Assessment of Nutritional Status in Sri Lankan Children: Validity of Anthropometry Cutoffs?

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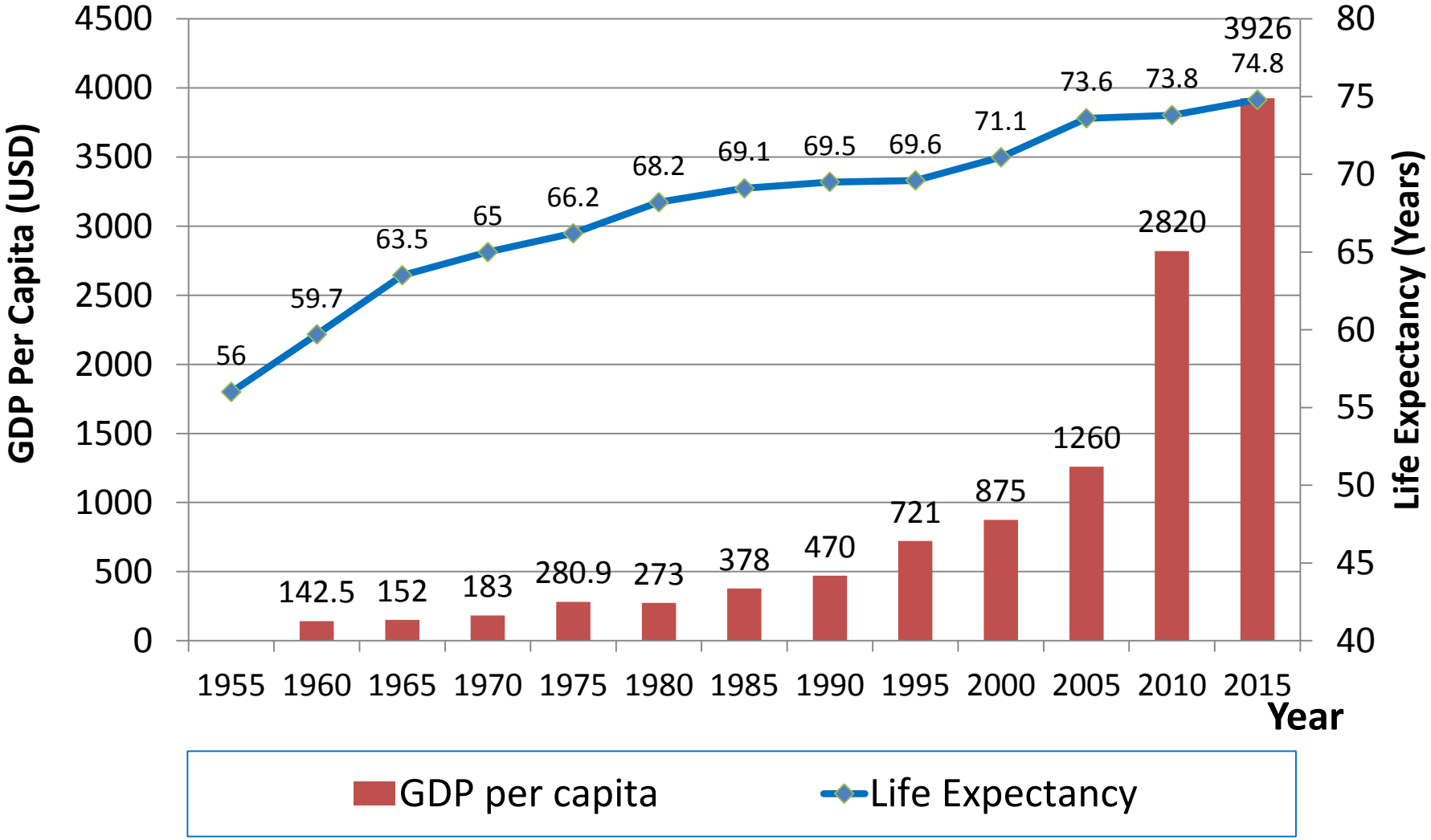
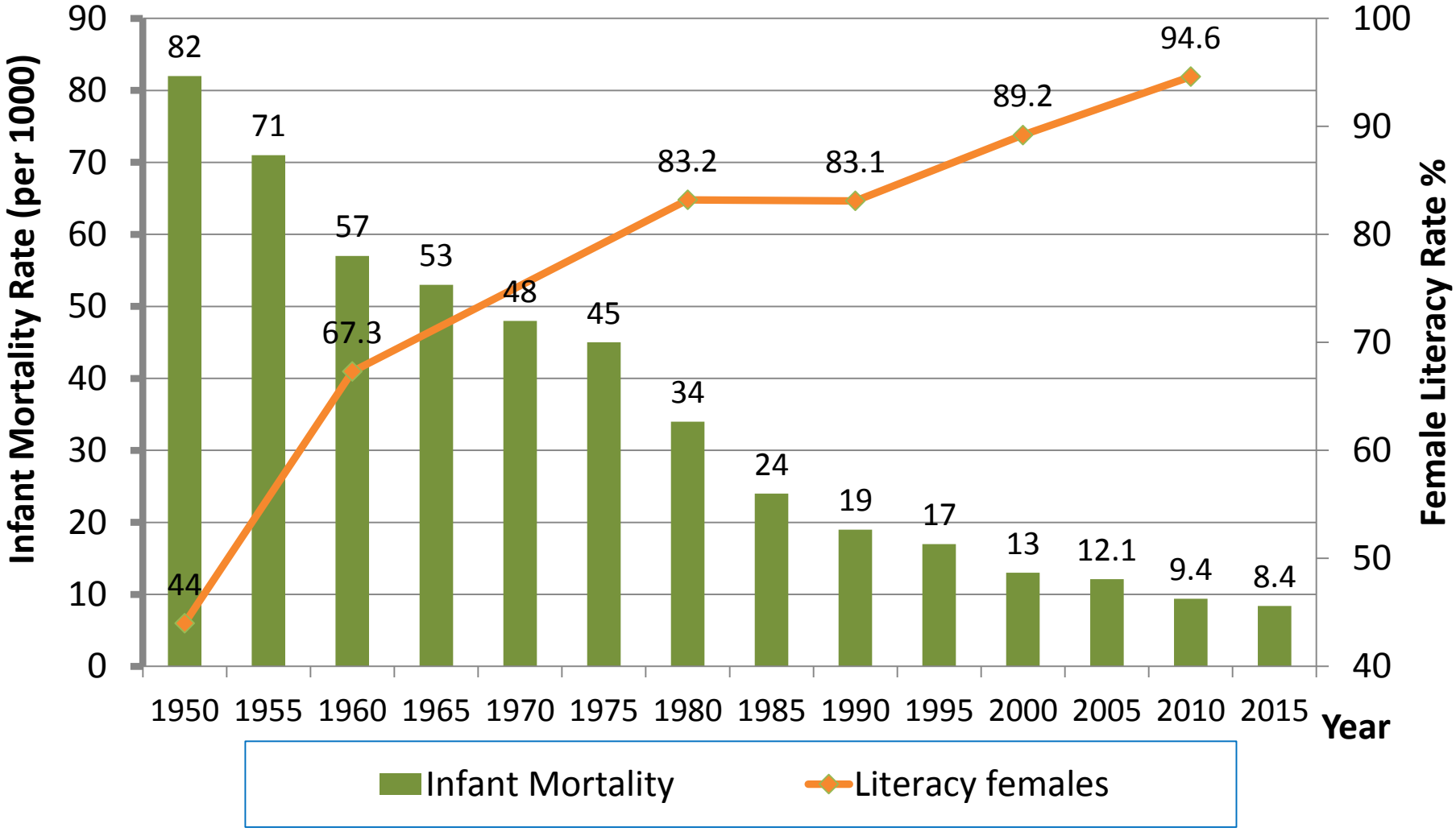
GDP Per Capita and Life Expectancy in Sri Lanka 1955 - 2015



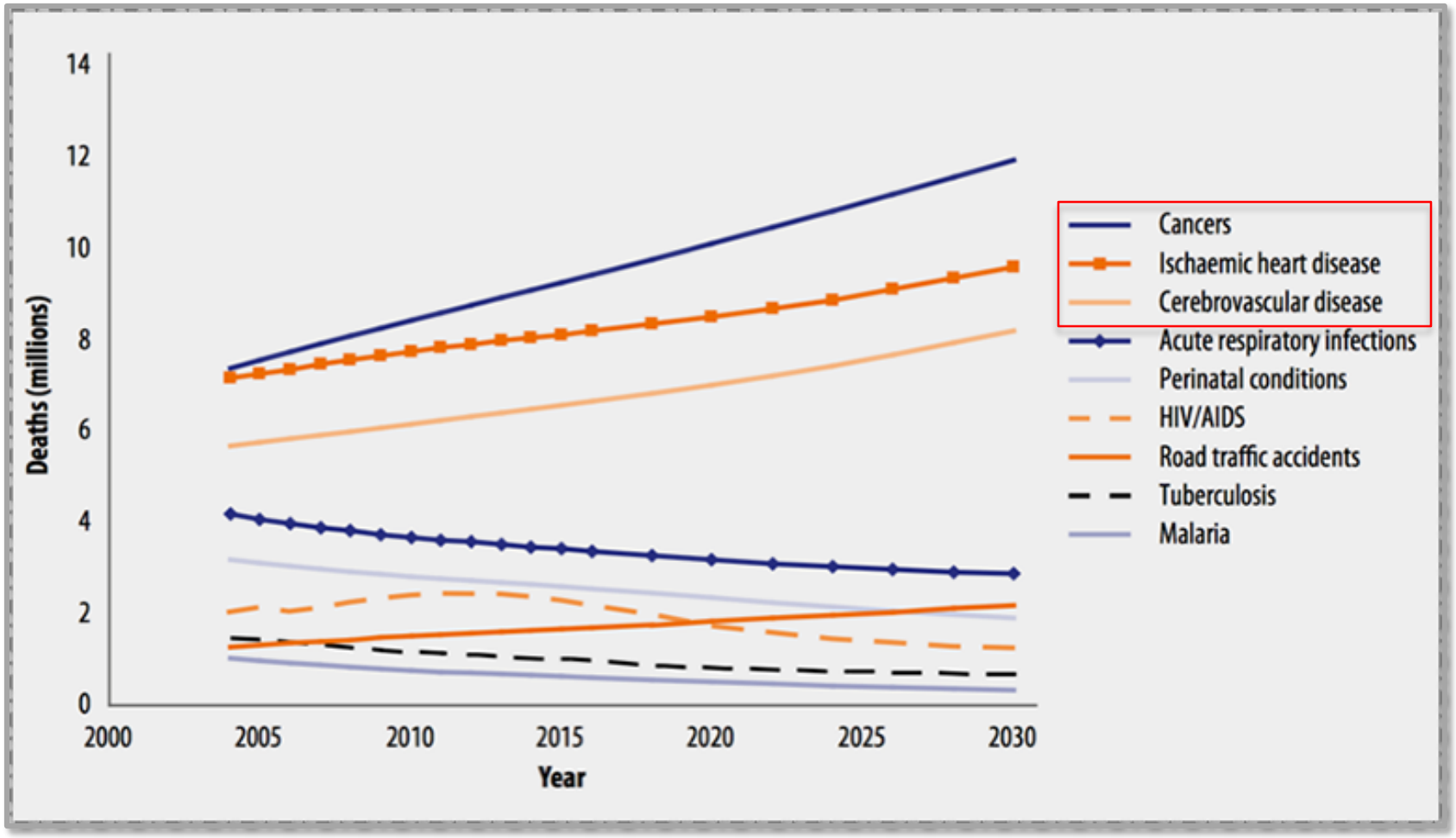
Source: World Bank database

Infant Mortality Rate and Female Literacy Rate
Sri Lanka 1950 - 2015

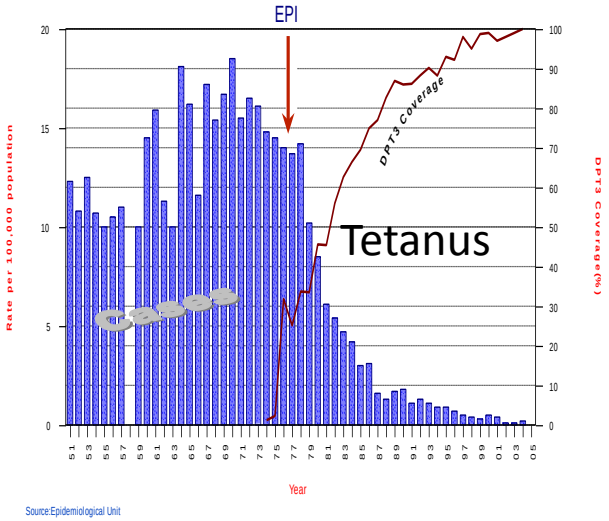


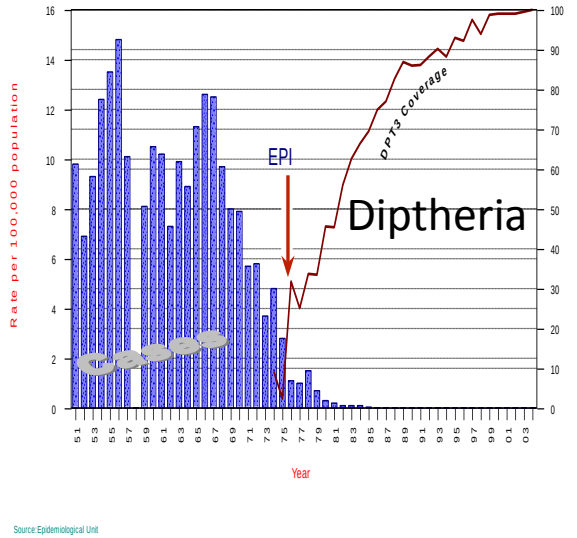
Source: Department of Census and Statistics; Registrar General's Department

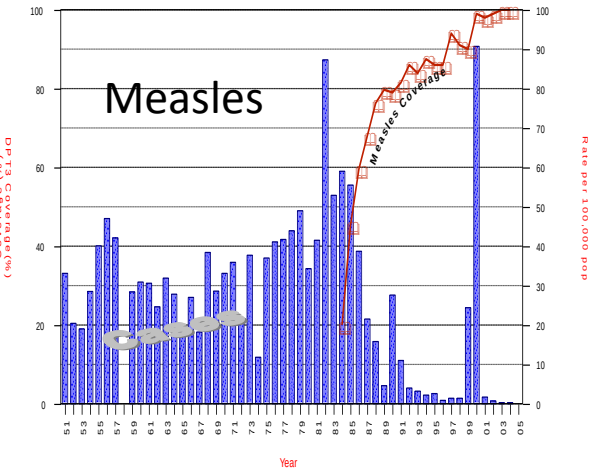
Change in Disease Patterns in the World

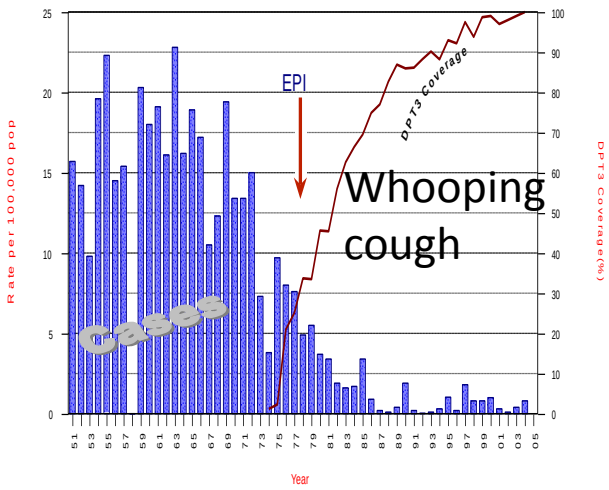


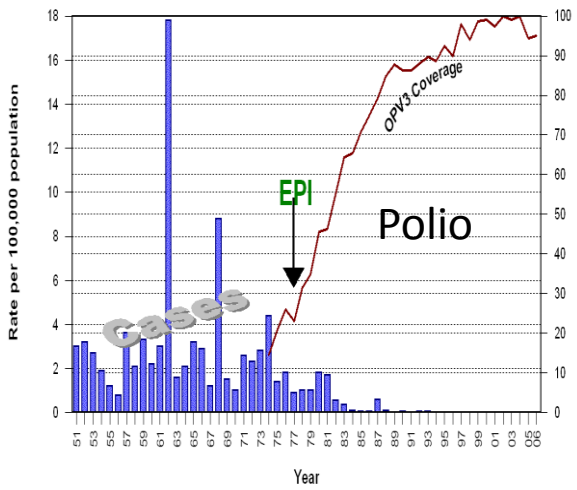
Sri Lanka: Communicable Disease

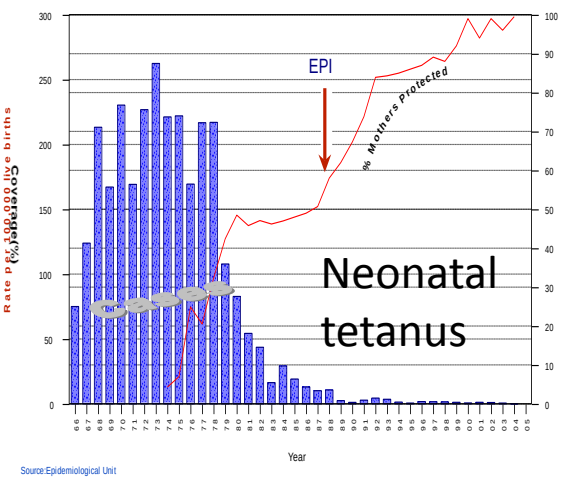




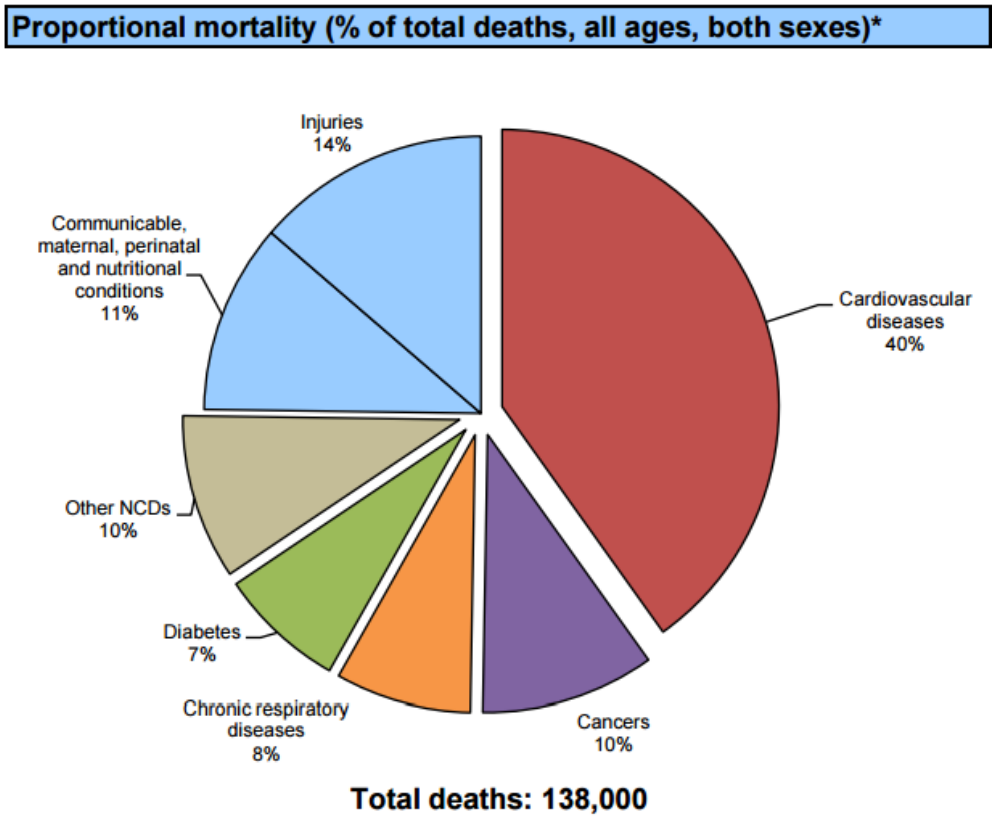








Sri Lanka: NCD Country Profile 2014 (WHO)



Total Population: **21 098 000**
Income Group: **Lower Middle**
Urban population: **15.1%**
Proportion between 30-70 years: **46.7%**

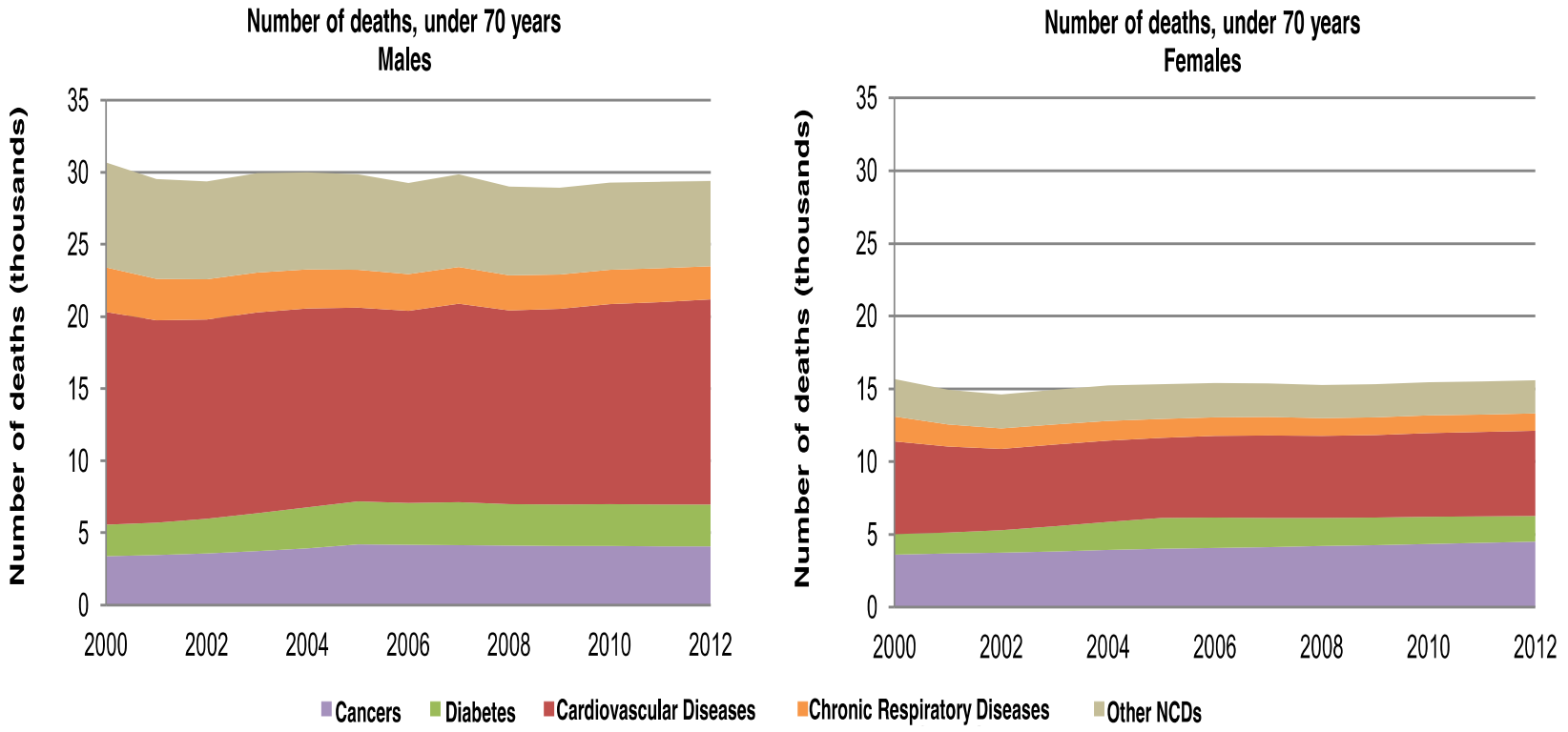
NCDs are estimated to account for 75% of all deaths

World Health Organization, *NCD country profile*, 2014

Sri Lanka: NCD Country Profile 2014 (WHO)

Premature mortality due to NCDs*

The probability of dying between ages 30 and 70 years from the 4 main NCDs is 18%.



Sustainable development goals identify **prevention and control of NCD** as a core priority

Preventing the main risk factor, “obesity” is important

Obesity: Definition

Excess **body fat** associated with adverse health outcomes (WHO)[1]

Obesity related health risks are associated with a percentage fat mass of;

Male	>25 %[2]
Female	>32 %[2]

[1] *WHO Technical Report Series 894*
[2] *Lohman T*

Indian J Pediatr
DOI 10.1007/s12098-016-2191-2

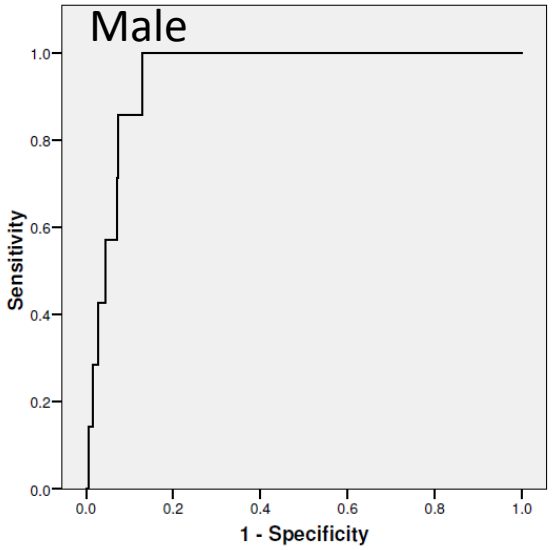
ORIGINAL ARTICLE

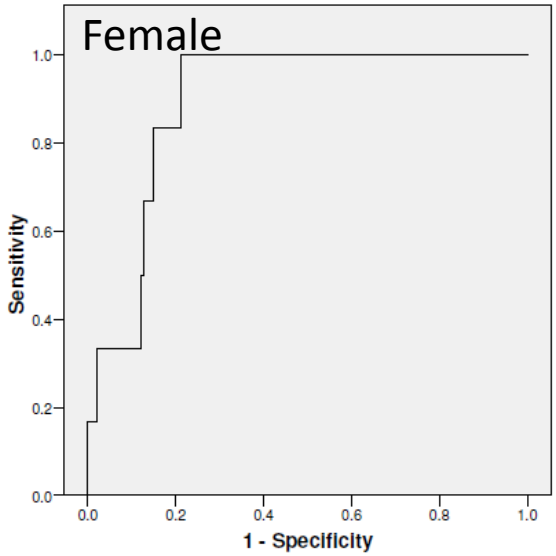
Defining Obesity Using a Biological End Point in Sri Lankan Children

Vithanage Pujitha Wickramasinghe[1] · Carukshi Arambepola[2] · Priyantha Bandara[1] · Mithila Abeysekera[1] · Suran Kuruppu[1] · Prasanna Dilshan[1] · Buddhini Samanthi Dissanayake[1]

Received: 25 October 2015 / Accepted: 20 June 2016

ROC curves to determine %FM of MetS





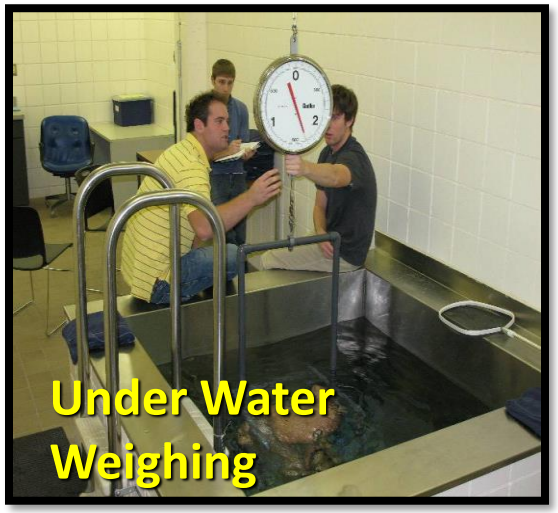
Fat mass associated with MetS

Male **28.6%**
(sensitivity 88%
specificity 87%)

Females **33.7%**
(sensitivity 83%
specificity 79%)

	Area	Std Error	Asymptotic Sig	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Male	0.047	0.017	0.000	0.914	0.980
Female	0.895	0.032	0.001	0.832	0.959

Assessment of Body Composition

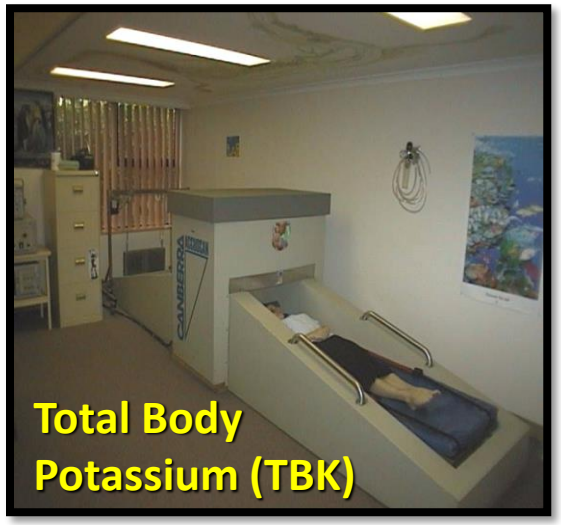

Under Water Weighing

"BodPod" Air Displacement Plethysmography


DEXA

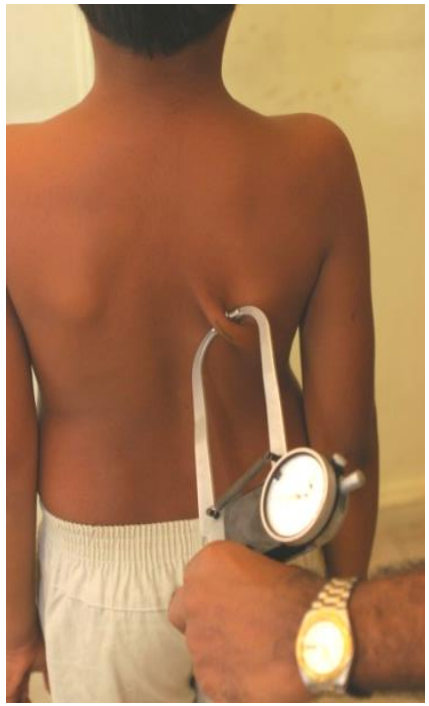
Bioelectrical Impedance Analysis (BIA)


MRI



Total Body Potassium (TBK)

Prediction of Body Composition



BMI as a Measure of Obesity…….

