters of central adiposity (mean ± SD)	
	1	2
Conicity index	1.30 ± 0.06	1.37 ± 0.06
Fat area of the arm	21.12 ± 6.67	38.24 ± 9.28
AC/Height index	0.56 ± 0.04	0.62 ± 0.05
AC/HC index	0.87 ± 0.05	0.93 ± 0.05
Energy-protein index	0.95± 0.06	1.04 ± 0.04

CA, circunferencia abdominal
CC, circunferencia de cadera

toneal fat as abdominal adiposity component (d) which showed an area under the curve of 0.822 (CI 0.750 to 0.894).

Table 3. Anthropometric clusters of general and central adiposity, according to mean values of abdominal adiposity components.

Anthropometric clusters of adiposity	Components of body and abdominal adiposity			
	Sum of TSF and SSF	SCF	PPF	ViscF
	Medias			
General				
Normal	31.13	9.31	7.7	19.77
Intermediate	50.72	14.2	9.86	29.1
High	68.27	19.24	13.08	35.67
Central				
Normal	31.71	10.00	9.74	21.76
High	54.79	15.33	10.61	30.64

PPF, preperitoneal fat; SCF, subcutaneous fat; SSF, subescapular skinfold; TSF, tricipital skinfold; ViscF, visceral fat.

DISCUSSION

The procedures applied systematically in the consultations of nutritional evaluation of healthy pregnant women from the values of the BMI do not allow to distinguish with clarity the particularities in the distribution of pregnant women by their corporal adiposity, according to if they are of suitable weight, overweight or obese.

When not taking into account more accurate data related to the location and amount of adipose tissue in pregnant women, their nutritional evaluation can offer biases from the limitations, which, in a not insignificant percentage of them, imposes the determination of the BMI. This causes a level of confidence in the work team at the primary care level that does not have all the support necessary to evaluate the true cardiometabolic risk that is hidden from this clinical situation; often, leading to nutritional orientations that improve the metabolic condition rather than worsen it, as a consequence of the increase in body adiposity.

Other researchers have proposed expanding the repertoire of adiposity indicators in pregnant women, to achieve quantitative discrimination and regional distribution of adiposity that better guide the medical performance. The identification of variations in the indicators of central adiposity in healthy pregnant women represents an opportunity to deepen the knowledge of adiposity, while confirming other proposals about the convenience of combining anthropometric indicators to demonstrate facts that would otherwise go unnoticed[31,32].

Having identified, at the beginning of gestation, differentiated characteristics of body adiposity by clusters according to the indicators used, warns about the threat posed by excessive accumulations of adipose tissue for the health of pregnant women and represents a very useful result in the efforts for identifying the possible vulnerability to risks of certain diseases, as well as in the timely implementation of preventive actions.

These results are consistent with the Ifeoma criteria on the need to take into account other elements

Table 4. Distribution of pregnant women according to groups of general and central adiposity.

Clusters with determinants of general adiposity	Clusters with determinants of central adiposity				Total	
	Normal		High			
	Nº	%	Nº	%	Nº	%
Normal	480	90.7	49	9.3	529	40.5
Intermediate	222	34.1	429	65.9	651	49.9
High	1	0.8	124	99.2	125	9.6
Total	703	53.9	602	46.1	1305	100.0

