Ph.D. THESIS

DIAGNOSTIC EFFICIENCY OF ANTHROPOMETRIC PARAMETERS IN THE DETECTION OF OBESITY, WITH SPECIAL REGARD TO VISCERAL ADIPOSITY AND CERTAIN CARDIOVASCULAR RISK FACTORS

Zoltán Pintér

Supervisors:

György Pálfi Ph.D., associate professor, head of the department

Varga Csaba Ph.D., associate professor

Ph. D. School in Biology

University of Szeged

The Faculty of Science and Informatics

Department of Anthropology

Szeged

2013

Introduction

Obesity, defined as excessive or abnormal fat accumulation, has reached epidemic levels in developed and developing countries. The prevalence of obesity has risen considerably over the past decades, and this trend keeps on growing nowadays. Furthermore, this problem affects not only adults, but also adolescents and children. An increased risk of a number of life threatening diseases is linked to obesity, such as cardiovascular diseases, diabetes mellitus, musculoskeletal disorders, different types of cancer.

There is strong evidence that visceral adipose tissue carries greater risk of developing cardiometabolic disorders than subcutaneous adipose tissue or whole-body obesity. Consequently, estimating fat distribution and intra-abdominal fat accumulation could be more useful to predict the risk of cardiovascular and metabolic diseases than whole body fat.

Modern imaging techniques, including dual-energy X-ray absorptiometry (DXA), computed tomography (CT) and magnetic resonance imaging (MRI) provide the most accurate *in vivo* estimates of abdominal visceral fat. However, these methods can not be applied in routine clinical practice because they are excessively costly and time-consuming, furthermore DXA and CT exposes the subjects to radiation. For these reasons, alternative methods are used to estimate intra-abdominal fat deposition. Ultrasonography has been reported as a precise and reliable way for the evaluation of visceral fat and cardiovascular risk. Bioelectrical impedance analysis (BIA), already put into practical use, is a simple, noninvasive and inexpensive method for body fat measurement, even if its measure accuracy depends on a number of various factors.

Because of their simplicity, a great number of different anthropometric measurements have become commonly used indirect methods for the identification of obesity in epidemiological studies and clinical settings. Body-mass index (BMI) is a useful method for the diagnosis of whole-body obesity, while waist circumference, waist-to-hip ratio (WHR) and sagittal abdominal diameter (SAD) are widely used indicators of central obesity. It has been verified through experiments that these measurements have good predictive abilities for abdominal adipose tissue and

cardiometabolic risk. In recent times a wide number of indices and models based on body measurements (AVI; abdominal volume index, CI; conicity index, BAI; body adiposity index, WHtR; waist-to-height ratio) have been created to easily and accurately estimate the distribution and amount of adipose tissue. The main problem is that they do not distinguish visceral tissue from subcutaneous abdominal adipose tissue. Furthermore, the strength of correlation with visceral fat area and metabolic abnormalities may vary at different levels of the degree of obesity and age. These show the necessity to validate the predictive accuracy of existing, indirect methods in relation to the accumulation and localization of adipose tissue and cardiometabolic risk factors and to develop new, inexpensive and reliable methods for clinical use.

Aims

The main aims and questions of the study were the following:

- To determine which anthropometric parameters have strong relation with VFA, and how could the strength of these relationships be influenced by the extent of VFA?
- To identify the anthropometric parameters that have the best ability to estimate visceral fat accumulation.
- To evaluate the relationships between changes in body fat content, VFA and anthropometric parameters.
- How reliable are the investigated anthropometric parameters in the identification of certain cardiovascular risk factors?

Materials and methods

In order to achieve the above mentioned goals, we performed the following study. The data of the participants were collected through a healthy lifestyle awareness campaign advertised throughout the city of Szeged. There were no restrictions for participation in this program; anyone could volunteer to participate in the four-month series of organized sport programs. The initial size of the sample was 305 individuals (67 men and 238 women). During data cleaning, exclusion criteria were the following: age under 18 years, pregnancy, persons under treatment for known chronic cardiovascular, metabolic or tumorous diseases, incomplete data set. At the end of the sport programs, we continued to work with data from 168 persons (37 men and 131 women). Anthropometric measurements were included the analysis: height, weight, hip width, sagittal abdominal diameter, waist, hip, upper arm and lower arm, thigh and calf circumferences, and skinfold thickness at 6 sites. BMI, WHR, AVI, BAI, CI, WHtR, extremity skinfold thickness (EST), trunk skinfold thickness (TST) and trunk-extremity ratio (TER) were also calculated. Body composition was evaluated by a multifrequency BIA device (Biospace InBody230 Body Composition Analyzer) with tetrapolar 8-point contact electrodes. Blood pressure was measured using an automatic, upper arm blood pressure monitor (OMRON M2 Compact). Chemical analysis of blood serum included glucose, total cholesterol, triglyceride, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and C-reactive protein (CRP) levels. The data were analyzed with SPSS for Windows (version 17) and MedCalc (version 11.5).

