

Assessment of weight gain : variations according to the reference and growth parameter used

The Power of Programming

Munich, May 6-8th 2010

Marie Françoise Rolland-Cachera

UREN - Inserm, Inra, Cnam, Université Paris-13

USEN - InVS, Université Paris-13, Cnam

Background

- Rapid growth in early life accounts for further child overweight
- In studies investigating the association between early growth and future obesity the methods vary considerably:
 - various growth references
 - different growth parameters

PLAN

- Growth studies
- WHO Standards
- Comparison between WHO standards/other references
- Comparisons between growth parameters to predict adult body composition

North American Longitudinal growth studies

(Tanner JM, The Cambridge Encyclopedia of human growth, 1998)

Early 20th century United States

1917-70: University of Iowa Child Welfare Research Station
(Baldwin et Meredith)

1922-34: Harvard Growth study (Dearborn, Shuttleworth)

1929- : Fels Research Institute. Yellow Springs (Roche, Falkner)

1948-: Philadelphia Center for Research in Growth (Krogman, Johnston)

European longitudinal growth studies

(Tanner JM, The Cambridge Encyclopedia of human growth, 1998)

Middle of the 20th century in Europe

1944: Oxford Child Health Survey (Ryle Stewart, Acheson)

1948: Harpenden Growth study (Tanner, Whitehouse, Marshall, Hughes, Cameron)

1953: International Children's Centre co-ordinated studies (N Masse et F Falkner)

London (Falkner, Tanner)

Paris (Masse, Sempé)

Zürich (Prader, Gasser)

Stockholm (Karlberg, Taranger)

Brussels (Graffar)

Louisville (Falkner, Wilson)

Dakar (Sénécal, Masse)

> 1950: Stockholm, Helsinki, Prague, Brno, Lublin, Wroclaw, Budapest, Edinburgh...
and more recent references (US, UK, Italy, Spain, etc...) and WHO standards

PLAN

- Growth studies
- WHO Standards
- Comparison between WHO standards / other references
- Comparison between growth parameters

Design of the WHO Multicentre Growth Reference Study (MGRS)

Combines 2 components:

- Longitudinal follow-up (0-24 mo)

Socioeconomic conditions favourable to growth

- . no known health or environmental constraints to growth
- . no maternal smoking before and after delivery
- . single term birth
- . absence of significant morbidity
- . exclusive or predominant breast feeding for at least 4 months

- Cross-sectional component (18-71 mo)

same inclusion criteria

minimum of 3 months of any breast feeding

Design of the WHO Multicentre Growth Reference Study (MGRS)

Implemented between 1997 and 2003

Population-based study conducted in six countries

Brazil

Ghana

India

Norway

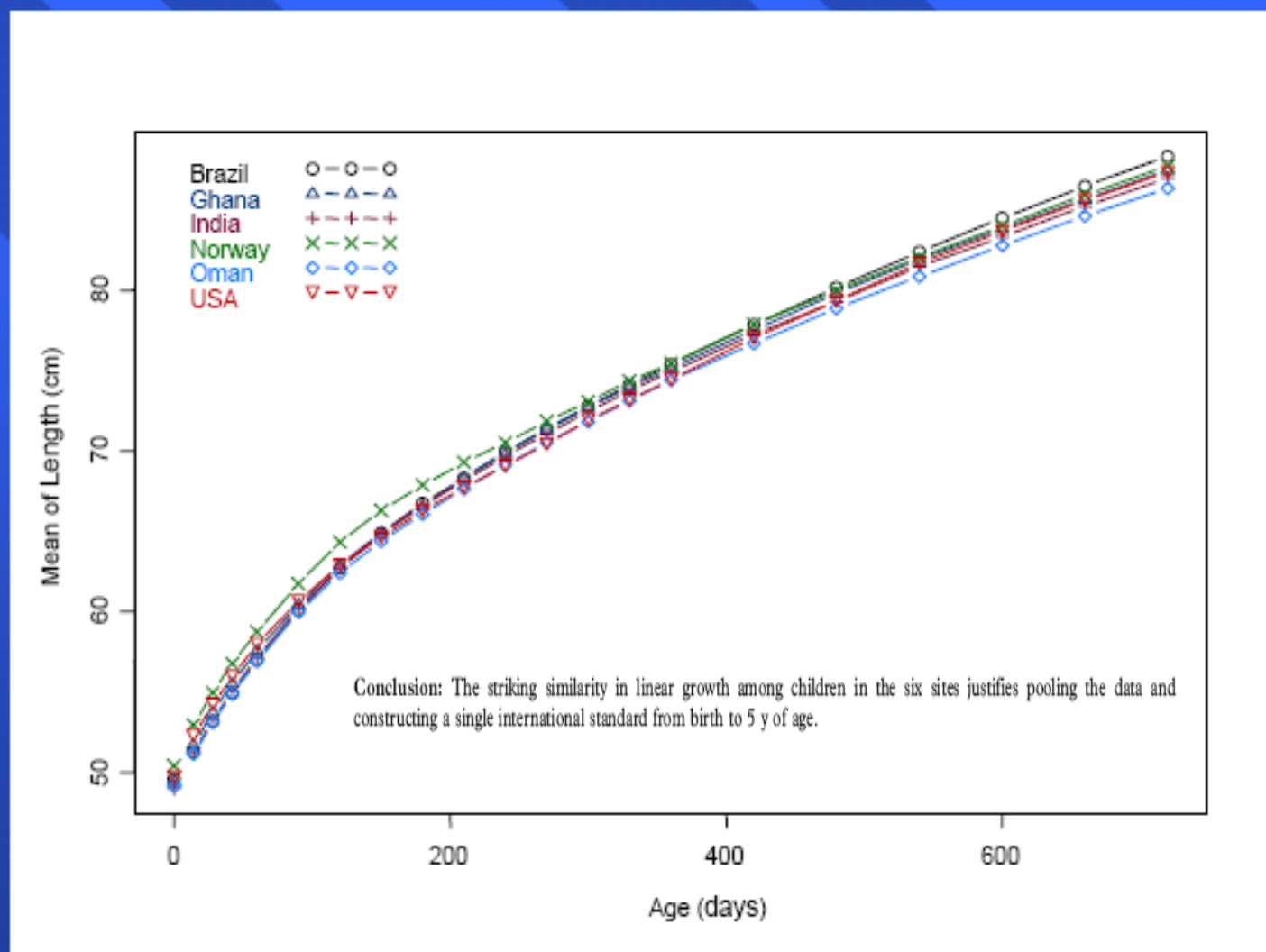
Oman

USA

WHO Multicentre Growth Reference Study (MGRS)



Mean length from birth to 24 months for the six MGRS sites



WHO Multicentre Growth Reference Study Group. Assessment of linear growth differences among populations in the WHO Multicentre Growth Reference Study. *Acta Paediatr Suppl* 2006;450:56-65.



World Health Organization

PLAN

- Growth studies
- WHO Standards
- Comparison between WHO standards / other references
- Comparison between growth parameters

French references and WHO Standards

French references

*Sempé M, Pédrón G, Roy-Pernot MP. Auxologie, 1979
Longitudinal data in France (1953-1979): birth to 21 y
Anthropometry : similar with WHO protocole
Nutrition: no criteria (less than half infants were breast fed)*

WHO standards

*de Onis M, Garza C, Onyango AW, Martorell R, editors. WHO Child Growth Standards. Acta Paediatr Suppl 2006; 450: 1-101.
Longitudinal data in 6 countries (1997-2003): birth to 5 years
Anthropometry: WHO recommendations
Nutrition: all infants breast fed*

WHO Software



Anthropometric calculator



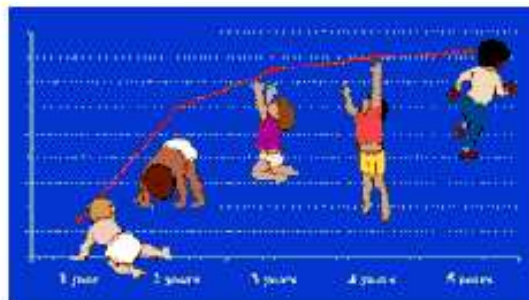
Individual assessment



Nutritional survey (cross-sectional)

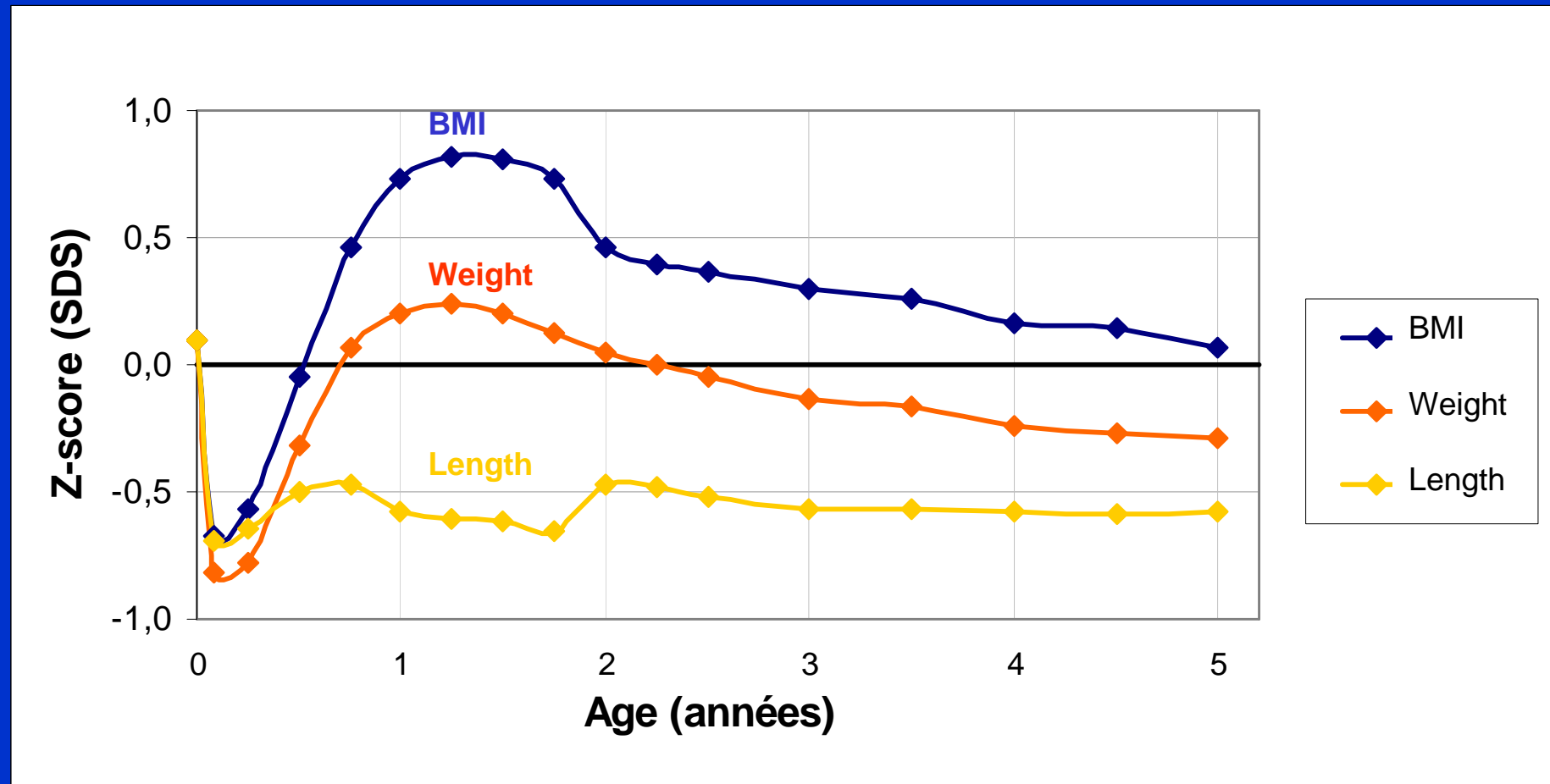


About



Beta version (Feb. 17th, 2006)

French references / WHO 2006

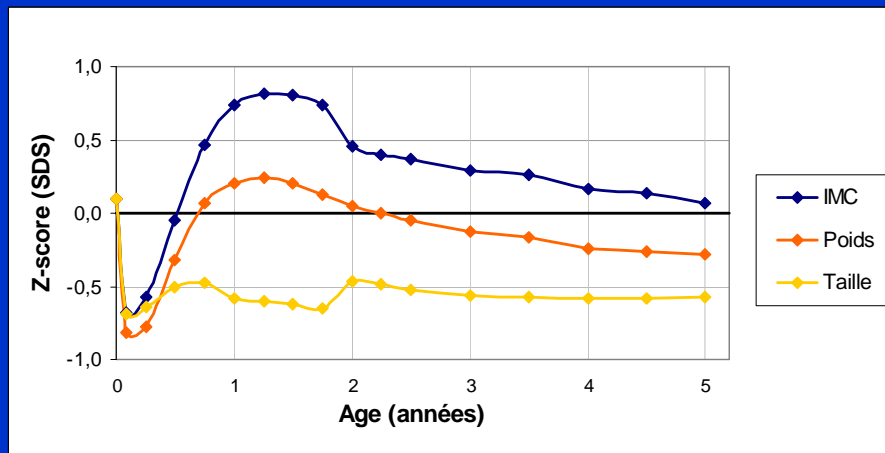


de Onis, Garza, Onyango, Rolland-Cachera et al. *Arch Pediatr.* 2009

French references / WHO 2006

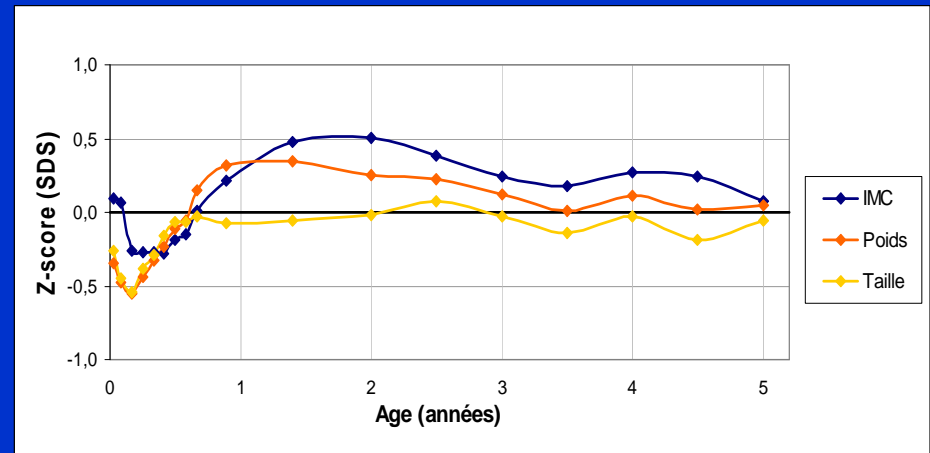
More recent study

Born in 1953-55



French reference

Born in 1991-93



Prevalence study (IJO 2002)

Reasons for the differences between WHO standards and French references

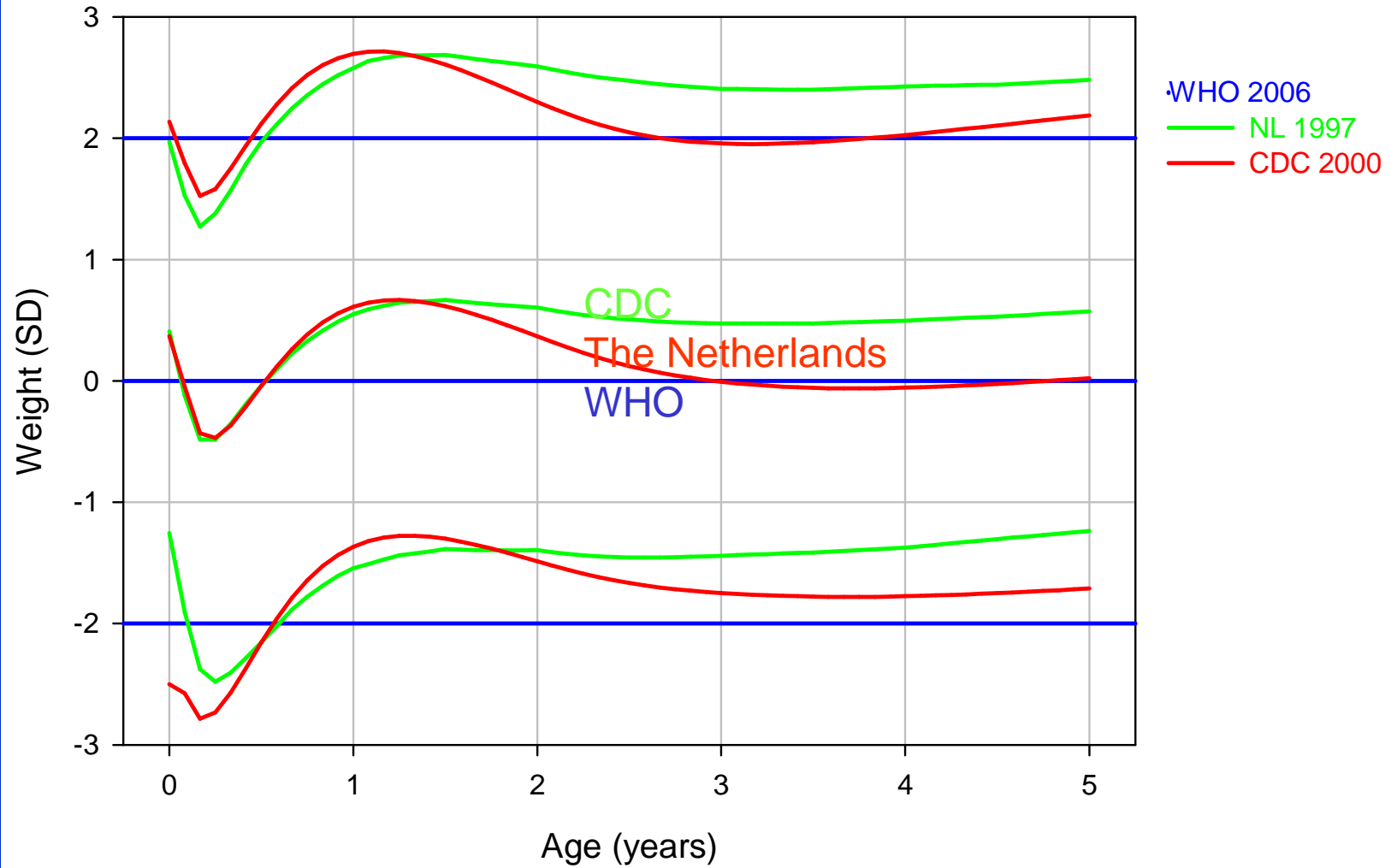
- **Feeding practice**
Breast fed vs non breast fed
- **Geography**
- **Secular trends**
Nutrition
Health surveillance
Others?