Source: Primary data

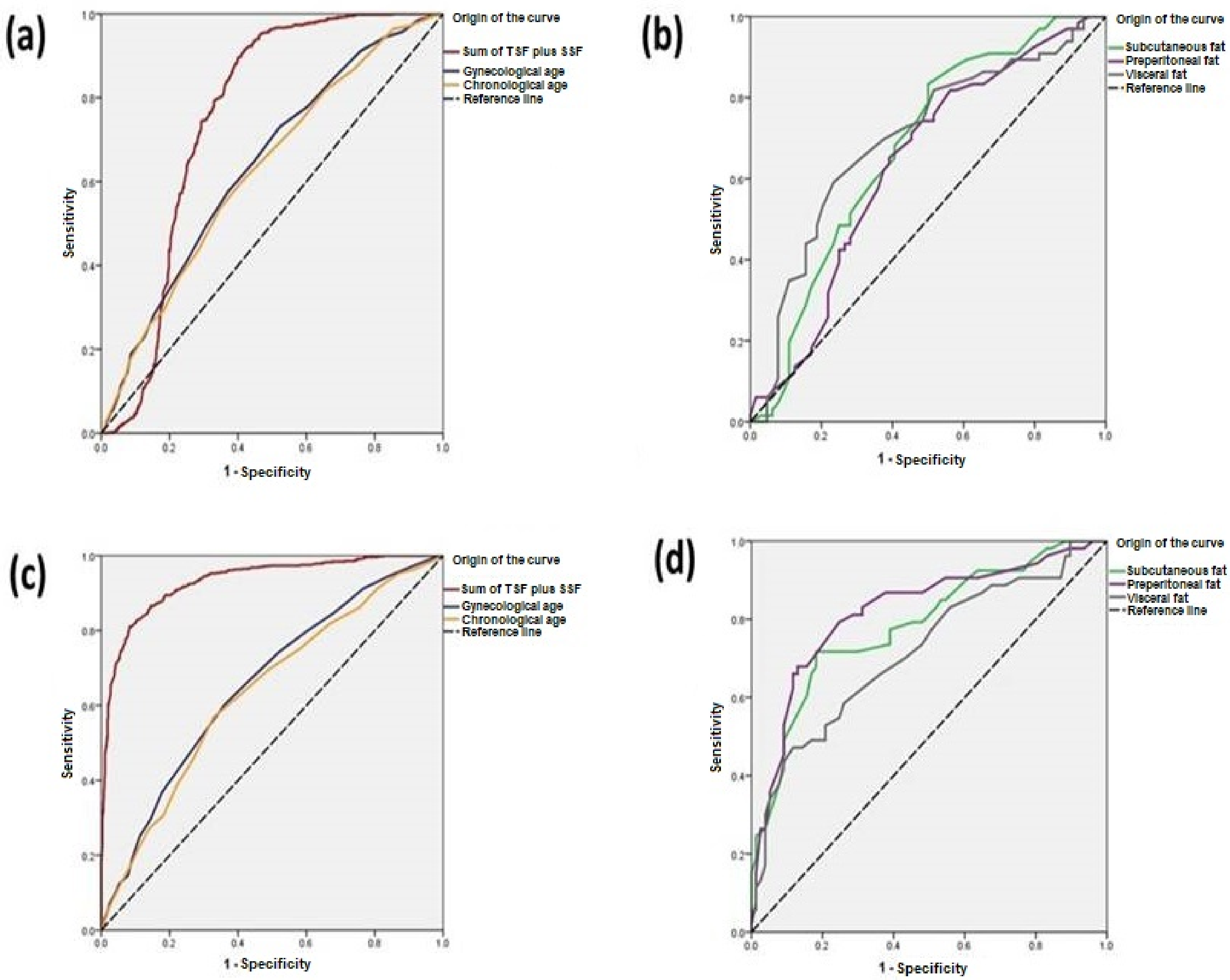

Figure. ROC curves of variables that intervene in body adiposity.
SSF, subescapular skinfold; TSF, tricipital skinfold

of body composition, in addition to BMI, in order to predict states of adiposity and obesity level of a population[32,33].

The obtaining of different mean values, but with very similar frequencies in the two clusters of the central adiposity, allows a greater precision on the levels of central adiposity in the pregnant women, a result that is also useful for orienting preventive actions and specialized prenatal care.