Results and discussion

- **Relationships between anthropometric parameters and VFA**

In terms of visceral adipose tissue, waist circumference and SAD were the best single diagnostic parameters. Among anthropometric indices derived from body measurements, AVI and WHtR appeared to be the most suitable to detect abnormal visceral fat accumulation. In general, the predictive efficiency of the investigated parameters was better at excessive visceral adiposity. On the contrary, the skinfold thicknesses showed stronger associations with VFA among persons without visceral obesity, reflecting that the increase of subcutaneous adipose tissue is not proportionate with the expansion of visceral adipose tissue. Although the correlations between the earlier mentioned four parameters and VFA were better in persons with visceral obesity, their predictive efficiency was less influenced by extension of VFA, in contrast to using other popular indices (BMI, WHR). The importance of waist circumference was emphasized by the fact that this measurement is required for the calculation of AVI and WHtR.

- **Reliability of prediction models based on anthropometric parameters**

Results of the regression analysis also confirmed that using anthropometric parameters for the estimation of VFA provides better results when visceral fat accumulation is dominant. In most of the cases, the prediction models consisted of waist circumference, SAD and age, but some parameters (thigh circumference, front thigh skinfold, hip width and circumference) could slightly improve the accuracy of estimation. Our results were comparable to previously reported data, consequently the convenient combination of these parameters could be a suitable and cost-effective way for reliable prediction of VFA. The further goal is to develop a generalized predictive model for determining VFA, but for this it is necessary to determine the amount of visceral adipose tissue with reference method and to recruit a convenience sample.

- **Following changes in adipose tissue by monitoring changes in anthropometric parameters**

  The utilization of body weight, waist circumference and BMI was simple and reliable way to follow the changes in body fat content and VFA too. We emphasize the relationship between body weight and VFA; the conclusion can be drawn that gain in body weight would imply growth in visceral fat compartments during adulthood.

- **Anthropometric parameters as predictors of cardiovascular risk factors**

  Although anthropometric parameters cannot substitute for routine laboratory tests, they proved to be useful tools in estimating and indicating certain risk factors in prevention. According to our results, the investigated body measurements and indices showed the strongest associations with HDL-C levels; consequently they performed best with regard to the detection of abnormal HDL-C concentration. In addition, these parameters seemed to be reliable predictors for high CPR level among men and for high triglyceride level among women. The diagnostic accuracy of BAI, SAD and WHtR exceeded that of the other investigated variables, but it could be seen as the weakness of these methods: the prognostic precision was more reliable in case of increased health risk (e.g. simultaneous presence of more than one cardiovascular risk factors, larger amount of visceral fat).

Publications providing basis for the graduation

Pintér, Z., Molnár, A., Szász, A., Kiss, G., Orbán, K., Varga, Cs., László, F., Molnár, E., Pálfi, Gy.: (2013): Reliability of anthropometric parameters in the prediction of the visceral fat area among adult women. Anthropologischer Anzeiger 70(2):147-164.
IF: 0.676

Pósa, A., Kupai, K., Ménesi, R., Szalai, Z., Szabó, R., **Pintér, Z**, Pálfi, Gy., Gyöngyösi, M., Berkó, A., Pávó, I., Varga, Cs: Sexual dimorphism of cardiovascular ischemia susceptibility is mediated by heme-oxigenase. Oxidative Medicine and Cellular Longevity Volume 2013; 2013: 521563
IF: 3.393

Cumulative impact factor: 4.096

Other publications

Pintér, Z, Vida, R., Németh, Zs., Just, Zs. (2009): Szegedi egyetemisták obezitás vizsgálata fizikai aktivitásuk tükrében. Természet-, Műszaki- és Gazdaságtudományok Alkalmazása 8. Nemzetközi Konferencia. Előadások – Presentations (CD-ROM – ISBN: 9-639290-69-6)

Pintér, Z, Báthoriné, K.A., Just, Zs. (2009): „Fiatalabbak is elkezdhetik" – középiskolások obezitás vizsgálata, fizikai aktivitása és fittsége. Előadáskötet. VI. Kárpát-medencei Biológiai Szimpózium, Budapest. 37-43. (ISBN: 978-963-87343-3-4)

Pintér, Z, Just, Zs., Vida, E., Németh, Zs., Pálfi, Gy.: (2009): The correlation between parameters indicating obesity and certain environmental factors. Acta Biologica Szegediensis 53(2):105-110.