- Although FM is the diagnostic yardstick for obesity,
- BMI is used as a surrogate measure
- But validity of universal cutoff points are questionable

Different BMI Based Assessment Tools

- International Obesity Task Force (IOTF)
- CDC centile charts (CDC 2000)
- British growth standard BMI-Z Scores
- WHO Growth Standards (2007)

This is used in the local CHDR

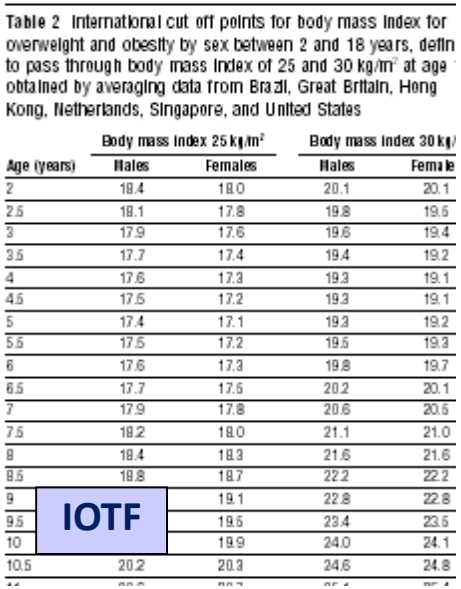
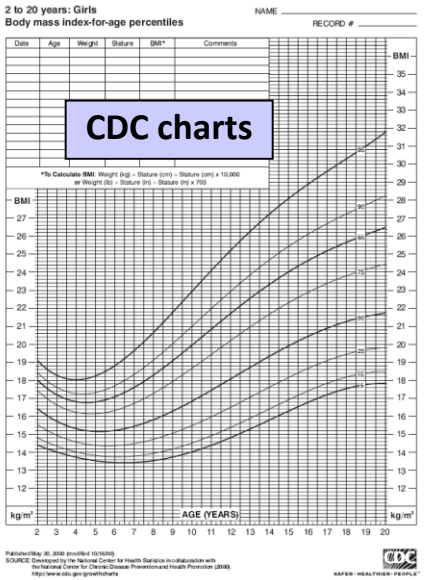
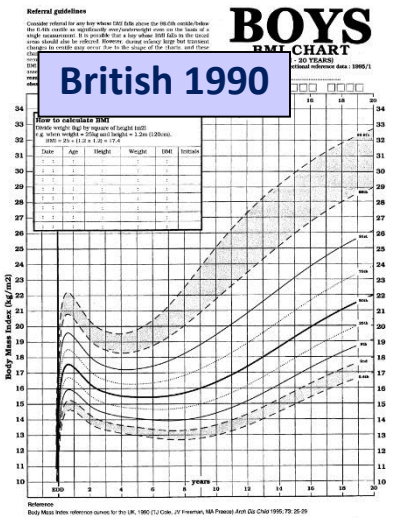


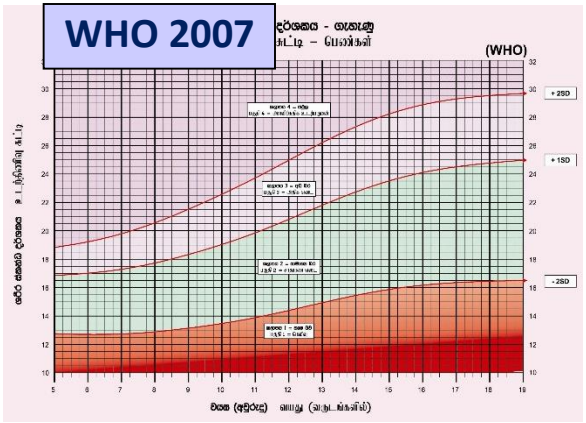
Table 2 International cut off points for body mass index for overweight and obesity by sex between 2 and 18 years, defin to pass through body mass index of 25 and 30 kg/m^2 at age obtained by averaging data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States

	Body mass index 25 kg/m^2		Body mass index 30 kg/	
Age (years)	Males	Females	Males	Female
2	18.4	18.0	20.1	20.1
2.5	18.1	17.8	19.8	19.5
3	17.9	17.6	19.6	19.4
3.5	17.7	17.4	19.4	19.2
4	17.6	17.3	19.3	19.1
4.5	17.5	17.2	19.3	19.1
5	17.4	17.1	19.3	19.2
5.5	17.5	17.2	19.5	19.3
6	17.6	17.3	19.8	19.7
6.5	17.7	17.5	20.2	20.1
7	17.9	17.8	20.6	20.5
7.5	18.2	18.0	21.1	21.0
8	18.4	18.3	21.6	21.6
8.5	18.8	18.7	22.2	22.2
9		19.1	22.8	22.8
9.5		19.5	23.4	23.5
10		19.9	24.0	24.1
10.5	20.2	20.3	24.6	24.8

IOTF







Public health

Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies

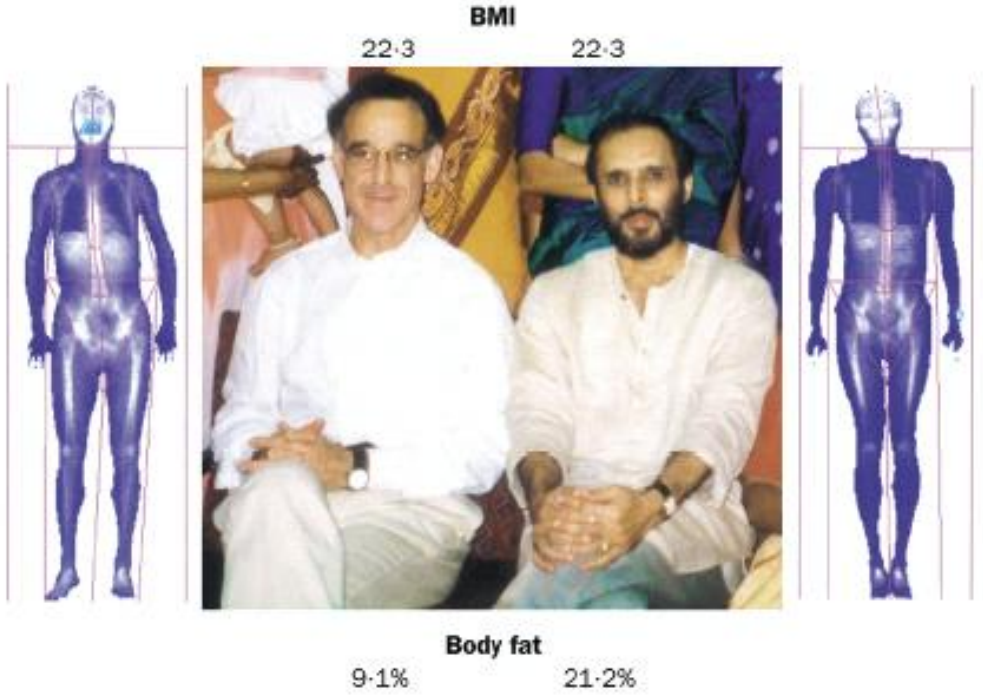
*WHO expert consultation**

A WHO expert consultation addressed the debate about interpretation of recommended body-mass index (BMI) cut-off points for determining overweight and obesity in Asian populations, and considered whether population-specific cut-off points for BMI are necessary. They reviewed scientific evidence that suggests that Asian populations have different associations between BMI, percentage of body fat, and health risks than do European populations. The consultation concluded that the proportion of Asian people with a high risk of type 2 diabetes and cardiovascular disease is substantial at BMIs lower than the existing WHO cut-off point for overweight (≥25 kg/m²). However, available data do not necessarily indicate a clear BMI cut-off point for all Asians for overweight or obesity. The cut-off point for observed risk varies from 22 kg/m² to 25 kg/m² in different Asian populations; for high risk it varies from 26 kg/m² to 31 kg/m². No attempt was made, therefore, to redefine cut-off points for each population separately. The consultation also agreed that the WHO BMI cut-off points should be retained as international classifications. The consultation identified further potential public health action points (23·0, 27·5, 32·5, and 37·5 kg/m²) along the continuum of BMI, and proposed methods by which countries could make decisions about the definitions of increased risk for their population.

Lancet 2004; **363:** 157–63

The Y-Y paradox

Chittaranjan S Yajnik, John S Yudkin



Identical BMI but significantly different body Fat

The image is a useful reminder of the limitation of BMI as a measure of adiposity across different populations

(The Lancet 2004;64:163)

Evidence for differences in Body fat

- Asians have low BMI with high fat mass

  Wang et al (1994)

- New Zealand (5-11 years)

  Fat content compared to European children.

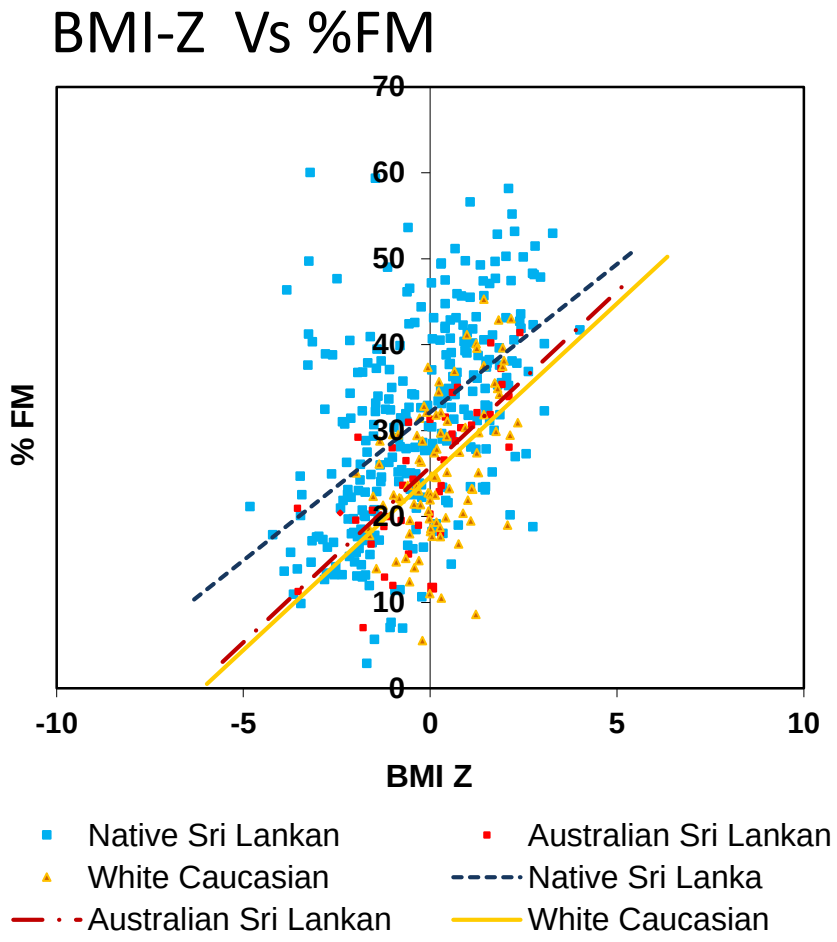
Indian origin	↑4.3%
Pacific Islanders	↓1.7%

  Duncan et al (2005)

- European Caucasians had 3.8% more fat than American Caucasians. Socio economic environments (of same ethnic origin) influence body fat Deurenberg et al (1998)

BMI based obesity cutoff should be different for different populations.

