Commentary: Anthropometric Indicators as a Tool for Diagnosis of Obesity and Other Health Risk Factors: A Literature Review

Hanen Samouda*

Population Health Department, Luxembourg Institute of Health, Strassen, Luxembourg

Keywords: obesity, overweight, visceral fat, waist circumference, anthropometry, DEXA, MRI, CT-scan

A Commentary on

Anthropometric Indicators as a Tool for Diagnosis of Obesity and Other Health Risk Factors: A Literature Review
by Piqueras, P., Ballester, A., Durá-Gil, J. V., Martinez-Hervas, S., Redón, J., and Real, J. T. (2021). Front. Psychol. 12:631179. doi: 10.3389/fpsyg.2021.631179

INTRODUCTION

We read with great interest the recently published article “Anthropometric Indicators as a Tool for Diagnosis of Obesity and Other Health Risk Factors: A Literature Review” (Piqueras et al., 2021). We felicitate the Authors as this a comprehensive literature review of the tools currently available to assess or diagnose obesity and potential related health issues.

Obesity is a chronic multifactorial disease and a global public health challenge, due to its high prevalence worldwide (World Health Organization, 2020) and the potential associated comorbidities, in particular in the presence of metabolically unhealthy obesity (MUO) (Samouda et al., 2019).

Body mass index (BMI) has widely been used to assess body fat accumulation characterizing obesity (WHO, 2000). However, BMI does not distinguish between fat mass and fat free mass, and therefore constitutes a poor diagnosis tool of obesity (Garn et al., 1986; Frankenfield et al., 2001; Adab et al., 2018). Yet, in order to manage a disease, we need first to diagnose it. Obesity diagnosis requires to have available easy to use and accurate tools to measure total and regional body fat storage, in particular visceral adiposity, major risk factor of developing obesity related comorbidities (Nicklas et al., 2006; Van Gaal et al., 2006; Cereda et al., 2007; Anan et al., 2010; Fontes-Carvalho et al., 2014; Yu et al., 2015; Brown et al., 2017, 2018; Han et al., 2017; Dan Lantsman et al., 2018; Kuritzkes et al., 2018; Magro et al., 2018; Tian et al., 2018).

ADDITIONAL ASSESSMENT METHODS OF OBESITY

Dual-Energy-X-ray-Absorptiometry (DEXA) is the reference method for body composition assessment, providing a gold standard measurement of fat mass at both total and regional levels. Computed tomography scan (CT-scan) provide a reproducible and accurate measurement of visceral adipose tissue (VAT). Nevertheless, DEXA and CT-scan are considered as prohibitive techniques owing to the limited accessibility for the machines, the high cost of the imaging examination and the radiation exposure delivered by the multi-slice CT-scan protocols (Kvist et al., 1988; Jensen et al., 1993; Pritchard et al., 1993; Heymsfield et al., 1995).
Piquerás et al. (2021) reported 17 indices or health indicators to assess obesity using non-invasive and low-cost anthropometric measurements, which constitute a good alternative to expensive and less accessible biomedical imaging.

Regarding the anthropometric assessment of visceral adipose tissue, the authors stated that the model proposed by Samouda et al. (2013) correlates Visceral Adipose Tissue Area with the waist circumference and proximal thigh circumferences, BMI, and age, for adult men and women (Piquerás et al., 2021).

**HEALTH ISSUES ASSOCIATED WITH OBESITY. RELATIONSHIP TO THE ANTHROPOMETRIC ASSESSMENT TOOLS**

Independently of the general fat mass accumulation, VAT depot has been highlighted as a major risk factor for developing several metabolic, cardiovascular, autoimmune, neurodegenerative, and oncological diseases, as well as an increased risk for early mortality (Van Gaal et al., 2006; Cereda et al., 2007; Fontes-Carvalho et al., 2014; Yu et al., 2015; Brown et al., 2017, 2018; Dan Lantsman et al., 2018; Kuritzkes et al., 2018; Magro et al., 2018). The Authors reported a significant relationship between the identified anthropometric tools assessing total and regional adiposity and several health issues, including glucose dysregulation, insulin resistance, metabolic syndrome, cardiometabolic dysregulation, type 2 diabetes, hypertension, cardiovascular diseases, cancer, as well as a higher risk of early cardiovascular and all-cause mortality (Piquerás et al., 2021).

**DISCUSSION**

Following these statements, we would like to clarify that our previous work related to the innovative anthropometric model to predict visceral adipose tissue without resort to CT-Scan or DXA (Samouda et al., 2013) did not aim to simply correlate the visceral adipose tissue with the waist circumference (Waist C), proximal thigh circumference (Proximal Thigh C), body mass index (BMI) and age.

