Diagnostic Test of Fat Location Indices and BMI for Detecting Markers of Metabolic Syndrome in Children

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Background

- Obesity is linked to both ***excess fatness*** and ***health risk*** (WHO, 2000)
- Classification systems can be evaluated on their ability to ***detect fatness*** or ***detect adverse health effects***
- No universally accepted BMI cutoffs to define childhood obesity
- Most of the proposed cutoffs are based on statistical criteria
- Two studies have proposed cutoffs for BMI and WC based on adult disease risk (Cole et al. 2000; Jolliffe & Janssen 2007)

Background

Health-related risk

- Pediatric obesity is a child health problem, so it seems appropriate to define it on the basis of child health considerations
- As the degree of adiposity in childhood increases, obesity-related morbidity manifested in early ages might be rising as well
- Cardiovascular risk factors track from childhood into adulthood (Chen et al, 2008; Li et al, 2003)
- Linking the definition of childhood obesity to immediate health outcomes

Objectives

- To evaluate the accuracy of anthropometric fat location indices and BMI as predictors of clustering of cardiovascular and metabolic risk factors in children and adolescents

- To define their respective cutoffs

Methods

The European Youth Heart Study (EYHS)

- Multicentre international study of the associations between lifestyle and risk factors for CVD in children
- 2822 children in the 3rd (8 –11 yrs) and 9th (14 – 17 yrs) grade
- Denmark (Odense), Estonia (Tartu) and Portugal (Madeira)

Clustering of cardiovascular and metabolic risk factors

- At least 3 of the following risk factors were present ≥ **3 RF**:

Pediatric cutoffs

  - ↑ Blood pressure **≥ 90th percentile for sex, age and height specific distribution**
  - ↑ HOMA-IR **> 2.5 pre-puberty; > 4 puberty**
  - ↑ % Body fat **> 25% ♂; > 30% ♀**
  - ↑ Triglyceride **≥ 1.1 < 10 yrs; ≥ 1.5 mmol/l ≥ 10 yrs**
  - ↑ Total cholesterol **≥ 4.4 mmol/l**
  - ↓ HDL-C level **< 1.03 mmol/l**
  - ↓ Aerobic fitness **< 25th percentile for sex, age and country specific distribution**

Homeostasis model assessment for insulin resistance (HOMA-IR)

Anthropometric measurements

- BMI weight/ height ($kg.m^{-2}$)
- WC, waist circumference (cm)
- HC, hip circumference (cm)
- WHR, waist-to-hip ratio waist / hip
- WHt, waist-to-height ratio waist / height
- HHt, hip-to-height ratio hip / height

Height-adjusted indices

Analysis

- The ability of each anthropometric index to discriminate between the absence and presence of clustering of risk factors (≥ 3RF) was evaluated through **R**eceiver **O**perating **C**haracteristic **(ROC)** analysis
- Derived cutoffs
  - producing equal sensitivity (Se) and specificity (Sp);
  - minimizing misclassifications
- The diagnostic accuracy was measured by the area under the ROC curve **(AUC)**