The distinction of two groups of pregnant women with central adiposity, according to the average values with respect to the cutoff points of the indicators used, was categorical for the high central adiposity and by approximation, to the values of normality for the group of normal central adiposity; results that could be better clarified with the study of a greater number of pregnant women and with the progress of pregnancy itself. Once again, the usefulness of the application of the cluster technique in the deepening of knowledge of body fat as part of the nutritional assessment of pregnant women was proven.

In a recent study, De Souza[34] referred to the importance of determining the deep adiposity in early gestation, because it allows us to infer the seriousness of insulin resistance and develop strategies to prevent gestational diabetes. The authors of this paper consider that, even when there existed the possibility of studying the deep adiposity, to identify the characteristics of central adiposity in pregnant women from early pregnancy is a factor to consider in health actions of prenatal care from the community.

People at high risk of metabolic syndrome and other alterations, with normal BMI values, have high levels of adiposity, a condition known as "normal weight obese", suggesting the need for a "high risk" stratification based on adiposity, rather than body weight, to guide preventive actions; considerations that could support studies of body fat in pregnant women[31].

A 2013 study reports that the concept of visceral adiposity is actually a priority in the evaluation of adipose tissue storage[5]. The frequency of pregnant women with intermediate or high general adiposity could be even higher if we take into account that other authors have proposed that the cutoff points of the BMI established to define overweight and obesity do not identify more than half of the people with high adiposity[6]; this is a situation that warns about the convenience of expanding the algorithms of clinical evaluation of pregnant women with the incorporation of other simple and low-cost measurements, such as skinfolds, circumferences , and others with diagnostic capability to detect levels of adiposity in pregnant women who are within normal ranges by their BMI.

The group analysis of pregnant women by levels of central adiposity showed that in the normal cluster was included only a minor part of pregnant women with intermediate general adiposity; while in the cluster of high central adiposity, almost all pregnant women with intermediate general adiposity were included. These results may have points of agreement with those obtained in a study conducted in Florida and published in 2011, in which 41.6% of women started their pregnancy in an overweight or obese condition[35].

Unlike what has been reported in other studies in adults of both sexes, in which the BMI and the body fat percentage have been compared as indicators of general adiposity using ROC curves[36], the present work −in the determination of the central adiposity in pregnant women− found that the values of the fat area of the arm showed the greatest differences between the normal and the late clusters; what could be related to the somatotypic characteristics of the predominant body composition in each of the clusters, which was not a subject of this research.

A local study, in women with weight gains above the recommended, found that the waist/height index was indicative of central obesity[37]. Some authors have used the subscapular and tricipital skinfolds as indicators, and have found an association between the highest values and low birth weight[38].

Studies in a sample of normal weight adult subjects of both sexes, aged between 23 and 25 years, but on condition of obesity because of their high percentage of body fat, reported that the sum of skinfolds above the 90th percentile expressed risk of presenting future metabolic alterations in the female sex[39]; results coinciding with the approaches of Madeira *et al*[15], who a year later recognized the value of the sum of these skinfolds in the identification of the obese normal weight phenotype.

Some authors consider, especially in women of adequate weight, that the lipid metabolism parameters correlate better with the ultrasound measurement of visceral fat, than with the measurement of the BMI, which indicates that probably, a group of thin women with accumulation of visceral fat could behave metabolically as obese[40].

The authors of this research considered of highly significance the contribution of abdominal adiposity variables to the high and intermediate categories of general and central adiposity clusters, given their relevance in the cardiometabolic disorders of the body, whether they may also warn about a given body composition; we are in the presence of a new path to the timely detection of groups vulnerable to cardiometabolic risks. The anthropometric techniques used, less expensive and more feasible, in combination with the ultrasound in the measurement of abdominal fat in pregnant women can be a very useful tool for monitoring their nutritional status.

Other authors have referred to the application of the cluster technique in early gestation, for identifying groups of visceral adiposity in the upper abdomen, and have watched to do positive association with abnormal lipid metabolism as pregnancy progresses, regardless the BMI[41]. Also, an association between visceral adiposity and other negative episodes during pregnancy have been reported.

