B”SD

**Jesse C Krakauer, MD**

**Associated Physicains/Endocrinology**

**Berkley, Michigan 48072**

**jckrakauer@gmail.com**

**Nir Y Krakauer, PhD**

**Department of Civil Engineering**

**The City College of New York**

**New York, NY**

**nkrakauer@ccny.cuny.edu**

**12/25/2023**

**ABSI references:**[**https://drjessekrakauer.com/absi.html**](https://drjessekrakauer.com/absi.html)

**https://en.wikipedia.org/wiki/Body\_shape\_index**

**ABSI = WC weight-2/3height5/6 = WC/(BMI2/3height1/2)**

**Allometric Anthropometric Reporting**

## Initially Prepared for The ****15th Annual International Conference of the D&CVD Study Group, endorsed by the EASD**** which took place B”H ****10-12 May 2023**** in****Tel Aviv**, **Israel****

**Introduction to Allometric Anthropometrics**

**Basic body measurements, height, weight, waist, and hip circumference are up to 90% correlated with each other. The premier obesity index, BMI is defined as body weight divided by the predicted weight for an individual of given height (H) which based on populations studies is approximated by H\*\*2. The relationship was first identified some 200 years ago and has come to universal acceptance as the best representation of weight-based body size.**

**BMI is the standard for classifying obesity and body size based on weight and height. Measurements of body shape, waist and/or hip circumference (WC,HC) are stongly correlated with BMI. A decade ago we introduce ABSI (A Body Shape Index) that is a formula adjusting WC across the range of BMI and similarly for HC, HI (Hip Index). We and numerous others have shown that ABSI provides the best vaildated anthropometric risk estimate for mortality. Associations have been established for common features of the metabolic syndrome (especially for triglycerides and HDL) and for risk for cardiovascular events, certain cancers as well as risk for abnormalities of metabolism, blood vessels and body composition. ABSI and HI identify risk across the spectrum of BMI from underweight to morbid obesity. On the one hand individuals with normal or low weight may be found to be at high risk, whereas those on the heavy side may actually not be at much increased risk if ABSI/HI are favorable.**

**BMI, ABSI and HI were derived to be statistically independent, based on division weight, WC, HC by empiracly derived estimands of the respective expected values (see Table). The performance of these indices has been demonstred by low intercorrelations, despite inherent measurment errors and physiologic variability. Therefore, these indices approach statistical independence. Consequently, unlike other common anthropometric indices, associations with mortality and other outcomes can be combined to give an overall association designated an Anthrpometric Risk Indicator (usually expressed as a HR- Hazard Ratio, RR – Relative Risk or OR- Odds Ratio). Given the approximate statistical independence of BMI and ABSI, the combined Odds Ratio (OR), Anthropometric Risk Indicator (ARI) can be computed as: Ln(ARI) = ln(ORBMI) + ln(ORABSI) + ln(ORHI).**

**Computing ABSI (w or w/o HI) and displaying the anthropometric profile and associated individual risk estimates and the combined risk for BMI, ABSI and HI provides clinicians and others with a tool for increasing awareness of both higher and lower anthropometrically mediated risk. We suggest that considerable benefit for health care providers and patients may result from a very low cost effort in a time of strained health care budgets.**

**Supplementary Background**

**Allometry refers to a methodology using power laws for correlated variables (**[**https://en.wikipedia.org/wiki/Power\_law**](https://en.wikipedia.org/wiki/Power_law)**). Undoubtedly, the most familiar application of allometry addresses the high correlation of weight and height by dividing weight by its expected value derived from height. About 200 years ago Quetelet (https://en.wikipedia.org/wiki/Adolphe\_Quetelet) derived that the expected value weight is approximated by height\*\*2. In a 1972 paper Professor Ansel Keys, pioneering chronic disease epidemiologist coined the resultant power law expression, a Body Mass Index or BMI = weight/ height\*\*2. Over the ensuing half century, the low correlation between BMI and height has been empirically confirmed in populations worldwide.**

 **https://en.wikipedia.org/wiki/Body\_mass\_index.**

**Our work began a decade ago, with the introduction of the allometric index ABSI (A Body Shape Index) that adjusts waist circumference (WC) for height and BMI (height and weight). (1) ABSI was found to be a linear predictor of mortality and the original paper has been cited in over 600 peer reviewed publications for a range of populations and outcomes.**