In order to develop our tools, multiple linear regressions with an empirical selection of the variables were developed by no controlled stepwise regressions (Samouda et al., 2013). The anthropometric VAT model we developed assumed that if we subtract the most correlated anthropometric measurement with subcutaneous abdominal adipose tissue (SAAT) from the most correlated anthropometric measurement with total abdominal adipose tissue (TAAT) and VAT as assessed by CT-Scan, we obtain the most accurate prediction of VAT by anthropometry. In our tools, Proximal Thigh C was the most correlated (R Pearson) anthropometric measurement with SAAT as assessed by CT-Scan, respectively Waist C was the most correlated anthropometric measurement with TAAT and VAT (Samouda et al., 2013).

The Authors also stated that there was no specific cut-offs for VAT accumulation (Piquerás et al., 2021). Actually, the cut-off of 130 cm² of VAT has previously been defined by Hunter et al. (1994) as associated with an increased risk of hypertension and dyslipidemia. The ability of our selected anthropometric tools for the diagnosis of a VAT excess ≥ 130 cm² was considerably high: sensitivity (97.7% in women, 100% in men), specificity (75% in men, 85.7% in women), positive predictive values (91.3% in women, 90.9% in men), and negative predictive values (96% in women, 100% in men) (Samouda et al., 2013).

In addition, the VAT anthropometric tools we developed have been validated as being the most accurate predictors of cardiometabolic abnormalities, cancer and early mortality (cardiovascular, cancer, and all causes), compared to BMI and Waist C, when biomedical imaging are not available. This validation was conducted in 10,624 participants of European descent to the National Health and Nutrition Examination Survey followed for 20 years (Brown et al., 2017, 2018). Similar findings were observed in a population-based study in North Europe (Ruiz-Castell et al., 2021).

Finally, we emphasize the potentialities offered by our innovative anthropometric method, which offer accurate and easy to use tools to predict VAT without resort to biomedical imaging.

**AUTHOR CONTRIBUTIONS**

HS drafted the Commentary.

