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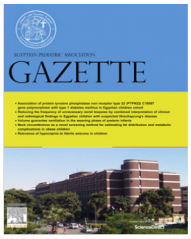

Neck circumference as a novel screening method for estimating fat distribution and metabolic complications in obese children

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KEYWORDS

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Central obesity;
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Abstract *Background:* Neck circumference (NC) has been shown to be an indicator of upper-body subcutaneous adipose tissue distribution. The aim of this study was to investigate the association between NC with pattern of fat distribution of obese children, hypertension, abnormal lipid profile and presence of insulin resistance.

Methods: A cross sectional case-control study was conducted on 50 obese subjects (27 male, 23 female), body mass index (BMI) $\geqslant$95th percentile for age and sex, aged 7–12 years and 50 healthy children (25 male, 25 female), BMI 15th to $<$85th percentile, age and sex matched as a control group. All children were subjected to history taking, complete clinical examination, blood pressure (BP), and anthropometric assessment (weight, height, BMI, NC, waist circumference (WC) and hip circumference (HC), biceps; triceps and sub scapular skin fold thickness); and fasting blood glucose, insulin and lipid profile estimation.

Results: All studied anthropometric parameters; including NC, were significantly higher in obese than control for total sample, males and females separately. The obese subjects also, showed statistically significantly higher low density lipoproteins (LDL), cholesterol, triglycerides (TG), glucose, insulin and homeostatic model assessment-insulin resistance (HOMA-IR). A significant positive correlation was recorded between NC and weight, height, BMI, WC, HC, triceps skin fold and diastolic blood pressure.

Abbreviations: Weight SDS, weight standard deviation score; Height SDS, height standard deviation score; BMI SDS, body mass index standard deviation score; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglycerides; TC, total cholesterol; HOMA-IR, Homeostasis Model Assessment-Insulin Resistance; IR, insulin resistance; NC, neck circumference; WC, waist circumference; HC, hip circumference; W/H ratio, waist hip ratio; FBG, fasting blood glucose; BP, blood pressure; CV, cardiovascular; DEMPU, Diabetes, Endocrine and Metabolism Pediatric Unit; RDA, recommended daily allowance.

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Conclusion: NC is a valuable predictor for body fat distribution among obese children either central (WC and HC) or peripheral (triceps skin fold). It should be used as a screening tool in population-based studies.

Introduction

The prevalence of childhood overweight/obesity in Egypt has increased during the past 30 years.[1] Childhood overweight/obesity; when is due to accumulation of body fat, is associated with health risk factors both during childhood and adolescence.[2] Consequently, identification of overweight/obese children early in life may be an important part of an overall health screening process that could be used to improve well-being in this population.[3,4] The most commonly used screening tool for detecting childhood overweight/obesity is the body mass index (BMI); (weight (kg)/height (m) squared). The standard method used in Egypt relies on the use of the BMI percentiles for Egyptian boys and girls constructed by Cairo University, Diabetes, Endocrine and Metabolism Pediatric Unit (DEMPU) and The National Research Centre in Cairo.[5] Children above the standard 85th percentile are considered overweight while youth above the 95th percentile are considered obese.

Neck circumference (NC) as an index of upper-body subcutaneous adipose tissue distribution was investigated as a screening tool for overweight individuals as it is easy to measure, inexpensive, noninvasive, and unlike waist circumference (WC), it does not show variations throughout the day. Moreover, NC correlates with many fat-related anthropometric measurements and cardiovascular (CV) risk factors.[6–9] The free fatty acid release from upper body subcutaneous fat was found to be larger than that from lower-body subcutaneous fat, a fact that further strengthens the relevance of measuring upper-body subcutaneous adipose tissue depots. These observations indicate that NC as an index of upper body fat distribution can be used to identify overweight and obese patients.[10] Also, changes in NC were best correlated with BMI.[11]

Anthropometric assessment is easy and practical; and early predictor for excess body fat in children. Therefore, the purposes of this study were to: (a) determine NC in a group of obese children as compared to a group of healthy non-obese children serving as controls. (B) Investigate the association between the pattern of fat distribution, hypertension, abnormal lipid profile and presence of insulin resistance on one hand and different NC values on the other hand.

Subjects and methods

Patients

The study is a cross sectional case-control conducted on 50 obese subjects (27 male, 23 female), BMI $\geqslant$95th percentile for age and sex based on the Egyptian Growth Reference Charts,[5] aged 7–12 years recruited from Diabetes Endocrine and Metabolism Pediatric Unit (DEMPU) at Children Hospital, Cairo University. Cases were compared to 50 healthy children (25 male, 25 female), BMI 15th to $<$85th percentile, age and sex matched, who were included as controls during the period from April 2013 to January 2014. Children with chronic illness, identified syndromes or chromosomal defects or endocrinal disorders causing obesity, chronic use of glucocorticoids, the use of drugs that may affect the metabolism of lipids and carbohydrates or blood pressure were excluded from the study. The study protocol was approved by both the Cairo University's Research Ethical Committee and National Research Center and it was conducted in accordance with the University's bylaws for human research. Written informed consent from one of parents was taken after an explanation of the study before the start.

Methods

All children were subjected to history taking, complete clinical examination, blood pressure assessment, and anthropometric assessment (body weight, height, neck circumference (NC), waist (WC) and hip (HC) circumferences). Anthropometric measurements were attempted following the recommendations of International Biological Program.[12] All anthropometric measurements were taken by the same individual who was duly trained for the task. NC was measured in the midway of the neck, between mid-cervical spine and mid-anterior neck, to within 1 mm, with a flexible non-stretchable plastic tape and approximated to the nearest 0.1 cm, calibrated weekly.[13] The WC was measured at the midpoint between the lowest rib and the iliac crest (the highest point of the ileum) at the end of normal expiration,[14] while HC is measured at the maximum circumference over the buttocks. Then, BMI (weight (kg)/height (m) squared) was calculated. Since Egyptians are close to Caucasians, British percentiles of McCarthy and colleagues were used to plot WC on.[15]

Laboratory investigations

Morning blood glucose, insulin and lipid profile were measured after an overnight (12-h) fasting. Plasma glucose was determined by the glucose oxidase method. Plasma insulin was measured using ELISA immunoassay (DRG Diagnostic Products Corporation, Los Angeles, CA). Blood concentrations of total cholesterol (TC) and triglycerides were estimated in serum using calorimetric assay kit produced by P.Z. cormay, Lublin, Poland. High-density lipoprotein (HDL) was determined in serum by using calorimetric assay kits produced by Stanbio laboratory, Boerne, Texas. Low-density lipoprotein (LDL) was calculated by the use of Friedewald equation [16] as follows: LDL = TC-HDL-TG/5.

Insulin resistance was given by the Homeostasis Model Assessment – Insulin Resistance Index (HOMA-IR) according to the fasting insulin and glucose levels as follows: