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Predictive value of excess body weight in childhood and adolescence compared to body mass index and waist to height ratio

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Background

Weight status in children is commonly defined using standard deviation scores of BMI (**BMI-SDS**; z-scores). However, this measure can be unreliable in certain situations, such as extreme obesity (1) and is not easy to understand for physicians or parents alike. Another measure quickly gaining acceptance is waist-to-height ratio (**WHtR**), and its predictive value is comparable to BMI(SDS) (2, 3). A cut-off-value ≥ 0.5 is associated with increased cardio-metabolic risk (4).

Excess body weight (**EBW**) is frequently used for adults, mainly in the context of bariatric surgery. However, an appropriate definition of EBW is not available for the paediatric population to date.

Objective

A simple definition for EBW in children/adolescents is introduced, which uses median weight as a function of height, age and gender as a robust reference point. The relationships between EBW, BMI-SDS, WHtR and metabolic parameters are examined.

Methods

Definition

EBW(%) = 100 x (weight - median weight*) / median weight*
where median weight* takes into account height, age and gender.

The relationship between EBW, BMI-SDS, and WHtR and several anthropometic / metabolic parameters is compared using data from **14,362 children aged 11-18** taken from two sources:

1. APV data base, which collects data from German/Swiss/Austrian obesity outpatient centres (7,553 overweight/obese children) (5)
2. KiGGS survey, which is a representative sample of German children covering all weight ranges (6,809 children) (6).

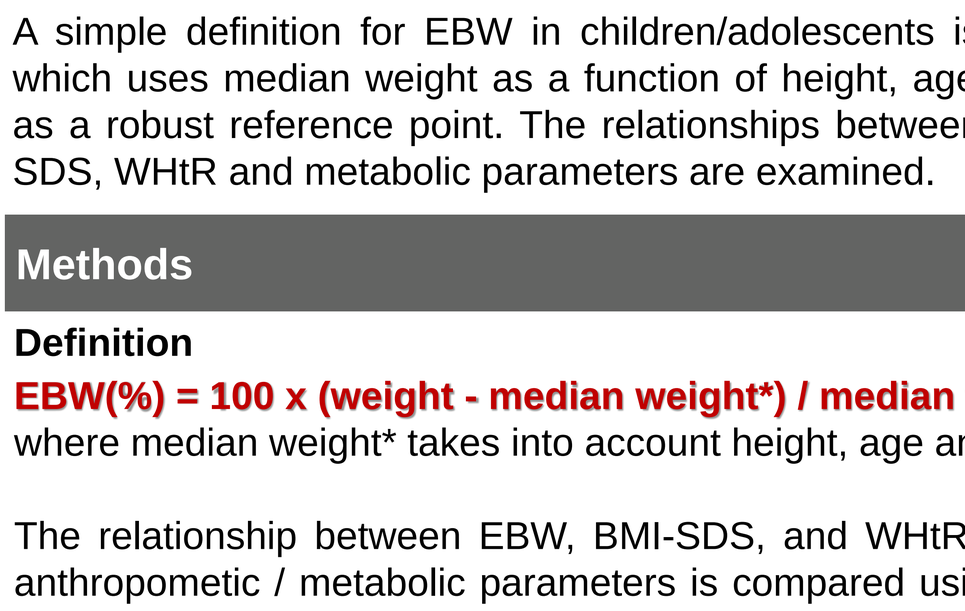

Fig. 1: EBW in percent vs BMI-SDS. The right panel shows an enlargement of the rectangle designated by the dashed line.

References

1. Javed A, Jumean M, Murad MH, et al. Pediatr Obes 2014; doi:10.1111/ijpo.242.
2. Browining LM, Hsieh SD, Ashwell M. Nutr Res Rev 2010; 23(2): 247-269.
3. SavvaSC; Lamnisos D,Kafatos AG. Diabetes Metab Syndr Obes 2013; 6: 403-419.
4. SavvaSC, Tornaritis M, Savva ME, Kourides Y, et al.Int J Obes Rel Metab Disord 2000; 24(11): 1453-1458.
5. Reinehr T, Wabitsch M, Andler W, et al. Eur J Pediatr 2004; 163(6): 308-312.
6. KurthBM, Kamtsiuris P, Hölling H, et al. BMC Public Health 2008; 8: 196.

Results

A) Characterization of study cohorts:

	n_{APV}	n_{KiGGS}	$n_{KiGGS\ ow/ob}$	APV	KiGGS	overweight/obese from KiGGS
# subjects / females				7553/3763 (49.8%)	6809/3318 (48.7%)	1191/586 (49.2%)
age [y]	7553	6809	1191	13.8 (1.8)	14.4 (2.0)	14.3 (2.0)
height [cm]	7553	6803	1191	164.0 (10.1)	163.8 (11.4)	165.2 (10.6)
weight [kg]	7553	6779	1191	83.7 (20.7)	56.8 (15.0)	75.2 (15.9)
BMI [kg/m^2]	7553	6776	1191	30.8 (5.5)	20.9 (4.0)	27.3 (3.7)
percent excess weight	7553	6776	1191	60 (26)	7 (20)	40 (17)
# > 40% excess weight				5893 (78.0%)	454 (6.7%)	454 (38.1%)
BMI-SDS	7553	6776	1191	2.38 (0.62)	0.25 (1.09)	1.90 (0.49)
# obese (> 97th percentile)				6055 (80.2%)	508 (7.5%)	508 (42.7%)
waist circumference [cm]	3008	6745	1180	97.5 (14.9)	70.3 (9.1)	83.6 (9.2)
# > 90th percentile				2848 (94.7%)	734 (10.9%)	693 (58.7%)
waist/height (WHtR)	2403	6737	1180	0.61 (0.08)	0.43 (0.05)	0.51 (0.05)
# WHtR > 0.5				2265 (94.3%)	605 (9.0%)	568 (48.1%)
systolic bp [mmHg]	5663	6801	1191	122.8 (13.7)	114.3 (10.8)	119.4 (11.1)
diastolic bp [mmHg]	5653	6801	1191	71.6 (10.6)	68.0 (7.5)	69.7 (7.4)
# > 95th percentile (systolic or diastolic)				2540 (44.9%)	673 (9.9%)	236 (19.8%)
triglycerides [mmol/l]	5134	6388	1100	1.26 (0.86)	1.21 (0.73)	1.56 (0.98)
# elevated				893 (17.4%)	1095 (17.1%)	341 (31.0%)
HDL-C [mmol/l]	4857	6387	1100	1.20 (0.30)	1.47 (0.34)	1.30 (0.31)
# too low				1661 (34.2%)	684 (10.7%)	237 (21.5%)
glucose [mmol/l]	4582	216	56	4.75 (0.56)	4.89 (0.46)	4.99 (0.35)
# elevated				254 (5.5%)	11 (5.1%)	2 (3.6%)
# with met. synd.	1567	6201	674	445 (28.4%)	169 (2.7%)	163 (24.2%)
# with met. synd. (BMI-SDS)	4862	6405	820	1043 (21.5%)	118 (1.8%)	118 (14.4%)
HOMA-IR	2253	0	0	3.56 (2.04)	–	–
GOT [U/l]	4018	0	0	28.7 (15.1)	–	–
GPT [U/l]	3855	0	0	31.9 (24.7)	–	–
γGT [U/l]	2463	6388	1100	22.3 (16.0)	13.6 (9.4)	17.4 (13.7)
CHOL [mmol/l]	5113	6386	1100	4.23 (0.94)	4.20 (0.76)	4.36 (0.81)
LDL-D [mmol/l]	4823	6388	1100	2.53 (0.80)	2.37 (0.67)	2.55 (0.72)

Table 1: Characterization of the APV- and KiGGS study cohorts

B) Correlation analyses:

→ In both cohorts EBW correlates strongly with BMI-SDS (lin. corr. coeff. ≥ 0.93) and with WHtR (linear correlation coefficients ≥ 0.76)
→ The relationships of all three measures with metabolic (triglycerides, HDL-cholesterol, fasting glucose) and clinical (systolic/diastolic blood pressure) parameters are quite similar
→ The strongest linear correlation can be found with HDL-cholesterol and systolic blood pressure

	EBW	BMI-SDS	WHtR	TG	HDL	Glucose	Systolic BP	Diastolic BP
EBW	1	**0.93** 0.96 [0.93, 0.93]	**0.78** 0.75 [0.76, 0.80]	**0.09** 0.12 [0.06, 0.11]	**−0.19** −0.21 [−0.21, −0.16]	**0.04** 0.04 [0.01, 0.07]	**0.27** 0.28 [0.25, 0.30]	**0.15** 0.14 [0.12, 0.17]
BMI-SDS		1	**0.76** 0.74 [0.74, 0.77]	**0.08** 0.12 [0.05, 0.11]	**−0.19** −0.21 [−0.21, −0.16]	**0.02** 0.02 [−0.01, 0.05]	**0.29** 0.30 [0.27, 0.32]	**0.17** 0.16 [0.14, 0.19]
WHtR			1	**0.10** 0.15 [0.06, 0.15]	**−0.19** −0.20 [−0.24, −0.15]	**−0.04** −0.04 [−0.08, 0.01]	**0.20** 0.21 [0.16, 0.24]	**0.03** 0.04 [−0.01, 0.08]
TG				1	**−0.23** −0.29 [−0.26, −0.21]	**0.00** −0.02 [−0.03, 0.03]	**0.05** 0.06 [0.02, 0.08]	**0.03** 0.04 [0.00, 0.06]
HDL					1	**−0.02** −0.01 [−0.05, 0.01]	**−0.08** −0.09 [−0.11, −0.05]	**−0.09** −0.10 [−0.12, −0.06]
Glucose						1	**0.03** 0.02 [−0.00, 0.06]	**0.15** 0.16 [0.12, 0.18]
Systolic BP							1	**0.41** 0.37 [0.38, 0.43]
Diastolic BP								1

Table 2: Pearson's (bold) and Spearman's correlation coefficients for anthropometric and metabolic parameters based on the APV data (square brackets: 95% confidence interval).

C) Prediction of metabolic risk

→ BMD-SDS, EBW and WHtR are similar in terms of their ability to predict metabolic risks, based on area under the curve from Receiver Operating Characteristic (ROC) analyses.
→ Suggested cut-offs are **30% for EBW, 0.5 for WHtR and 92nd percentile for BMI**

Conclusions

EBW is a novel four-dimensional marker, comparing individual weight to a gender, age and height related ideal weight. BMI-SDS, WHtR and EBW have similar predictive values for metabolic comorbidities in the paediatric population. As EBW is valid even for extremely obese patients and is intuitive, it would make a very useful addition to existing anthropometric tools in paediatric obesity. Its ability to measure weight change should be examined.