Having found, in healthy pregnant women, that the sum of the subscapular and tricipital skinfolds was the indicator of greater diagnostic capability, both of general and central adiposity, focuses the authors' analysis towards the real possibility of identifying cases of the normal weight obese phenotype or at the beginning of pregnancy in apparently healthy women; this represents a novel aspect in the local characterization of body adiposity during pregnancy. Other researchers have worked this conceptualization as an individual who presents central obesity, identified by the waist/height index, metabolic disorders and[14] with the participation of relevant sum of tricipital and subscapular skinfolds above the 90th percentile[15,43].

The results of the present work demonstrate a high diagnostic capability of the sum of the tricipital and subscapular skinfolds in the identification of the general and central adiposity. Not only is this confirmed by other researchers on the usefulness of these indicators in body adiposity studies in general, but it is an opportunity to expand the use of anthropometry in prenatal care from primary health care, for the early research of nutritional conditions unfavorable at the beginning of pregnancy, which may evolve towards cardiometabolic risk in the pregnant woman.

Another novel result of this study is the combination of the ultrasonographic techniques for routine use in prenatal diagnosis, less expensive and aggressive than the CAT and NMR, with simple anthropometric measures, which could improve early diagnosis of obesity and the central distribution of adipose tissue in pregnant women, in addition to optimizing the human and material resources available for diagnosis, especially when cardiometabolic alterations have not yet been clinically expressed.

This knowledge would also be useful to guide interventions on the lifestyles of pregnant women who, as it is known, have a significant impact on the health of the pregnant woman and her product[44].

It has also been found that the nutritional status of the pregnant woman at the beginning of pregnancy, according to the BMI values, can mask the real proportions of adipose tissue and, in particular, abdominal adiposity; however, the waist/height index could reveal in time the behavior of the amount and distribution of this tissue in pregnant women since the beginning of pregnancy and thus avoid maternal-fetal complications[45].

These findings, together with those published by other authors, could support the call to complement the use of the BMI in the pregnant woman's weight monitoring, with other anthropometric indicators that better inform about the general and central adiposity in the organism, and thus have an earlier and more accurate orientation of possible health risks[46,47].

The main limitations of this study are related to its development in a single health area of Santa Clara municipality and the scarce specialized literature with results on adiposity in healthy pregnant women at the beginning of pregnancy, which limits the making of more precise comparisons and analyses[2].

CONCLUSIONS

The anthropometric indicators of general and central adiposity of healthy pregnant women at the beginning of pregnancy allowed the identification of clusters that may be useful for personalized conduction from the primary health care level. Variables as the sum of the subscapular and tricipital skinfolds, preperitoneal and visceral fat, showed higher diagnostic excessive deposition in adipose tissue of healthy pregnant at the time of the first territorially based care of the pregnant.

REFERENCES

1. Moral García JE, Redondo Espejo F. La obesidad. Tipos y clasificación. Lect Educ Fís Deportes (B. Aires). [Internet]. 2008 [citado 27 May 2018]; 13(122). Disponible en: http://www.efdeportes.com/efd122/la-obesidad-tipos-y-clasificacion.htm
2. World Health Organization. Overweight and obesity in the Western Pacific Region. Manila, Philippines: WHO Regional Office for the Western Pacific; 2017.
3. Gába A, Pridalová M. Diagnostic performance of body mass index to identify adiposity in women. Eur J ClinNutr. 2016;70(8):898-903.
4. Vila Candel R, Sanchis Valero S, Mateu Ciscar C, Bellvis Vázquez E, Planells López E, Martínez Ballester A, *et al*. ¿Cuál es el mejor indicador antropométrico para el control del embarazo? Nutr Clín Diet Hosp. 2016;36(3):87-96.
5. Granér M, Siren R, Nyman K, Lundbom J, Hakkarainen A, Pentikäinen MO, *et al*. Cardiac steatosis associates with visceral obesity in nondiabetic obese men. J Clin Endocrinol Metab. 2013;98(3): 1189-97.
6. Okorodudu DO, Jumean MF, Montori VM, Romero-Corral A, Somers VK, Erwin PJ, *et al*. Diagnostic performance of body mass index to identify obesity as defined by body adiposity: a systematic review and meta-analysis. Int J Obes (Lond). 2010;34(5):791-9.
7. Stokes A, Preston SH. The contribution of rising adiposity to the increasing prevalence of diabetes in the United States. Prev Med. 2017;101:91-5.
8. Lee YH, Pratley RE. Abdominal obesity and car