Results

Population characteristics

- Mean age
  - 3rd grade 10 yrs ± 0.4
  - 9th grade 15 yrs ± 0.5

- Clustering of risk factors
  - Girls 12%
  - Boys 10%

Table 1. Diagnostic characteristics and derived cutoffs

75th

85th – 95th

Specifity and % correctly classified

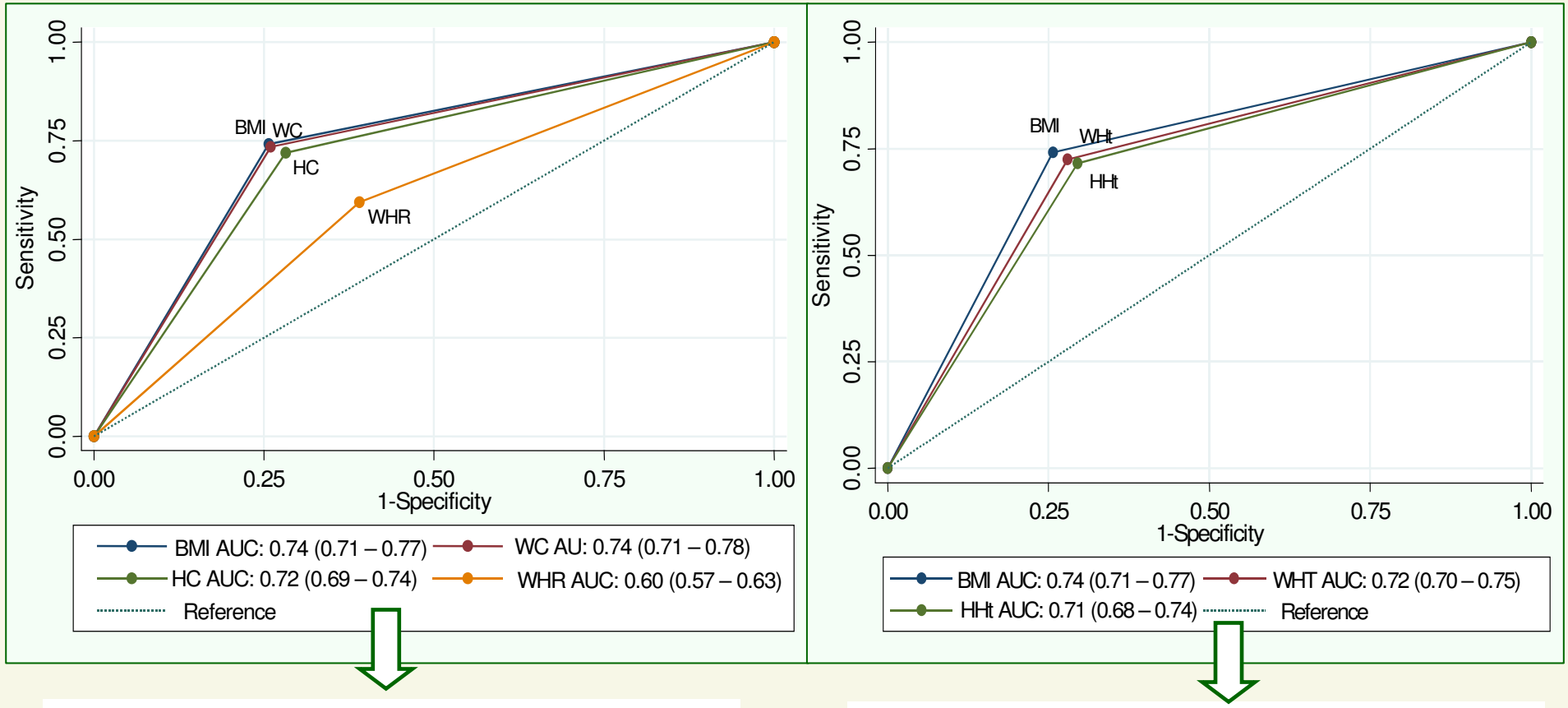
Yrs	ROC	GRILS											
		BMI		Waist		Hip		Waist-to-Ht		Hip-to-Ht		Waist-to-hip	
		a	b	a	b	a	b	a	b	a	b	a	b
8 – 9	Cutoff	17.8	20.5	59.0	64.5	73.0	81.3	0.43	0.48	0.53	0.58	0.81	0.92
	Se %	76.7	45.3	75.6	53.5	72.1	39.5	75.6	33.7	73.3	34.9	60.5	2.3
	Sp %	76.8	95.9	75.4	94.7	72.7	95.1	75.2	96.9	73.3	95.1	60.5	99.0
	CC %	76.8	88.6	75.5	88.7	72.6	87.1	75.3			86.4	60.5	85.0
	LR +	3.3	11.0	3.1	10.1	2.6	8.0	3.0	10.7	2.7	7.1	1.5	2.4
	LR -	0.3	0.6	0.3	0.5	0.4	0.6	0.3	0.7	0.4	0.7	0.6	1.0

Trade-off

a Cutoffs producing equal sensitivity and specificity **b** Cutoffs minimizing the percentage of misclassifications

Se, sensitivity; Sp, specificity; CC, fraction correctly classified; LR, likelihood ratio

Figure1 Test of equality of two or more AUC using cutoffs producing equal sensitivity & specificity



No significant difference between BMI and waist (p >0.05)

No significant difference between height-adjusted and unadjusted indices (p >0.05)

BMI performed better than hip (p < 0.05) and waist-to-hip ratio (p < 0.001)

Comparisons using BMI as reference Bonferroni's test: adjustment for multiple comparisons

Table 2. Comparison of cutoffs for BMI in the present study (**EYHS**) with values proposed by the International Obesity Task Force (**IOTF**)

	Age (yrs)	OVERWEIGHT						OBESITY					
		GIRLS			BOYS			GIRLS			BOYS		
		EYHS	IOTF	Diff[a]	EYHS	IOTF	Diff[a]	EYHS	IOTF	Diff[b]	EYHS	IOTF	Diff[b]
BMI ($kg.m^{-2}$)	8 - 9	17.8	18.7	-0.9	18.2	18.8	-0.6	20.5	22.2	-1.7	20.9	22.2	-1.3
	10 - 11	18.3	20.3	-2.0	17.9	20.2	-2.3	22	24.8	-2.8	22.3	24.6	-2.3
	14 - 15	21.5	23.6	-2.1	21.3	23.0	-1.7	27.3	29.0	-1.7	26.2	28.0	-1.8
	16 - 17	22.4	24.5	-2.1	22.0	24.2	-2.2	26.5	29.6	-3.1	27.2	29.1	-1.9

Cutoffs derived from the EYHS

Cutoffs proposed by the IOTF (Cole et al, 2000)

Cutoffs proposed by the IOTF are presented as mean values for the specific age range

[a] Differences were calculated using cutoffs producing equal sensitivity and specificity

[b] Differences were calculated using cutoffs minimizing misclassifications

Discussion

- Estimates of prevalence based on adult health risk tend to be more conservative than linking obesity to current health profile
- Cutoffs producing equal Se and Sp might be a better option for screening and monitoring obesity health-related risks in ***public health settings***
- Cutoffs minimizing misclassifications might be a better option in ***clinical settings***, where minimizing ***false +*** rate is preferable due to the stigma of being mislabeled as obese

Neglect a high percentage of ***true +*** cases in need of health attention

Study Limitations

- Datasets were not based on nationally representative surveys
- Lack of consensus on the definition of cardiovascular and metabolic disorders in children
- The adverse effects of excess fatness are gradual and depend on both duration and level of adiposity
- Obesity-related morbidity is not as pronounced in children as in adults

Study Perspectives

- This study did not have the ambition of creating a standard classification system of childhood obesity
- This study was intended to serve as groundwork for establishing cutoffs for BMI and fat location indices based on disease risk

Conclusions

- BMI and fat location indices (waist; waist-to-height) showed to be useful tools to identify children at risk
- The proposed cutoffs should be tested in other populations

THANKS

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