**https://en.wikipedia.org/wiki/Body\_shape\_index**

**Unlike other shape indices based on WC, hazards for ABSI and BMI can be combined by a simple log sum of individual hazards to give an Anthropometric Risk Indicator (ARI). Unfortunately, investigators have generally not used ARI, which will improve prediction when hazards for BMI and ABSI are individually significant. Hip circumference is frequently measured and the allometric power law designated HI (hip index) and the log hazard can be included in ARI (2). Formulas for the indices are displayed in the Table:**

**Table Computational definitions for BMI, ABSI and HI**

|  |  |  |  |
| --- | --- | --- | --- |
| **Allometric Index** | **Power law formula** | **x** | **y** |
| **BMI** | **WxHy** | **1** | **-2** |
| **ABSI** | **WC/ WxHy** | **2/3** | **-5/6** |
| **HI^** | **HC/ (W\*)x(H\*)y**  | **0.482** | **-0.310** |

**BMI = Body Mass Index, ABSI = A Body Shape Index, HI = Hip Index**

**W = weight in kg, H= height in cm, WC = waist circumference in cm, HC = hip circumference in cm. x and y are the exponents in the power law formulas**

**^ HI was derived normalized to average weight and average height**

**W\* = W/73; H\* = H/166**

**More recently we introduced adjustment of DXA derived body composition measurements with ABSI and BMI. We found that most elements of body composition such as % fat, are largely accounted for by BMI and ABSI. Lean tissue in the limbs, a marker of skeletal muscle mass and lean (non-fat) tissue in the trunk remained predictive and could therefore be combined with BMI and ABSI to increase power of the estimated mortality hazard. (3) ABSI also associates with grip strength and sarcopenia, of importance in geriatric assessment. (4, 5)**

**Metabolic Syndrome (MS) is a conceptual construct used to predict health risk by combined presence of readily assessable measures: WC, elevated glucose, elevated BP, elevated triglycerides and low HDL These are scored 0 or 1 according to specific cut offs, that often vary for different population. Within the context of MS, by substituting ABSI or ARI for WC strengthens the power of the MS mortality hazard. (6) Recent support for using ABSI in place of WC in MS comes from Japan. (7)**

**We have reported evidence from a longitudinal observational study that dietary composition associates with ABSI as a mediator of mortality. (8)**

**We collaborated in a genomic study which found numerous SNAP associations with both ABSI and HI. (9) Further data from international surveys supports good performance of the allometric triad, BMI, ABSI, and HI across world populations. Based on the above, we believe that consideration should be given to standardizing ABSI and HI wherever WC or HC are of interest.**

**As highlighted by the American Heart Association, risk assessment is shifting from MS to Cardiovascular-Kidney-Metabolic (CKM) Health spectrum approach to diagnosis and treatment. (10) A companion statement from the AHA discusses risk quantification equations (11) with 16 mentions of BMI, but none for “waist”, perhaps start of a paradigm shift to relative from absolute waist circumference.**

**Studies across the CKD spectrum continue to accumulate addressing multiple CVD outcomes. (12-16) Renal studies have been conducted (9, 16) as well as for various metabolic disorders (17, 18), hypertension (19) diabetes (20) and lipids (21). Based on these and other studies (22) we propose that ABSI will be useful**