diovascular disease risk: the emerging role of the adipocyte. J Cardiopulm Rehabil Prev. 2007;27(1): 2-10.
9. Yang Q, Cogswell ME, Flanders WD, Hong Y, Zhang Z, Loustalot F, *et al*. Trends in cardiovascular health metrics and associations with all-cause and CVD mortality among US adults. JAMA. 2012;307(12):1273-83.
10. Garvey WT, Garber AJ, Mechanick JI, Bray GA, Dagogo-Jack S, Einhorn D, *et al*. American association of clinical endocrinologists and american college of endocrinology position statement on the 2014 advanced framework for a new diagnosis of obesity as a chronic disease. Endocr Pract. 2014;20(9):977-89.
11. De Lorenzo A, Bianchi A, Maroni P, Iannarelli A, Di Daniele N, Iacopino L, *et al*. Adiposity rather than BMI determines metabolic risk. Int J Cardiol. 2013;166(1):111-7.
12. Ruderman N, Chisholm D, Pi-Sunyer X, Schneider S. The metabolically obese, normal-weight individual revisited. Diabetes. 1998;47(5):699-713.
13. De Lorenzo A, Martinoli R, Vaia F, Di Renzo L. Normal weight obese (NWO) women: an evaluation of a candidate new syndrome. Nutr Metab Cardiovasc Dis. 2006;16(8): 513-23.
14. Romero-Corral A, Somers VK, Sierra-Johnson J, Korenfeld Y, Boarin S, Korinek J, *et al*. Normal weight obesity: a risk factor for cardiometabolic dysregulation and cardiovascular mortality. Eur Heart J. 2010;31(6):737-46.
15. Madeira FB, Silva AA, Veloso HF, Goldani MZ, Kac G, Cardoso VC, *et al*. Normal weight obesity is associated with metabolic syndrome and insulin resistance in young adults from a middle-income country. PLoS One [Internet]. 2013 [citado 22 Mar 2018];8(3):e60673. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3610876/pdf/pone.0060673.pdf
16. Liu PJ, Ma F, Lou HP, Zhu YN. Normal-weight central obesity is associated with metabolic disorders in Chinese postmenopausal women. Asia Pac J Clin Nutr. 2017;26(4):692-7.
17. Grosso CP, Díaz RF, Wassermann AO. Obesidad y riesgo cardiometabólico [Internet]. Buenos Aires: Fundación para el Estudio, la Prevención y el Tratamiento de la Enfermedad Vascular Aterosclerótica; 2010 [citado 25 May 2018]. Disponible en: http://www.fepreva.org/curso/5to_curso/bibliografia/volumen1/u4_vol1_obesidad.pdf
18. Kannieappan LM, Deussen AR, Grivell RM, Yelland L, Dodd JM. Developing a tool for obtaining maternal skinfold thickness measurements and assessing inter-observer variability among pregnant women who are overweight and obese. BMC Pregnancy Childbirth [Internet]. 2013 [citado 25 May 2018];13(42). Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3583701/pdf/1471-2393-13-42.pdf
19. Philipsen A, Carstensen B, Sandbaek A, Almdal TP, Johansen NB, Jørgensen ME, *et al*. Reproducibility of ultrasonography for assessing abdominal fat distribution in a population at high risk of diabetes. Nutr Diabetes [Internet]. 2013 [citado 20 May 2018];3:e82. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3730221/pdf/nutd201323a.pdf
20. Centro de Nutrición e Higiene de los Alimentos (MINSAP). Indicadores de nutrición materna: Situación nutricional de las mujeres en Cuba [Internet]. La Habana: Instituto Nacional de Higiene, Epidemiología y Microbiología [citado 27 May 2018]; 2014. Disponible en: https://www.unicef.org/cuba/AF_Nutricion_Materna(1).pdf
21. Kanhai DA, Kappelle LJ, van der Graaf Y, Uiterwaal CS, Visseren FL, *et al*. The risk of general and abdominal adiposity in the occurrence of new vascular events and mortality in patients with various manifestations of vascular disease. Int J Obes (Lond). 2012;36(5): 695-702.
22. Galjaard S, Pexsters A, Devlieger R, Guelinckx I, Abdallah Y, Lewis C, *et al*. The influence of weight gain patterns in pregnancy on fetal growth using cluster analysis in an obese and nonobese population. Obesity (Silver Spring). 2013;21(7):1416-22.
23. Ministerio de Salud Pública. Tablas Antropométricas de la Embarazada. La Habana: MINSAP; 2010.
24. Lecube A, Monereo S, Rubio MÁ, Martínez-de-Icaya P, Martí A, Salvador J, *et al*. Prevention, diagnosis, and treatment of obesity. 2016 position statement of the Spanish Society for the Study of Obesity. Endocrinol Diabetes Nutr. 2017;64(Supl 1):15-22.
25. Calloway CW, Chumlea WC, Bouchard C. Circunferences. En: Lohman TG, Roche AF, Martorell R, eds. Anthropometric standardization reference manual. Champaign: Human Kinetics Publishing; 1988. p. 39-45.
26. Valenzuela K, Bustos P. Índice cintura estatura como predictor de riesgo de hipertensión arterial en población adulta joven: ¿Es mejor indicador

