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Sonographic Assessment of the Abdominal Wall Thickness in Primary School Children of Dera Ismail Khan, Pakistan

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Abstract: The present study was carried out to assess the abdominal wall thickness/abdominal fat in school children (6-11 years) at Dera Ismail Khan Pakistan. Abdominal Ultrasound was the sole criteria for the assessment of abdominal wall thickness. It included 103 school children; 58 (56.31%) boys and 45 (43.68%) girls. 76 (73.79%) were obese and 27 (26.21%) were normal weight children. Thorough clinical examination excluded those with chronic health problems. Body weight status was determined according to Quatelet's Index and CDC's gender specific growth charts 2-20 years (2000). Those, having BMI-for-age-percentile 5^{th}-<85^{th} percentile were declared as normal weight and obese with $\geq 95^{th}$ percentile. An ultasononic probe of 7.5MHZ was used to assess the abdominal fat (subcutaneous and preperitoneal) on two points: 2 cm above and 2 cm below umbilicus in the midline. Abdominal wall thickness/abdominal fat were found higher below the umbilicus than above the umbilicus in obese as well as in normal weight children. Maximum thickness of abdominal wall was found below the umbilicus in an obese girl (3.25 cm). Mean, for the abdominal thickness in normal weight children was calculated as 1cm. It is an important indicator for abdominal obesity in children.

Key words: Abdominal wall thickness, abdominal fat, obesity, primary school children

INTRODUCTION

The incidence of chronic or non communicable diseases is increasing much more rapidly in the developing countries than the developed countries. World Health Organization (WHO) has estimated that by the year 2010, three quarters of all deaths in the developing countries will be from chronic or non communicable diseases (WHO, 1997). Childhood Obesity is emerging as a public health problem in developing countries and is likely to result in enormous socioeconomic burden on the meager health resources in near future (Freedman *et al.*, 2001). Childhood obesity could lead to the development of a number of cardiovascular risk factors such as dyslipidemia (Friedland *et al.*, 2002), impaired glucose tolerance (Sinha *et al.*, 2002), atheromatous plaque formation and coronary artery disease in adult life.

Increased adipose tissue mass is the primary phenotypic characteristic of obesity. The amount and distribution of adipose tissue is associated with many of adverse consequences of obesity, such as Coronary Artery Disease (CAD) and type 2 diabetes mellitus (Evans *et al.*, 1984; Brochu *et al.*, 2000). Recently, it has been discovered that adipose tissue is not a single homogenous compartment but rather a tissue with specific regional depots with varying biological functions (Vanderburgh, 1992; Ross *et al.*, 1996). Moreover, individual adipose tissue compartments have stronger associations with physiological and pathological processes than does total adipose tissue mass (Despres *et al.*, 1989; Ronnemaa *et al.*, 1997).

Adipose tissue is a specialized connective tissue heavily loaded with adipocytes. Adipose tissue is mainly regarded as energy storage depot, thermal insulator and mechanical cushion in mammals. The 70 kg reference man has 21% of adipose tissue body fat mass (Snyder *et al.*, 1975). The percentage is higher in women, the elderly and overweight subjects. Adipose tissue is distributed throughout the human body. Pattern of adipose tissue distribution is influenced by many factors. These include sex, age, genotype, diet, physical activity level, hormones and drugs (An *et al.*, 2000; Kanaley *et al.*, 2001).

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Although the complications of the obesity are well known, it is also becoming very clear that regional fat distribution is more important index of cardiovascular and metabolic deterioration than total body mass (Kennel, 1995). Regional obesity can be assessed with anthropometric data and imaging techniques. The former include waist to hip ratio, waist circumference and abdominal sagital diameter. These parameters are easily obtained, cost effective and do not involve ionizing radiation and correlate with metabolic markers and imaging estimates (Wajchenberg, 2000). They are accepted as indicators for intra abdominal fat. However, they are less accurate and reproducible (Wei *et al.*, 1997; Bonora *et al.*, 1995).

Computed Tomography (CT) at abdominal level has provided the best estimation of visceral fat and cutoff values have been proposed to predict morbidity (Rössner *et al.*, 1990). Considering the high ionizing radiation exposure, great expense and low availability of CT, alternative non invasive methods to quantify regional adiposity have been used in clinical and epidemiological studies. The use of Ultrasonography as predictor of cardiovascular risk has been investigated (Seidell *et al.*, 1992; Armellini *et al.*, 1990). Evidence in the literature has suggested that the visceral fat thickness measured by Ultrasonography could be a reliable method to quantify visceral fat compared to CT (Armellini *et al.*, 1993; Tomaghi *et al.*, 1994). In addition, Ultrasonography determined visceral to subcutaneous fat ratios have also been shown to be highly correlated to CT measurements (Suzuki *et al.*, 1993; Cucchi *et al.*, 1997).