**across the CKM spectrum.**

**References:**

1. **Krakauer NY, Krakauer JC. A new body shape index predicts mortality hazard independently of body mass index. PLoS One. 2012;7(7):e39504. doi:10.1371/journal.pone.0039504. Epub 2012 Jul 18. PMID: 22815707; PMCID: PMC3399847.**
2. **Krakauer NY, Krakauer JC. An Anthropometric Risk Index Based on Combining Height, Weight, Waist, and Hip Measurements. J Obes. 2016;2016:8094275. doi: 10.1155/2016/8094275. Epub 2016 Oct 18. PMID: 27830087; PMCID: PMC5088335.** [**https://www.hindawi.com/journals/jobe/aip/8094275/**](https://www.hindawi.com/journals/jobe/aip/8094275/)
3. **Krakauer, N.Y.; Krakauer, J.C. Association of X-ray Absorptiometry Body Composition Measurements with Basic Anthropometrics and Mortality Hazard. Int. J. Environ. Res. Public Health 2021, 18, 7927. https://doi.org/10.3390/ijerph181579274.**
4. **Krakauer NY, Krakauer JC. Association of Body Shape Index (ABSI) with Hand Grip Strength. Int J Environ Res Public Health. 2020 Sep 17;17(18):E6797. doi: 10.3390/ijerph17186797. PMID: 32957738.**
5. **Biolo G, Di Girolamo FG, Breglia A, Chiuc M, Baglio V, Vinci P, Toigo G, Lucchin L, Jurdana M, Pražnikar ZJ, Petelin A, Mazzucco S, Situlin R. Inverse relationship between "a body shape index" (ABSI) and fat-free mass in women and men: Insights into mechanisms of sarcopenic obesity. Clin Nutr. 2015 Apr;34(2):323-7. doi: 10.1016/j.clnu.2014.03.015. Epub 2014 Apr 13. PMID: 24814384**
6. **Krakauer NY, Krakauer JC. Anthropometrics, Metabolic Syndrome, and Mortality Hazard(2018). Journal of Obesity. 2018;2018:9241904. doi:10.1155/2018/9241904.**[**https://doi.org/10.1155/2018/9241904**](https://doi.org/10.1155/2018/9241904)
7. **Nagayama D, Sugiura T, Choi SY, Shirai K. Various Obesity Indices and Arterial Function Evaluated with CAVI - Is Waist Circumference Adequate to Define Metabolic Syndrome? Vasc Health Risk Manag. 2022 Sep 12;18:721-733. doi: 10.2147/VHRM.S378288. PMID: 36120718; PMCID: PMC9480599**.
8. **Krakauer NY, Krakauer JC. Diet Composition, Anthropometrics, and Mortality Risk. Int J Environ Res Public Health. 2022 Oct 8;19(19):12885. doi: 10.3390/ijerph191912885. PMID: 36232184; PMCID: PMC9566505.**
9. **Kjaergaard AD, Krakauer J, Krakauer N, Teumer A, Winkler TW, Ellervik C. Allometric body shape indices, T2D and kidney function: A two-sample Mendelian randomization study. Diabetes Obes Metab. 2023 Feb 28. doi: 10.1111/dom.15037. Epub ahead of print. PMID: 36855799.**
10. **Ndumele CE, Rangaswami J, Chow SL, Neeland IJ, Tuttle KR, Khan SS, Coresh J, Mathew RO, Baker-Smith CM, Carnethon MR, Despres JP, Ho JE, Joseph JJ, Kernan WN, Khera A, Kosiborod MN, Lekavich CL, Lewis EF, Lo KB, Ozkan B, Palaniappan LP, Patel SS, Pencina MJ, Powell-Wiley TM, Sperling LS, Virani SS, Wright JT, Rajgopal Singh R, Elkind MSV; American Heart Association. Cardiovascular-Kidney-Metabolic Health: A Presidential Advisory From the American Heart Association. Circulation. 2023 Nov 14;148(20):1606-1635. doi: 10.1161/CIR.0000000000001184. Epub 2023 Oct 9. PMID: 37807924.**
11. **Khan SS, Coresh J, Pencina MJ, Ndumele CE, Rangaswami J, Chow SL, Palaniappan LP, Sperling LS, Virani SS, Ho JE, Neeland IJ, Tuttle KR, Rajgopal Singh R, Elkind MSV, Lloyd-Jones DM; American Heart Association. Novel Prediction Equations for Absolute Risk Assessment of Total Cardiovascular Disease Incorporating Cardiovascular-Kidney-Metabolic Health: A Scientific Statement From the American Heart Association. Circulation. 2023 Dec 12;148(24):1982-2004. doi: 10.1161/CIR.0000000000001191. Epub 2023 Nov 10. PMID: 37947094.**