que la circunferencia de cintura? Arch Lat Nutr. 2012;62(3):220-6.

27. Hernández Rodríguez J, Mendoza Choqueticlla J, Duchi Jimbo P. Índice de conicidad y su utilidad para detectar riesgo cardiovascular y metabólico. Rev Cuba Endocrinol [Internet]. 2017 [citado 27 May 2018];28(1):1-13. Disponible en: http://scielo.sld.cu/pdf/end/v28n1/end08117.pdf
28. Tan PN, Steinbach M, Kumar V. Data mining cluster analysis: basic concepts and algorithms. En: Addison-Wesley L. Introduction to data mining. 1ra ed. India: Pearson Education; 2005. p. 487-568.
29. James GM, Sugar CA. Clustering for Sparsely Sampled Functional Data. J Am Stat Assoc. 2003; 98(462):397-408.
30. Asociación Médica Mundial. Declaración de Helsinki de la AMM - Principios éticos para las investigaciones médicas en seres humanos. Seúl: WMA; 2008.
31. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Inter-relationships among childhood BMI, childhood height, and adult obesity: the Bogalusa Heart Study. Int J Obes Relat Metab Disord. 2004;28(1):10-6.
32. Martos-Moreno GÁ, Barrios V, Martínez G, Hawkins F, Argente J. Effect of weight loss on high-molecular weight adiponectin in obese children. Obesity (Silver Spring). 2010;18(12):2288-94.
33. Odo IF, Ezeanyika LUS, Nene U. The relationship among body composition and body mass index in a population of adolescents in Enugu State, Nigeria. Int J Curr Microbiol App Sci. 2015;4(1):884-97.
34. De Souza LR, Kogan E, Berger H, Alves JG, Lebovic G, Retnakaran R, *et al*. Abdominal adiposity and insulin resistance in early pregnancy. J Obstet Gynaecol Can. 2014;36(11): 969-75.
35. Park S, Sappenfield WM, Bish C, Salihu H, Goodman D, Bensyl DM. Assessment of the Institute of Medicine recommendations for weight gain during pregnancy: Florida, 2004-2007. Matern Child Health J. 2011;15(3):289-301.
36. Liu P, Ma F, Lou H, Liu Y. The utility of fat mass index vs. body mass index and percentage of body fat in the screening of metabolic syndrome. BMC Public Health [Internet]. 2013 [citado 2 May 2018];13:629. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3703297/pdf/1471-2458-13-629.pdf
37. Orozco Muñoz C, Sarasa Muñoz NL, Cañizares Luna O, Hernández Díaz D, Limas Pérez Y, Machado Díaz B. Retención de peso postparto y riesgo cardiovascular. CorSalud [Internet]. 2016 [citado 15 Abr 2018];8(2):94-101. Disponible en: http://www.revcorsalud.sld.cu/index.php/cors/article/view/105/248