REFERENCES

Adah, P., Pallan, M., and Whincup, P. H. (2018). Is BMI the best measure of obesity? BMJ 366:k1274. doi:10.1136/bmj.k1274
Anan, F., Masaki, T., Ito, Y., Eto, T., Umeno, Y., Eshima, N., et al. (2010). Diabetic retinopathy is associated with visceral fat accumulation in Japanese type 2 diabetes mellitus patients. Metabolism 59, 314–319. doi:10.1016/j.metabol.2009.06.001
Brown, J. C., Harhay, M. O., and Harhay, M. N. (2017). Anthropometrically-predicted visceral adipose tissue and mortality among men and women in the third national health and nutrition examination survey (NHANES III). Am. J. Hum. Biol. 29. doi:10.1002/ajhb.23298
Brown, J. C., Harhay, M. O., and Harhay, M. N. (2018). Anthropometrically predicted visceral adipose tissue and blood-based biomarkers: a cross-sectional analysis. Eur. J. Nutr. 57, 191–198. doi:10.1007/s00394-016-1308-8
Cereda, E., Sansone, V., Meola, G., and Malavazos, A. E. (2007). Increased visceral adipose tissue rather than BMI as a risk factor for dementia. Age Ageing 36, 488–491. doi:10.1093/ageing/afm096
Dan Lantsman, C., Herman, A., Verlaan, J. J., Stern, M., Mader, R., and Eshed, I. (2018). Abdominal fat distribution in diffuse idiopathic skeletal hyperostosis
and ankylosing spondylitis patients compared to controls. Clin. Radiol. 73, 910-915. doi: 10.1016/j.crad.2018.06.008
Fontes-Carvalho, R., Fontes-Oliveira, M., Sampaio, F., Mancio, J., Bettencourt, N., Teixeira, M., et al. (2014). Influence of epicardial and visceral fat on left ventricular diastolic and systolic functions in patients after myocardial infarction. Am. J. Cardiol. 114, 1663–1669. doi: 10.1016/j.amjcard.2014.08.037
Frankenfield, D. C., Rowe, W. A., Cooney, R. N., Smith, J. S., and Becker, D. (2001). Limits of body mass index to detect obesity and predict body composition. Nutrition 17, 26–30. doi: 10.1016/S0899-9007(00)00471-8
Garn, S. M., Leonard, W. R., and Hawthorne, V. M. (1986). Three limitations of body mass index. Am. J. Clin. Nutr. 44, 996–997. doi: 10.1093/ajcn/44.6.996
Han, S. J., Kim, S. K., Fujimoto, W. Y., Kahn, S. E., Leonetti, D. L., and Boyko, E. J. (2017). Effects of combination of change in visceral fat and thigh muscle mass on the development of type 2 diabetes. Diabetes Res. Clin. Pract. 134, 131–138. doi: 10.1016/j.diabres.2017.10.003
Heymsfield, S. B., Allison, D. B., Heshka, S., and Pierson, R. N. J. (1995). “Assessment of body composition” in Handbook of Assessment Methods for Eating Behaviors and Weight-Related Problems (Sage Publication), 515.
Hunter, G. R., Snyder, S. W., Kekes-Szabo, T., Nicholson, C., and Berland, L. (1994). Intra-abdominal adipose tissue values associated with risk of possessing elevated blood lipids and blood pressure. Obes. Res. 2, 563–568. doi: 10.1002/1550-8528.1994.tb00106.x
Jensen, M. D., Kanaley, J. A., Roux, L. R., O’Brien, P. C., Braun, J. S., Dunn, W. L., et al. (1993). Assessment of body composition with use of dual-energy x-ray absorptiometry: evaluation and comparison with other methods. Mayo Clin. Proc. 68, 867–873. doi: 10.1016/S0025-6196(12)60695-8
Kuritzkes, B. A., Pappou, E. P., Kiran, R. P., Basar, O., Fan, L., Guo, X., et al. (2018). Visceral fat area, not body mass index, predicts postoperative 30-day morbidity in patients undergoing colon resection for cancer. Int. J. Colorectal Dis. 33, 1019–1028. doi: 10.1007/s00384-018-3038-2
Kivist, H., Chowdhury, B., Grangard, U., Tylen, U., and Sjostrom, L. (1988). Total and visceral adipose-tissue volumes derived from measurements with computed tomography in adult men and women: predictive equations. Am. J. Clin. Nutr. 48, 1351–1361. doi: 10.1093/ajcn/48.6.1351
Magro, D. O., Barreto, M. R. L., Cazzo, E., Camargo, M. G., Kotze, P. G., and Coy, C. S. R. (2018). Visceral fat is increased in individuals with crohn’s disease: a comparative analysis with healthy controls. Arq. Gastroenterol. 55, 142–147. doi: 10.1590/S0004-2803.201800000025
Nicklas, B. J., Cesari, M., Penninx, B. W., Kritchevsky, S. B., Ding, J., Newman, A., et al. (2006). Abdominal obesity is an independent risk factor for chronic heart failure in older people. J. Am. Geriatr. Soc. 54, 413–420. doi: 10.1111/j.1532-5415.2005.00624.x
Piqueras, P., Ballester, A., Dura-Gil, J. V., Martinez-Hervas, S., Redon, J., and Real, J. T. (2021). Anthropometric indicators as a tool for diagnosis of obesity and other health risk factors: a literature review. Front. Psychol. 12:631179. doi: 10.3389/fpsyg.2021.631179
Pritchard, J. E., Newson, C. A., Strauss, B. J., Carlson, J. S., Kaymakci, B., and Wark, J. D. (1993). Evaluation of dual energy X-ray absorptiometry as a method of measurement of body fat. Eur. J. Clin. Nutr. 47, 216–228.
Ruiz-Castell, M., Samouda, H., Bocquet, V., Fagherazzi, G., Stranges, S., and Huiart, L. (2021). Estimated visceral adiposity is associated with risk of cardiometabolic conditions in a population based study. Sci. Rep. 11:9121. doi: 10.1038/s41598-021-88587-9
Samouda, H., Dutour, A., Chaumoitre, K., Panuel, M., Dutour, O., and Dadoun, F. (2013). VAT-TAT-SAAT: innovative anthropometric model to predict visceral adipose tissue without resort to CT-Scan or DXA. Obesity 21, E41–E50. doi: 10.1002/oby.20033
Samouda, H., Ruiz-Castell, M., Karimi, M., Bocquet, V., Kummerle, A., Chioti, A., et al. (2019). Metabolically healthy and unhealthy weight statuses, health issues and related cost: findings from the 2013-2015 European Health Examination Survey in Luxembourg. Diabetes Metab. 45, 140–151. doi: 10.1016/j.diabet.2017.11.007
Tian, Z., Li, Y., Li, L., Liu, X., Shi, Y., Yang, K., et al. (2018). Dose-response relationship between visceral fat index and untreated hypertension in Chinese rural population: the RuralDiab study. J. Am. Soc. Hypertens. 12:448–456.e1. doi: 10.1016/j.jshs.2018.03.009
Van Gaal, L. F., Mertens, I. L., and De Block, C. E. (2006). Mechanisms linking obesity with cardiovascular disease. Nature 444, 875–880. doi: 10.1038/nature05487
WHO (2000). Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation. WHO Technical Report Series, 894.
World Health Organization (2020). Obesity and Overweight [Online]. Available online at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (accessed July 30, 2021).
Yu, H., Di, J., Rao, Y., Zhang, P., Zhang, L., Tu, Y., et al. (2015). Visceral fat area as a new predictor of short-term diabetes remission after Roux-en-Y gastric bypass surgery in Chinese patients with a body mass index less than 35 kg/m2. Surg. Obes. Relat. Dis. 11, 6–11. doi: 10.1016/j.soard.2014.06.019

Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher’s Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2021 Samouda. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.