Body Composition, Ethnicity and Socioeconomic Environment



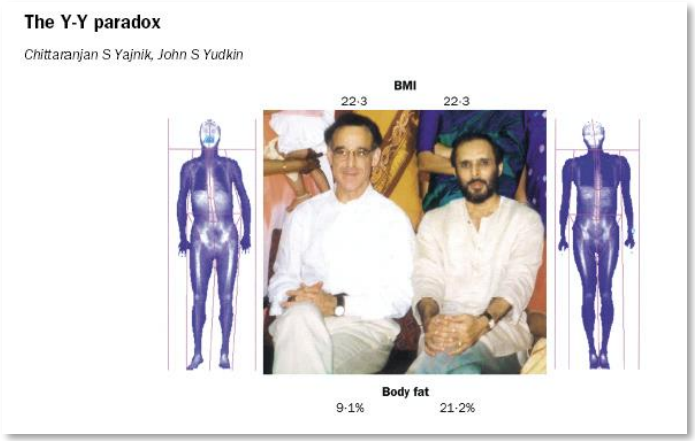
At any given BMI-Z score, native Sri Lankan children had the highest %FM while the Australian Caucasian children had the lowest %FM.

These differences were statistically significant.

This shows that **genetics** as well as **living environment** influences body composition.

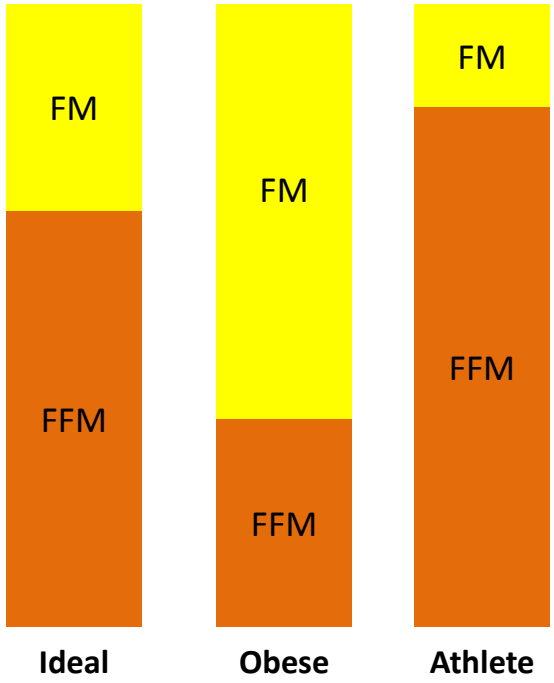
Modified from Wickramasinghe et al Ann Hum Biol. 2005:;32: 60-72

BMI as a Surrogate Marker of Body Composition



BMI = Mass/Height^2

Mass = Fat + Fat free



Could have same BMI but different body compositions

Anthropometric cutoffs used for nutritional assessment in Sri Lankan Children, are they valid?

Are we Feeding and Monitoring the growth of our children correctly?

Materials & Methods

- Subjects: 5 – 15 year old children from 8 schools in the Education Zone of Negombo, Western Province.
- Sample size 13000 children were screen form the Negombo education zone
- Ethics Obtained from Ethical review committee of Sri Lanka College of Paediatricians

Materials & Methods (cont..)

Anthropometry

- Height
- Weight
- Circumferences

Body composition

Assessed using **InBody 230** BIA machine

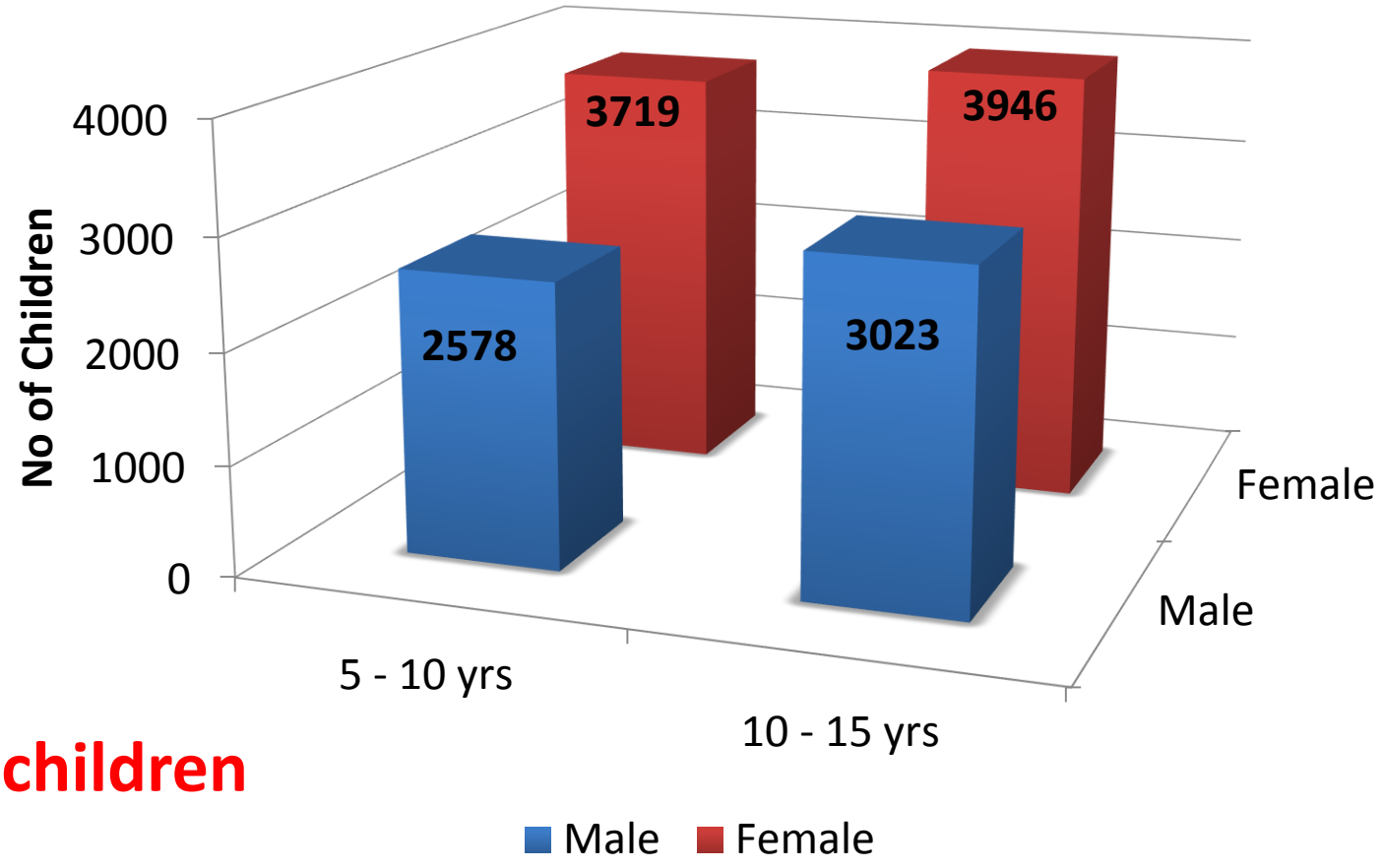
Calculated the;

Body Mass Index (BMI) $\rightarrow$ Weight/Height^2 (kgm^{-2})

Waist hip ratio (WHR) $\rightarrow$ WC/HC

Waist height ration (WHtR) $\rightarrow$ WC/Ht

Distribution of the Study Population



13266 children were screened

Distribution of the Nutritional Status

	5 -10 years (n=6297)		11 – 16 years (n=6969)	
Nutritional status*	**Female**	**Male**	**Female**	**Male**
Severe wasting <-3SD	122 (3.2%)	121 (4.7%)	111 (2.8%)	186 (6.2%)
Wasting -3SD to – 2SD	528 (14.2%)	442 (17.1%)	385 (9.8%)	449 (14.9%)
Normal -2SD to +1SD	2596 (69.8%)	1694 (65.7%)	2748 (69.6%)	1860 (61.5%)
Overweight +1SD to +2SD	337 (9.1%)	172 (6.7%)	512 (13.0%)	358 (11.8%)
Obese >+2SD	136 (3.7%)	149 (5.8%)	190 (4.8%)	170 (5.6%)
TOTAL	3719	2578	3946	3023