WHO vs other references and data

- US: CDC (<http://www.cdc.gov/growthcharts/>)
(Kuczmarski et al, Vital Health Stat, 2002)
- NL: Van Buuren S. Implications for surveillance at the European level. WHO meeting Brindisi 2006
(Fredriks et al, Ped Res, 2000, Roede et al, TSG, 1985)
- Belgium: Reference for growth and pubertal development
(Roelants M, Hauspie R, Hoppenbriuwes K, Ann Hum Biol, 2010)
- UK: Scientific Advisory Committee on Nutrition (SACN)
Application of WHO growth standards in the UK 2007.
http://www.sacn.gov.uk/pdfs/report_growth_standards_2007_08_10.pdf
- CHOP Study
(Koletzko et al., Am J Clin Nur, 2009)

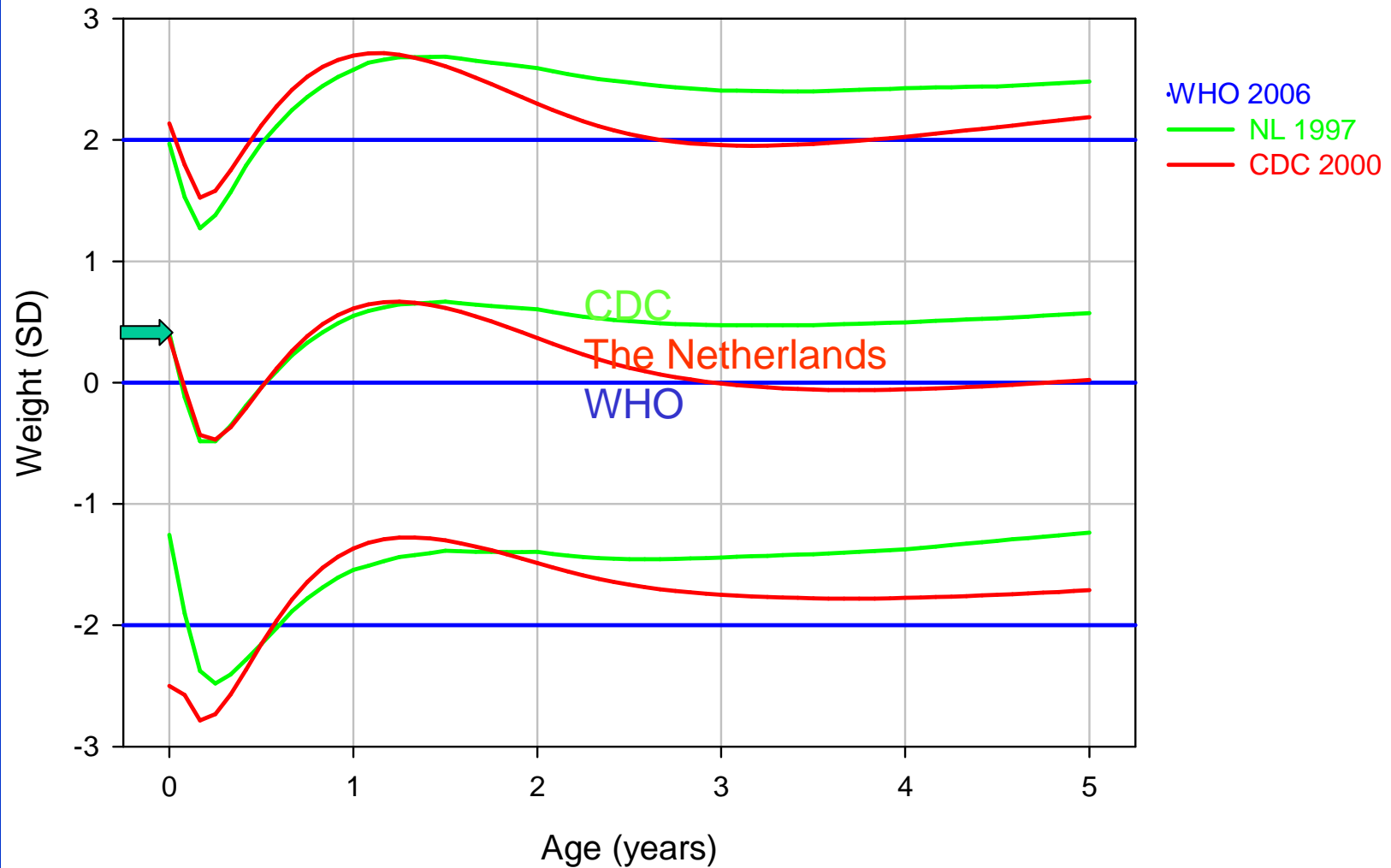
Weight / AGE

Weight for age (0-5 yrs) - boys (-2SD, 0SD, +2SD)

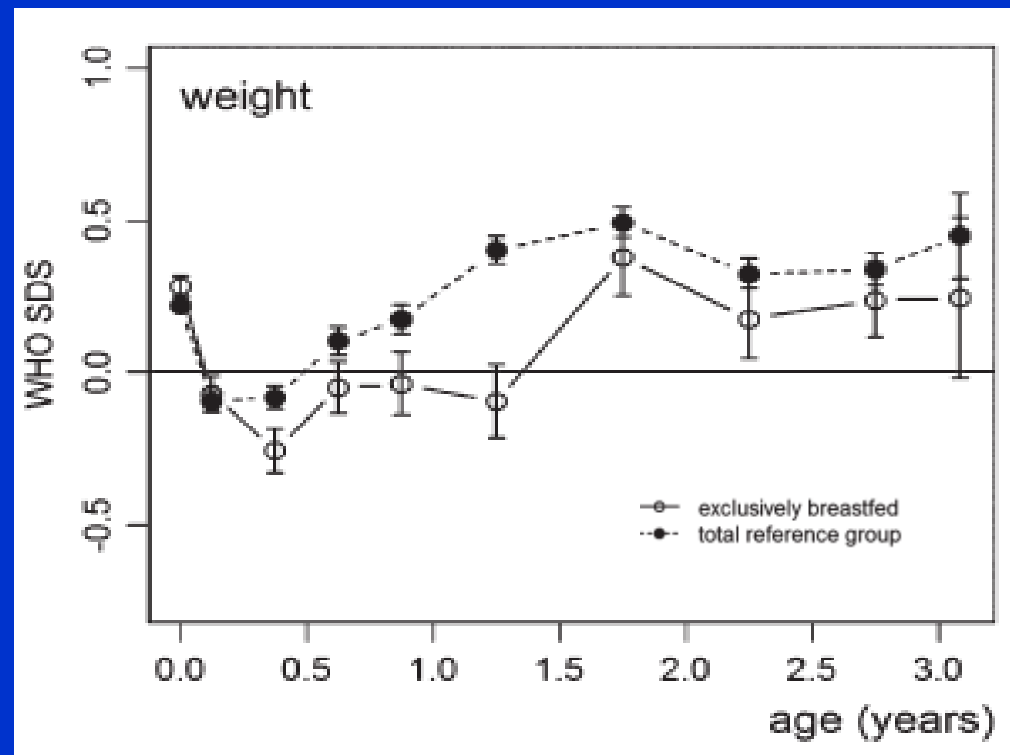


Weight / AGE

Weight for age (0-5 yrs) - boys (-2SD, 0SD, +2SD)