Pintér, Z, Móricz, L,, Szabó, K., Csanádi, M., Linczenbold, M., Molnár, A., Szász, A., Kiss, G., Orbán, N., Pálfi, Gy., László, F. (2011): Antropometriai jelzők kapcsolata a zsigeri elhízással. Természet-, Műszaki- és Gazdaságtudományok Alkalmazása 10. Nemzetközi Konferencia. Előadások. CD-ROM (ISBN: 9-639290-69-6)

Pintér, Z, Vida, R., Németh, Zs., Pálfi, Gy., Just, Zs. (2011): Egyetemisták elhízottságának kapcsolata az étkezési szokásokkal és a szülők iskolázottságával. Anthropologiai Közlemények 52:131-142.

Pintér, Z, Molnár, E., Kiss, G., László, F., Molnár, A., Orbán, K., Szász, A., Varga, Cs., Pálfi, Gy. (2012): Antropometriai paraméterek használhatósága felnőtt nők zsigeri zsírterületének becslésében. Anthropologiai Közlemények 53:115-132.

Conference posters

Pintér, Z., Móricz, L,, Szabó, K., Csanádi, M., Linczenbold, M., Molnár, A., Szász, A., Kiss, G., Orbán, N., Pálfi, Gy., László, F. (2010): Zsigeri zsírterület becslése antropometriai adatok felhasználásával. „Sport-Kultúra-Életminőség" Nemzetközi Sporttudományi Konferencia, Pécs, 2010. 10. 28.

Szablics, P., Nagy, P., Ungvári, M., Szabó, S., Nagyelszki, G., **Pintér, Z**., Orbán, K., Kovács, T., Kisuczky, É., Kiss, G., Varga, Cs., László, F., Béres, S. (2010): 3D mozgáselemző rendszer alkalmazhatósága a testsúlycsökkentés hatékonysága nyomon követésére. „Sport-Kultúra-Életminőség" Nemzetközi Sporttudományi Konferencia, Pécs, 2010. 10. 28.

Szablics, P., Nagy, P., Szabó, S., Kiss, G., Orbán, K., Kovács, T., **Pintér, Z**., Varga, Cs., László, F. (2011): A tömegközéppont dinamikai változásai testsúlycsökkenés hatására guggolásnál és felugrásnál. VIII. Országos MSTT Konferencia, Győr, 2011. 05. 18-20.

SZEGEDI TUDOMÁNYEGYETEM
TERMÉSZETTUDOMÁNYI ÉS INFORMATIKAI KAR
ÉLETTANI, SZERVEZETTANI ÉS IDEGTUDOMÁNYI TANSZÉK

6726, Szeged, Közép fasor 52.
TEL: (62)544-149
FAX: (62)544-291

Társszerzői nyilatkozat

Aláírásommal igazolom Pintér Zoltán hozzájárulását a Pósa et al., 2013-as tanulmány (Pósa A, Kupai K, Ménesi R, Szalai Z, Szabó R, Pintér Z, Pálfi Gy, Gyöngyösi M, Berkó A, Pávó I, Varga Cs (2013) Sexual dimorphism of cardiovascular ischemia susceptibility is mediated by heme-oxigenase. Oxid Med Cell Longev. 2013; 2013: 521563) létrehozásához. Kijelentem, hogy a jelöltnek meghatározó fontosságú szerepe volt a publikáció alábbi pontjaival kapcsolatban:

2.4. Measuring of Basal Blood Pressure and the Response of Blood Pressure to AVP.
2.7. Measurement of Surviving Aorta Contraction.

Nyilatkozom, hogy az adott tanulmányt nem fogom felhasználni Ph.D. fokozat megszerzéséhez, és hogy a jelölt által a fokozatszerzésben felhasznált (fentebb említett) anyagrészről más jelöltnek nem adok ki hasonló tartalmú nyilatkozatot.

....

Dr. Pósa Anikó, Ph.D.

Szeged, 2013. szeptember 20.