*** Assessed by BMI for Age WHO 2007 standards**

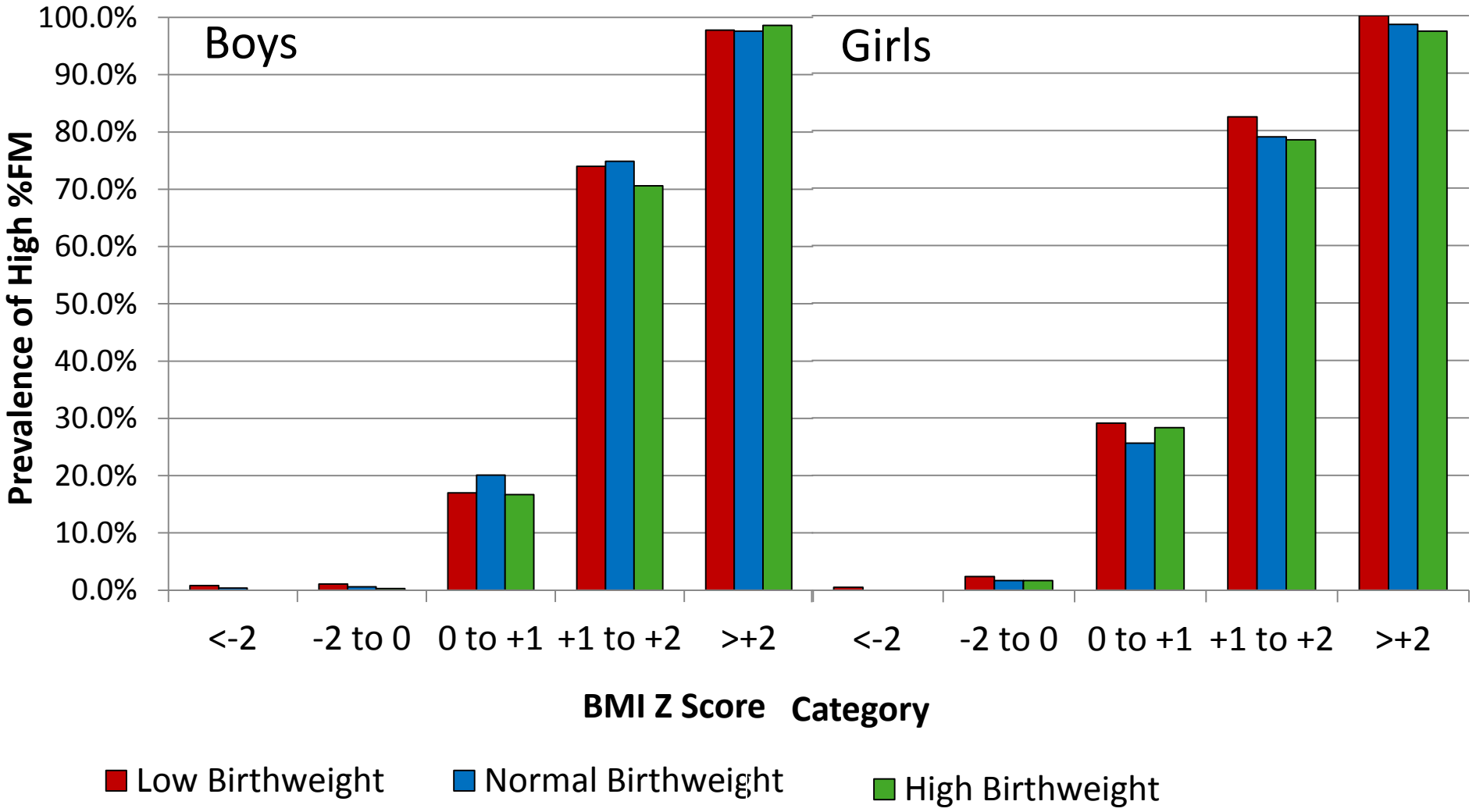
Results– Nutritional Status

	5 -10 years (n=6297)		11 – 16 years (n=6969)		TOTAL (13266)
	Female	**Male**	**Female**	**Male**	
High %FM*	337 (9.1%)	189 (19.6%)	1541 (39.1%)	694 (22.9%)	2761 (20.8%)
WHtR >0.5	163 (4.4%)	131 (5.1%)	448 (11.4%)	484 (16.1%)	1226 (9.2%)
Overweight[Ø] +1SD to +2SD	337 (9.1%)	172 (6.7%)	512 (13.0%)	358 (11.8%)	1379 (10.4%)
Obese[Ø] >+2SD	136 (3.7%)	149 (5.8%)	190 (4.8%)	170 (5.6%)	645 (4.8%)

*** %FM >33.7% in females and >28.6% in males**

[Ø] Assessed by BMI for Age WHO 2007 standards

Prevalence of High Percentage Fat mass according to Birth weight and BMI category in 5-15 years



Validity of Existing Anthropometric Cut-offs in Diagnosing Obesity in 5-10yrs

		Girls		Boys	
Anthro' parameter	Cut-off	Se	Sp	Se	Sp
BMI	WHO >+2 SD	36%	99.9%	56.7%	99.7%
	IOTF	28.4%	100%	31.7%	100%
	Wickramas' 2011	94.2%	95.1%	97%	95.6%
WC	British >+2 SD	42.7%	98.9%	42.1%	98.3%
	Wickramas' 2011	90.2%	89.9%	98.8%	84.1%
WC-Ht Ratio	>0.5	37.8%	98.7%	58.5%	99.4%
	>0.45	87.6%	83.9%	97%	85.7%

Validity of Existing Anthropometric Cut-offs in Diagnosing Obesity in 10 -15 yrs

		Girls		Boys	
Anthro' parameter	Cut-off	Se	Sp	Se	Sp
BMI	WHO >+2SD	18%	100%	51.2%	99.9%
	IOTF	13.3%	100%	19.5%	100%
	Wickramas' 2011	96.7%	80%	97.4%	81.2%
WC	British >+2 SD	46.8%	99.3%	62.8%	99.3%
	Wickramas' 2011	90.4%	77.9%	99.5%	62.4%
WC-Ht Ratio	>0.5	30.4%	99.4%	63.5%	99.3%
	>0.45	70.7%	92.8%	92.8%	91%

Validity of currently used cutoff values of body mass index as a measure of obesity in Sri Lankan children

V P Wickramasinghe[1], S P Lamabadusuriya[1], G J Cleghorn[2] and P S W Davies[2]

(Index words: children, body composition, fat mass, BMI)

CMJ. 2009; 54: 114-9.

Validity of BMI as a measure of obesity in Australian white Caucasian and Australian Sri Lankan children

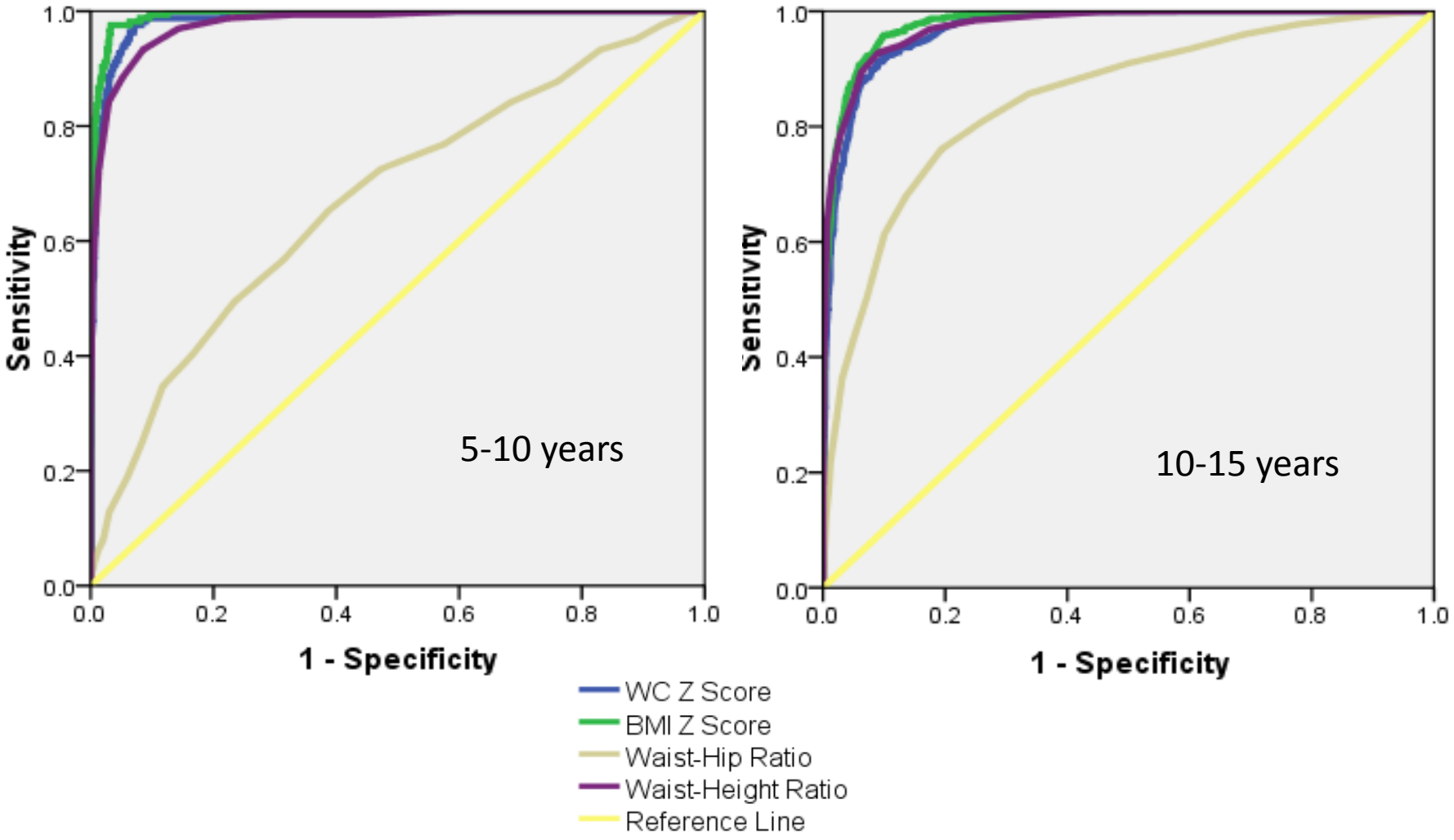
V. P. WICKRAMASINGHE[1], G. J. CLEGHORN[1], K. A. EDMISTON[1], A. J. MURPHY[1], R. A. ABBOTT[1,2] & P. S. W. DAVIES[1]