MATERIALS AND METHODS

The present study involved 103 school children with 58 (56.31%) boys and 45 (43.61%) girls from a mixed population. They were among 1336 children randomly selected and evaluated for the biochemical and hormonal changes in childhood obesity and their correlation with the cardiovascular and endocrinological complications. They were from the various primary schools of Dera Ismail Khan City N.W.F.P, Pakistan. Those suffering from chronic health ailments were excluded by thorough clinical examination.

Ultrasonography of the abdomen was the sole criteria for the measurement/assessment of thickness of abdominal wall/abdominal fat in school children. Ultrasonography is inexpensive, simple and easily available and uses average technical skill. Ultrasonography, using a strict protocol is precise, reliable and reproducible (Stolk *et al.*, 2003). It does not need any abdominal preparation and is valuable for epidemiological studies. Other imaging techniques, Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) are more accurate measures of body fat but are impracticable for routine clinical use, require technical skill, are expensive and deliver unacceptable levels of radiation.

For the assessment, subjects were placed in supine position with shoulders, heels and buttocks in contact with the examination bed. Abdomen was uncovered and lights were switched off. Conductive gel was applied to the two sites which were earmarked for the assessment: 02 cm above and 02 cm below the umbilicus in the midline. Transducer was placed on the two sites and a probe of 7.5 MHZ was pressed lightly to measure the total abdominal fat thickness as the sum of subcutaneous, preperitoneal and visceral fats (Kim *et al.*, 2004).

Thickness of the subcutaneous fat was measured as the distance from the anterior surface of the Linea Alba and the fat under skin barrier; preperitoneal fat between the Rectus Abdominis and posterior surface of Linea Alba and peritoneal/visceral fat was measured between the posterior surface of the Rectus Abdominis and posterior wall of the Aorta (Tomaghi *et al.*, 1994; Ribeiro-Filho *et al.*, 2003). Other intra-abdominal organs were also scanned especially liver for any steatosis or fatty changes (Ioannis *et al.*, 2007). Thickness of the abdominal fat or anterior abdominal wall was expressed in centimeters. Skin was cleaned after the completion of the procedure.

RESULTS

The present study was carried out to measure the thickness of anterior abdominal wall by using the Ultrasonography in primary school children of Dera Ismail Khan. Gender wise distribution of the sample on the basis of body mass status is given in Table 1. The study included 103 school children (6-11 years), having 58 (56.31%) boys and 45 (43.61%) girls. Among them were 76 (73.79%) obese and 27 (26.21%) as healthy/normal weights. Ultrasonography of the abdomen was the sole parameter for the measurement of anterior abdominal wall thickness/fat.

Ultrasound thickness of the abdominal wall fat on the basis of body mass index and gender is expressed in Table 2. Abdominal wall fat thickness in normal weight boys, was greater below umbilicus (1.09 cm) than above umbilicus (0.88 cm) expressing the greater deposition of abdominal fat below the umbilicus than above umbilicus. Similar trend was noted in normal weight girls (0.93 cm vs. 0.75 cm). The quantity of abdominal fat was also found greater in obese children than normal weight children. In obese boys, abdominal fat was noted greater below the umbilicus (2.60 cm) than above umbilicus (2.38 cm). Obese girls revealed similar trends (2.62 cm vs. 2.33 cm). Maximum quantity of abdominal fat was measured in obese girls (below the umbilicus) as 3.20 cm. Quantity of abdominal fat was not related to the values of body mass index.

Table 1: Gender wise distribution of children (6-11 years) on the basis of body mass status

	Obese children		Normal weight children		Total		
Body mass status	Boys	Girls	Boys	Girls	Boys	Girls	
No of children	41	35	17	10	58	45	103
Percentage gender	39.81%	33.98%	16.50%	9.71%	56.31%	43.61%	

Table 2: Gender wise distribution of the sample on the basis of body mass status and thickness of anterior abdominal wall through ultrasound