38. Ay L, Kruithof CJ, Bakker R, Steegers EA, Witteman JC, Moll HA, *et al*. Maternal anthropometrics are associated with fetal size in different periods of pregnancy and at birth. The Generation R Study. BJOG. 2009;116(7):953-63.
39. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA. 2012;307(5):491-7.
40. Marín Segura P. Medición ultrasonográfica de la grasa visceral y su asociación con factores de riesgo cardiovasculares y metabólicos en gestantes con sobrepeso [tesis]. España: Universidad de Cádiz; 2016.
41. Cardellá Rosales LL, Valdés Moreno J, Gómez Álvarez AM, Hernández Fernández ML. Estado nutricional de la gestante y su repercusión sobre el lipidograma durante el embarazo. Panorama Cuba y Salud. 2013;8(2):15-9.
42. Ray JG, De Souza LR, Park AL, Connelly PW, Bujold E, Berger H. Preeclampsia and preterm birth associated with visceral adiposity in early pregnancy. J Obstet Gynaecol Can. 2017;39(2):78-81.
43. Gómez-Ambrosi J, Silva C, Galofré JC, Escalada J, Santos S, Millán D, *et al*. Body mass index classification misses subjects with increased cardiometabolic risk factors related to elevated adiposity. Int J Obes (Lond). 2012;36(2):286-94.
44. Orozco-Muñoz C, Cañizares-Luna O, Sarasa-Muñoz NL. Postpartum Obesity in Cuba: Risk Outweighs Response. MEDICC Review. 2017;19(2-3):75.
45. Hernández Díaz D, Sarasa Muñoz NL, Cañizares Luna O, Orozco Muñoz C, Lima Pérez Y, Machado Díaz B. Antropometría de la gestante y condición trófica del recién nacido. AMC [Internet]. 2016 [citado 22 May 2018];20(5):477-87. Disponible en: http://scielo.sld.cu/pdf/amc/v20n5/amc040516.pdf
46. Hernández Díaz D, Sarasa Muñoz NL, Cañizares Luna O. El índice de masa corporal puede no ser suficiente en el seguimiento ponderal de las gestantes. Medicentro [Internet]. 2016 [citado 22 May 2018];20(3):209-12. Disponible en: http://scielo.sld.cu/pdf/mdc/v20n3/mdc07316.pdf
47. Limas Pérez Y, Gómez Estacio L, Sarasa Muñoz N, Hernández Díaz D, Cañizares Luna O, Pérez Mar-

tínez D. Composición corporal grasa de las gestantes normopeso y sobrepeso. MorfoVirtual 2016 [Internet]. La Habana: CENCOMED; 2016 [citado 25 May 2018]. Disponible en: http://www.morfovirtual2016.sld.cu/index.php/Morfovirtual/2016/paper/view/361/110