Ann Hum Biol. 2005:;32: 60-72

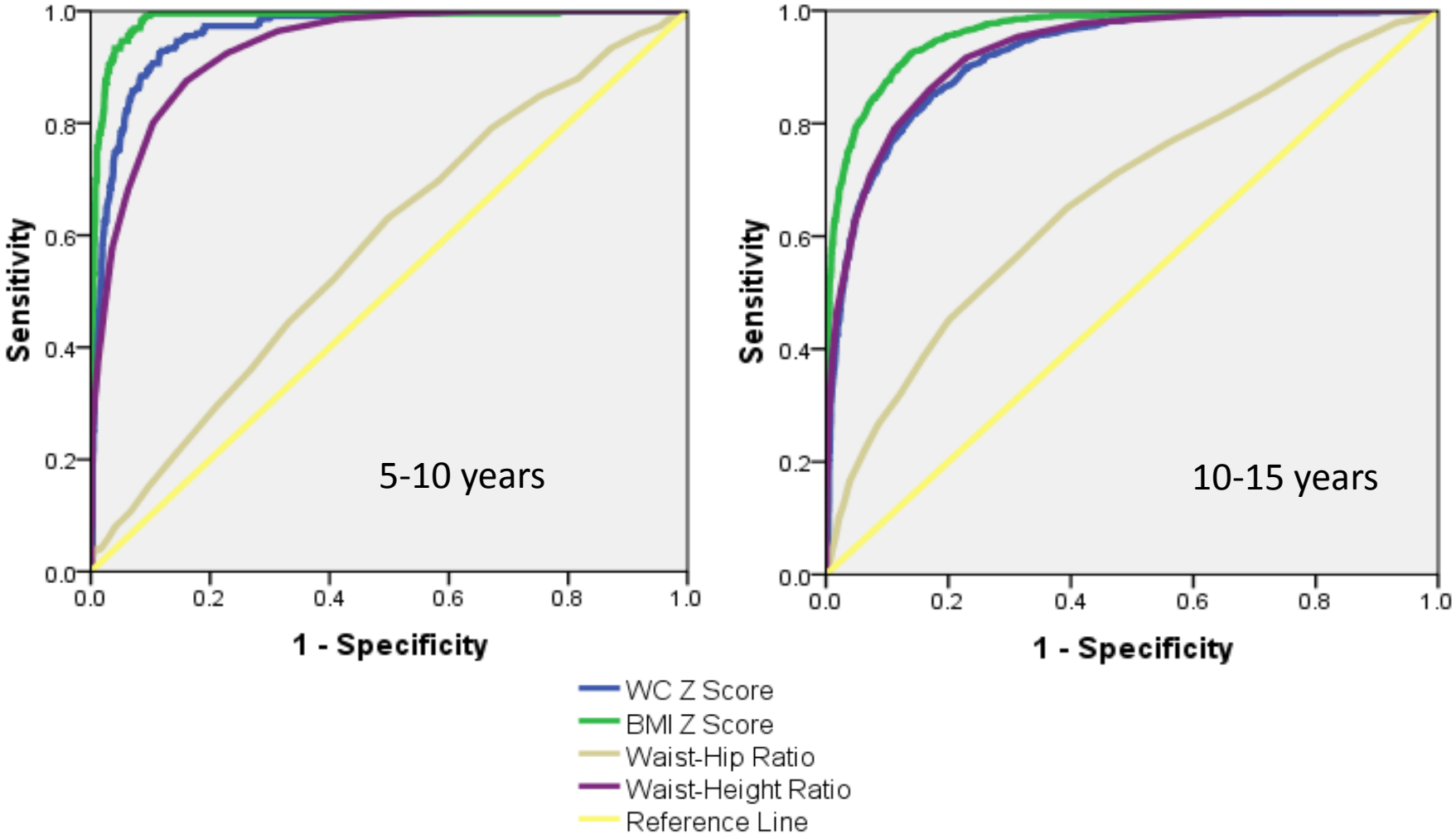
What need to be done?

- Revise cutoff to suit the population
- Newer screening methods

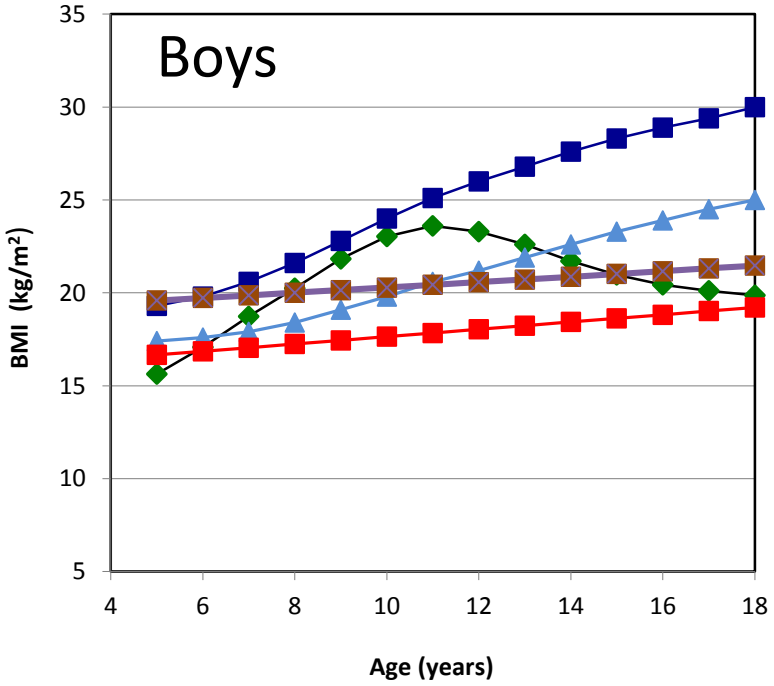
ROC of selected anthropometric parameters in predicting abnormal %FM (28.6) in Boys

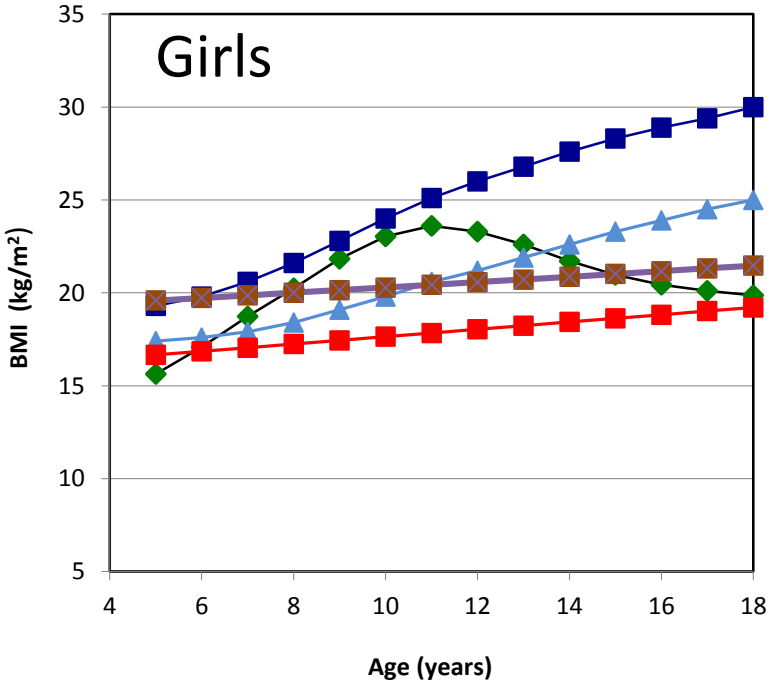


ROC of selected anthropometric parameters in predicting abnormal %FM (33.7) in Girls



Established BMI cutoff Compared with the Newly Developed





- BMI comparable to 98th centile FM
- IOTF Obesity cutoff
- IOTF Over weight cutoff
- BMI comparable to 25%/ 32% FM
- BMI comparable to 28.6% 33.7%FM

Comparison of Cutoff with Available Data

	BMI (kgm^{-2})		WC (cm)	
	Male	Female	Male	female
Katulanda *et al* (Sri Lanka 2010)	20.7	22.0	76.5	76.3
Razak *et al* (Canada 2007)	21.0		-	
Dudeja *et al* (India 2001)	21.5	19.0	-	
Wickramasinghe *et al* (Sri Lanka 2011)	19.2	19.7	68.4	70.4
Current Study	**24.2**	**21.5**	**87.8**	**70.9**
Suggested by WHO (2004)	22.0 – 25.0		-	
IDF (2006)	-		90	80

It is important to have correct diagnostic tool to Identify Obesity

Obesity cutoffs should be……

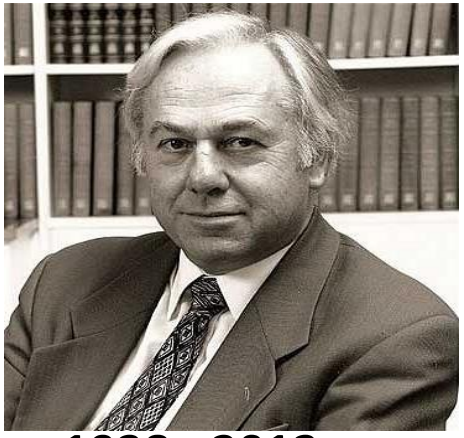
- Ethnic specific BMI cutoffs ? (Misra 2003)
- Population specific cutoffs? (Stevens 2003)
- BMI cutoff values in Asians for metabolic risk varies between 22 kg/m^2 to 25kg/m^2

(WHO, Lancet 2004)

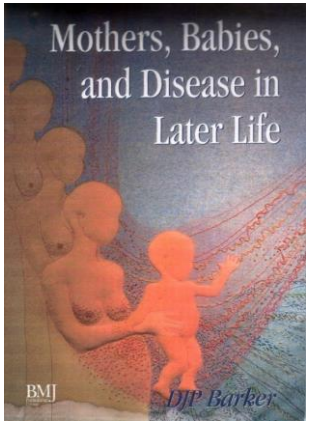
Anthropometric cutoff developed based on a ***biological end point****, ie. corresponding to the FM associated with metabolic complications would be relevant than a* ***population distribution (statistical****) cutoff*

Therefore……

- Ethnicity as well as living environment influences the body composition
- Current BMI based cutoff values are not sensitive detect high body fat content of Sri Lankan children
- Caution should be exerted when using non-validated growth references
- Anthropometric cutoffs should be developed to detect disease risks
- **We cannot ignore the paediatric population**



1938 - 2013



"Fetal Origin of Adult Diseases"

Under-nutrition during perinatal period leads to **many adverse outcomes later** in life

(David Barker 1994)

"Postnatal Growth Acceleration" hypothesis

Term small for date infants that had **catch up growth** showed ↑**BP** and ↑ **Fat Mass** at 8 years of age

Singhal & Lucas *Circulation*. 2007;115:213-220

Effects of Childhood Obesity on Later Obesity

		Overweight/Obesity at 5-7 yrs					Overweight/Obesity at 15-17 yrs				
			Crude		Adjusted			Crude		Adjusted	
Age	Weight class	%	OR	95%CI	OR	95%CI	%	OR	95%CI	OR	95%CI
2-4	Thin/Normal		1.0		1.0			1.0		1.0	
	Owt/Obese	52.5	11.6	6.4-21.0	11.0	6.0-21.0	39.3	3.0	1.7-5.3	3.2	1.8-5.6

Evensen E et al. 2016 BMC Pediatrics 16(64)

<10% of NORMAL weight children

Becomes **OBESE** Adults

>75% of OBESE children

Becomes **OBESE** Adults

Freedman DS et al, Relationship of Childhood Obesity to Coronary Heart Disease Risk Factors in Adulthood: The Bogalusa Heart Study. Pediatrics 2001;108:712-8

Consequence on Long Term Health

Obesity has the potential to **negate** many of the health benefits that have contributed to increase of life expectancy

"This is the first generation where children may die before their parents."

Paul Zimmet

"Early detection followed by treatment is vital to halt the progression of the metabolic syndrome and safeguard the future health of children and adolescents."