Body Mass Index (BMI)	Mean (kg/m^2)	S.D	Min. (kg/m^2)	Max. (kg/m^2)	TAWAU (cm)	TAWBU (cm)
Normal weight boys	15.37	±0.952	14.056	16.993	0.88±0.40	1.09±0.67
Normal weight girls	14.819	±0.907	13.926	15.708	0.75±0.22	0.93±0.27
Obese boys	25.274	±1.555	23.769	26.753	2.38±0.30	2.60±0.30
Obese girls	23.15	±2.43	21.83	25.04	2.33±0.49	2.62±0.60

Min. = Minimum; Max. = Maximum; TAWAU = Thickness of Abd. Wall Above Umbilicus (cm); TAWBU = Thickness of Abd. Wall Below Umbilicus (cm)

Table 3: Descriptive statistics: Ultrasound thickness of abdominal wall (UST) in school children 6-11 years

Variable	Mean (cm)	S.D	Minimum (cm)	Maximum (cm)
Normal weight children (6-11 years)				
UST above Umbilicus	0.794	±0.355	0.400	1.516
UST below Umbilicus	1.00	±0.533	0.600	2.160
Obese children (6-11 years)				
UST above Umbilicus	2.360	±0.389	1.800	2.875
UST below Umbilicus	2.616	±0.146	2.044	3.525

Thickness of abdominal wall (above and below umbilicus) in children is expressed in Table 3 (Descriptive Statistics). Minimum thickness of abdominal wall above the umbilicus in normal weight boys was noted 0.4 cm and maximum as 1.5 cm above the umbilicus and mean was centered at 0.79 cm. Abdominal wall thickness below the umbilicus in normal weight children was noted 0.60-2.16 cm and mean was noted 1.00 cm. Thickness of abdominal wall was more variable below umbilicus in normal weight children than above the umbilicus. Mean, for the abdominal wall thickness was noted higher (2.61 cm) below than above the umbilicus (2.36 cm), although non significantly.

Minimum thickness of abdominal wall in obese children, above the umbilicus was expressed as 1.8 cm, maximum as 2.8 cm and mean was calculated as 2.36 cm. Thickness of abdominal wall below the umbilicus in obese children was noted 2.04-3.52 cm and mean as 2.61 cm. Abdominal wall thickness in obese children below the umbilicus was more variable than the thickness above the umbilicus. This is in agreement with the similar trend observed in normal weight children. These findings suggest that there is greater deposition of abdominal fat below than above the umbilicus, both in normal weight and obese children.

DISCUSSION

The present study investigated 103 primary school children (6-11 years) at Dera Ismail Khan for the sonographic assessment of the abdominal fat as well as for the biochemical and hormonal changes in childhood obesity. Two sites, 2 cm above and 2 cm below the umbilicus were selected for the measurement of abdominal fat by an ultrasound probe of 7.5 MHZ. Maximum thickness of abdominal wall (below the umbilicus) was found to be 2.90 cm in obese boys and 3.52 cm in obese girls. However, 2.16 cm and 1.25 cm was measured to be the maximum thickness of abdominal wall in normal boys and girls respectively. Abdominal wall thickness was noted to be higher in obese girls below than above the umbilicus. Cut off values for the normal thickness of abdominal wall was not reported in literature. The observed cut off value for the normal thickness of abdominal wall/fat in the present study was calculated to be 0.79 cm above umbilicus and 1.00 cm below umbilicus.

Our study can be compared with quantification of the abdominal fat (subcutaneous, preperitoneal and visceral fat) explored by many researchers (Semiz *et al*., 2007; Mook-Kanamori *et al*., 2009; Wei Shen *et al*., 2003). Similar study was reported by Yano Kenji *et al*. (2003). Sonographic assessment of the abdominal fat thickness was undertaken for the 50 female patients at the 12 anatomic sites. These patients required breast reconstruction surgery with a transverse Rectus Abdominis musculocutaneous flap. Highest thickness of the abdominal wall was found 2cm below the umbilicus (29.0±10.00 mm) and lowest value of 2cm above the umbilicus (17.8cm±7.6 mm). However, there was difference of age.

Some of the studies have used the parameters for the sonographic measurement of abdominal wall fat other than used in the present study (centimeters) (Mook-Kanamori *et al*., 2009; Semiz *et al*., 2008). However, they have recommended that sonographic assessment of the abdominal fat is a valid method for the assessment of abdominal fat (Armellini *et al*., 1993; Tomaghi *et al*., 1994). Sonographic assessment of the abdominal wall/fat is a useful indicator for assessing the pediatric obesity. It can be carried out in the pediatrician's office as a part of clinical examination of obese children and can be followed on subsequent visits. It will also be helpful in detecting the complications of obesity such as hepatic steatosis.

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