12. **Dhana K, Ikram MA, Hofman A, Franco OH, Kavousi M. Anthropometric measures in cardiovascular disease prediction: comparison of laboratory-based versus non-laboratory-based model. Heart. 2015 Mar;101(5):377-83. doi: 10.1136/heartjnl-2014-306704. Epub 2014 Dec 11. PMID: 25502814.**
13. **Moon S, Park JH, Ryu OH, Chung W. Effectiveness of Z-score of log-transformed A Body Shape Index (LBSIZ) in predicting cardiovascular disease in Korea: the Korean Genome and Epidemiology Study. Sci Rep. 2018 Aug 14;8(1):12094. doi: 10.1038/s41598-018-30600-9. PMID: 30108276;**
14. **Gomez-Marcos MA, Gomez-Sanchez L, Patino-Alonso MC, Recio-Rodriguez JI, Gomez-Sanchez M, Rigo F, Marti R, Agudo-Conde C, Ramos R, Rodriguez-Sanchez E, Maderuelo-Fernandez JA, Garcia-Ortiz L; MARK Group. A body shape index and vascular structure and function in Spanish adults (MARK study): A cross-sectional study. Medicine (Baltimore). 2018 Nov;97(47):e13299. doi: 10.1097/MD.0000000000013299. PMID: 30461641; PMCID: PMC6392544.**
15. **Nam KW, Kwon HM, Jeong HY, Park JH, Kwon H. Association of Body Shape Index with Cerebral Small Vessel Disease. Obes Facts. 2023;16(2):204-211. doi: 10.1159/000528701. Epub 2022 Dec 19. PMID: 36535265; PMCID: PMC10028365**
16. **Zhang Y, Gao W, Li B, Liu Y, Chen K, Wang A, Tang X, Yan L, Luo Z, Qin G, Chen L, Wan Q, Gao Z, Wang W, Ning G, Mu Y. The association between a body shape index and elevated urinary albumin-creatinine ratio in Chinese community adults. Front Endocrinol (Lausanne). 2022 Jul 28;13:955241. doi: 10.3389/fendo.2022.955241. PMID: 35966103; PMCID: PMC9365939.**
17. **Christakoudi, S., Riboli, E., Evangelou, E. *et al.* Associations of body shape index (ABSI) and hip index with liver, metabolic, and inflammatory biomarkers in the UK Biobank cohort. *Sci Rep* 12, 8812 (2022).** [**https://doi.org/10.1038/s41598-022-12284-4**](https://doi.org/10.1038/s41598-022-12284-4)
18. **Tian X, Ding N, Su Y, Qin J. Comparison of Obesity-Related Indicators for Nonalcoholic Fatty Liver Disease Diagnosed by Transient Elastography. Turk J Gastroenterol. 2023 Oct;34(10):1078-1087. doi: 10.5152/tjg.2023.23101. PMID: 37737216; PMCID: PMC10645279. NHANES – ARI applicable**
19. **Wu LD, Kong CH, Shi Y, Zhang JX, Chen SL. Associations between novel anthropometric measures and the prevalence of hypertension among 45,853 adults: A cross-sectional study. Front Cardiovasc Med. 2022 Nov 3;9:1050654. doi: 10.3389/fcvm.2022.1050654. PMID: 36407444; PMCID: PMC9669705. NHANES:** **“ABSI had the highest OR (OR: 3.4; 95% CI: 2.73–4.24) after adjusting for age, sex, race/ethnicity, education, smoking, drinking, diabetes, and eGFR”.**
20. **Zhao W, Tong JJ, Cao YT, Li JH. A Linear Relationship Between a Body Shape Index and Risk of Incident Type 2 Diabetes: A Secondary Analysis Based on a Retrospective Cohort Study in Japan. Diabetes Metab Syndr Obes. 2020 Jun 22;13:2139-2146. doi: 10.2147/DMSO.S256031. PMID: 32606872; PMCID: PMC7319528**
21. **Gentile M, Iannuzzo G, Mattiello A, Rubba F, Panico S, Rubba P. Association between body shape index and small dense LDL particles in a cohort of mediterranean women: findings from Progetto ATENA. J Clin Biochem Nutr. 2017 Sep;61(2):130-134. doi: 10.3164/jcbn.17-13. Epub 2017 Aug 11. PMID: 8955130;**
22. [**https://drjessekrakauer.com/absi.html**](https://drjessekrakauer.com/absi.html)