Sir George Alberti

REPORT OF THE COMMISSION ON

ENDING CHILDHOOD OBESITY

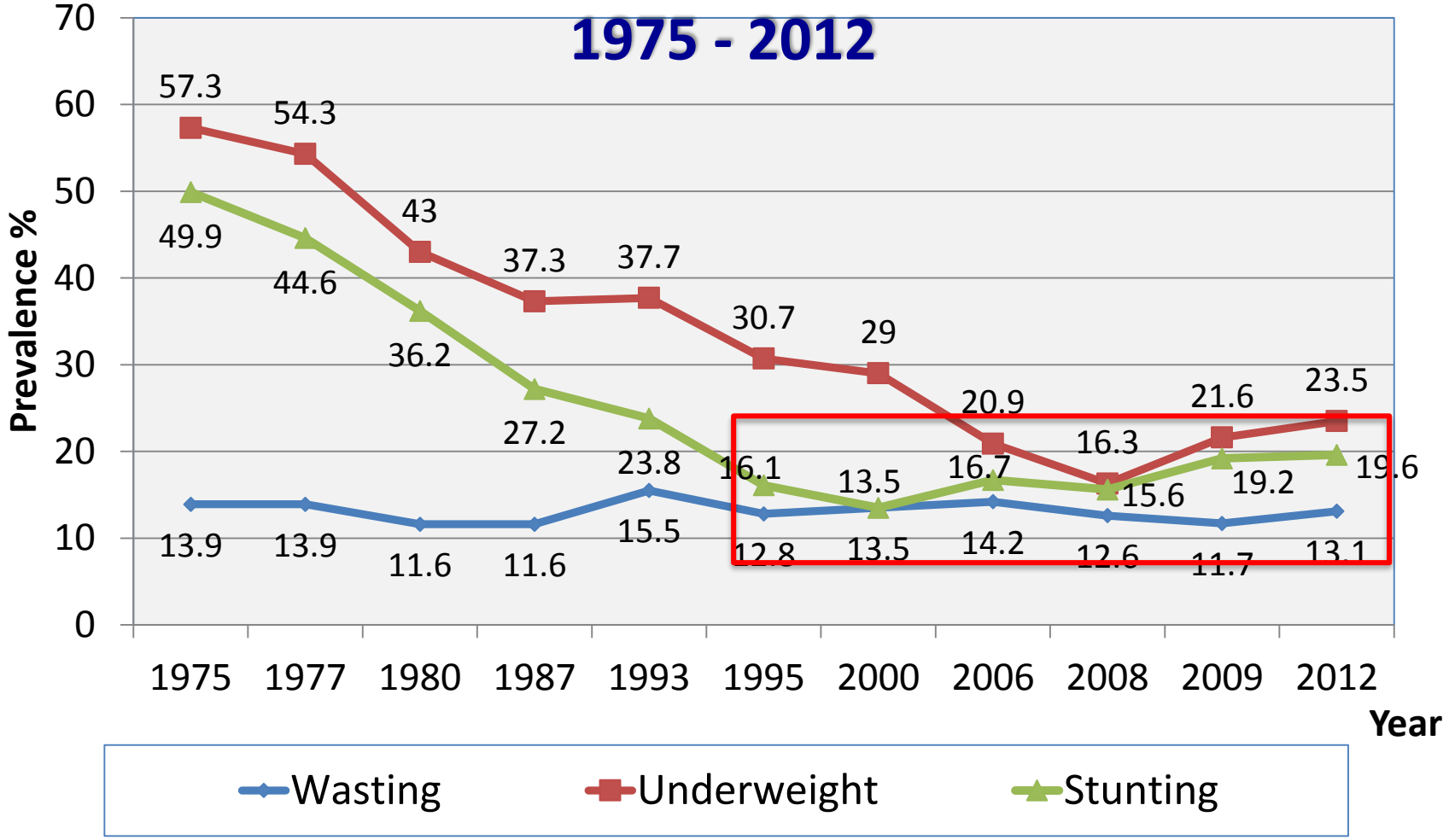
World Health Organization

On the contrary……..

- Does lack of appropriate anthropometric tools affect our children?

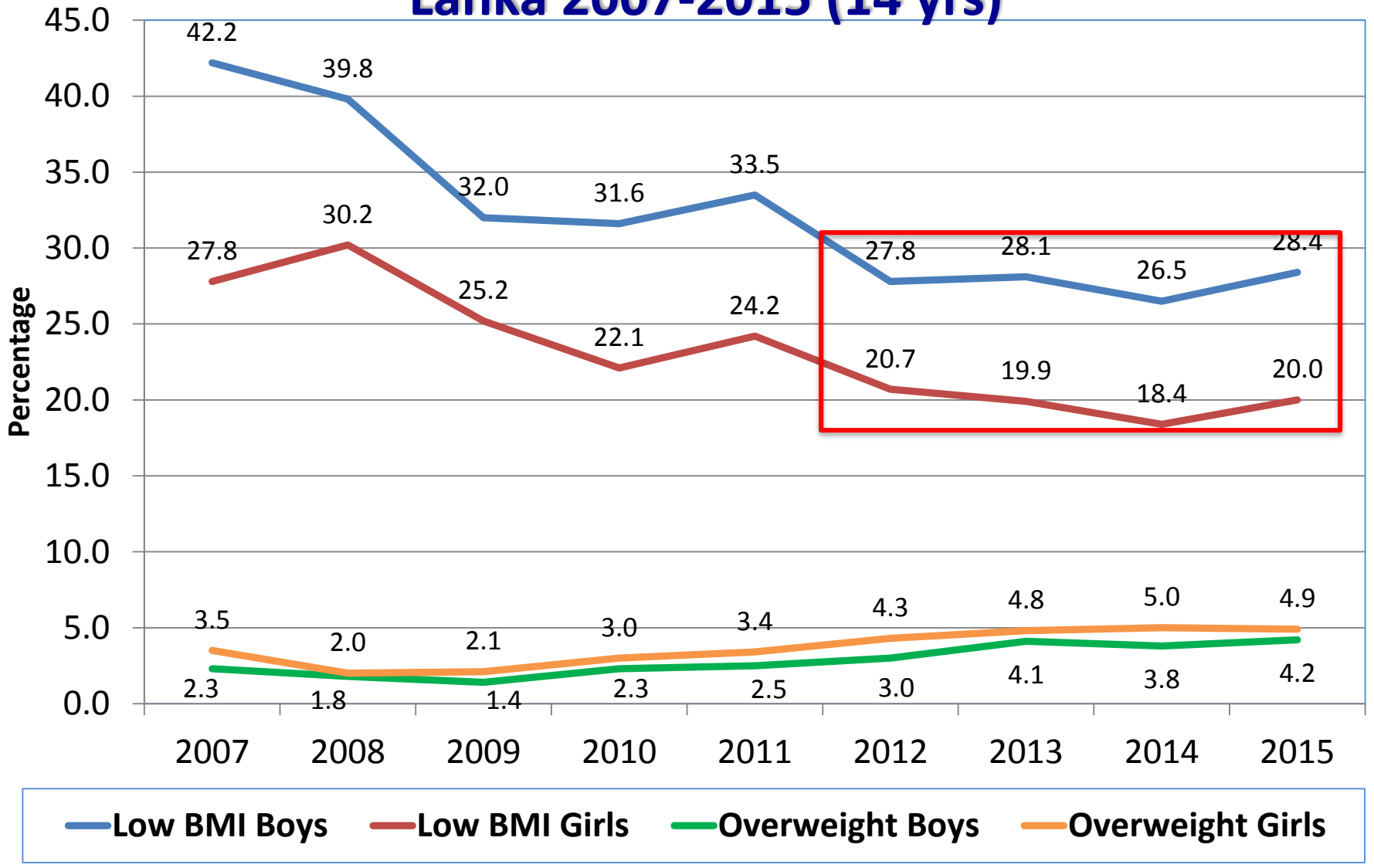
- Would it lead to the development of Overweight/Obesity?

Prevalence of Underweight, Stunting and Wasting in Sri Lanka (<5 yrs) 1975 - 2012



Source: Medical Research Institute, 2002; Demographic Health Survey 2006/07; National Food Security Assessment 2009; Sri Lanka Complementary Feeding Study; National Nutrient and Micronutrient Survey 2012

Prevalence of wasting and overweight in Sri Lanka 2007-2015 (14 yrs)



Source: School & Adolescent Health Unit, Family Health Bureau

Wickramasinghe and Samaranayake *BMC Res Notes (2016) 9:208*
DOI 10.1186/s13104-016-2016-4

BMC Research Notes

RESEARCH ARTICLE

Open Access

Growth charts: do they reflect healthy growth in Sri Lankan children?

V. P. Wickramasinghe[1*] and D. B. D. L. Samaranayake[2]

Distribution of children with adversely high %FM in each BMI for age SD category in 5 ≤ to <10 and 10≤ to <15 year age groups, by gender

		5 ≤ to <10 year Category				10≤ to <15 year old category			
		Male (>25%FM)		Female (>32%FM)		Male (>25%FM)		Female (>32%FM)	
SD Category		N	%	N	%	N	%	N	%
1.	< -3	1	11.1%	1	33.3%	0	0%	4	100.0 %
2	-3--2	2	15.4%	2	50.0%	2	25.0%	2	33.3%
3.	-2--1	2	8.0%	8	66.7%	4	30.8%	8	72.7%
4.	-1- 0	3	23.1%	3	50.0%	7	63.6%	7	50.0%
5.	0 -+1	6	60.0%	14	87.5%	9	81.8%	14	73.7%
6.	1-+2	9	69.2%	5	62.5%	14	100.0%	9	90.0%
7.	2-+3	7	87.5%	6	100%	6	75.0%	4	80.0%
8.	+3	2	66.7%	1	100%	-	-	1	100.0 %
	Total	62	34.0%	40	71.4%	42	61.8%	49	70.0%

Note: the highlighted area show the 'suggested normal range' of the parameter for Sri Lankan children

- Are we **over** diagnosing **stunting/wasting** and **und**er diagnosing **overweight/obesity**?

- What would be the **health** and **economic implication** of this?

- These need to be **discussed** and **resolved** at **scientific, managerial and policy formulating** circles.

CONCLUSION

- Sri Lankan /South Asia populations have a **different body composition**
- it's important to have **appropriate anthropometric cutoff** values thus enabling early detection of unhealthy body composition (in children).
- Anthropometric cutoff values should **suit the population / ethnic group** and not be mere 'universal' value

We, who care for health, have a great responsibility in the prevention of NCDs in the next generation

Thank you

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