Comparison of SDS of breast fed and non breast fed Belgian children according to WHO growth standards



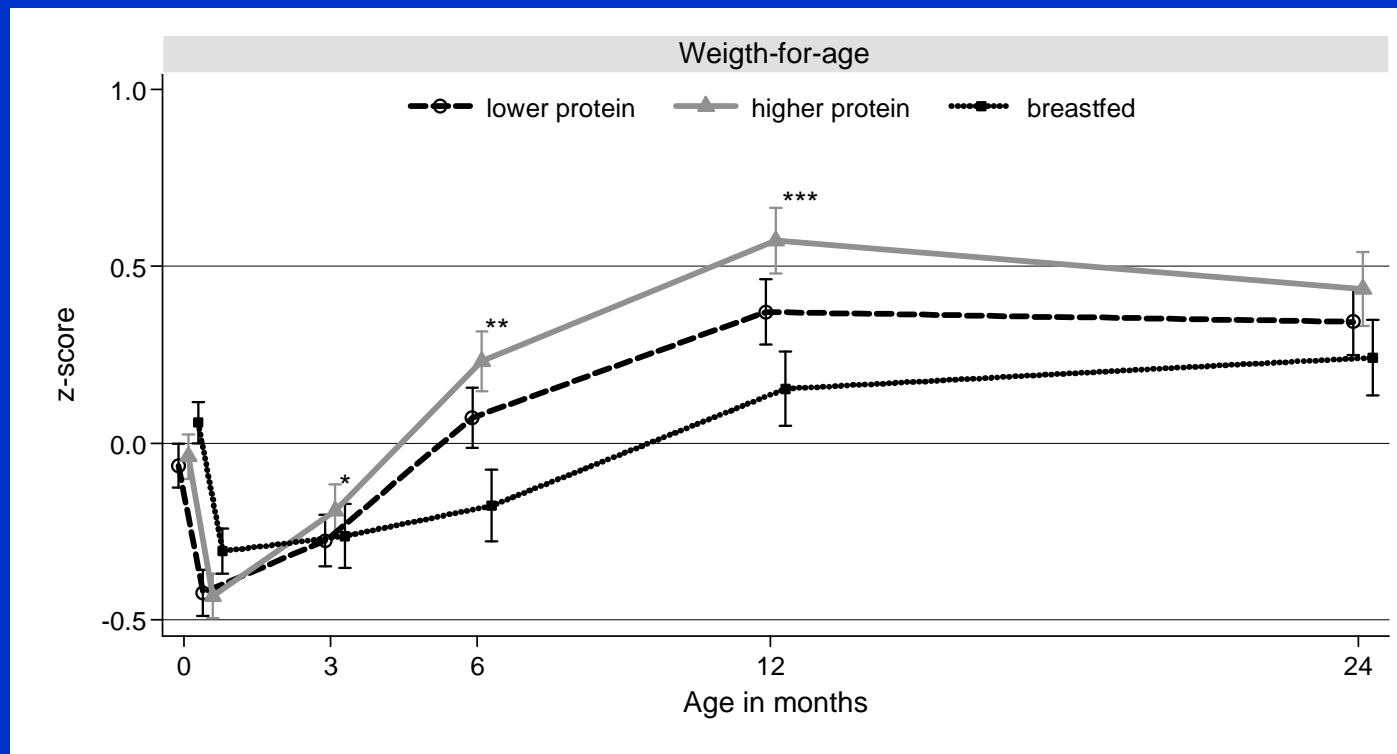
Roelants M, Hauspie R, Hoppenbrouwers K, Ann Hum Biol, 2010

20

Weight development in the CHOP study

(Zscores established on the WHO standards)

(Birth weight: WHO = 3.3kg; CHOP = 3.3kg)



After Koletzko et al. *Am J Clin Nutr* 2009

Weight / AGE

Weight – WHO 2006 relative to British 1990 - boys

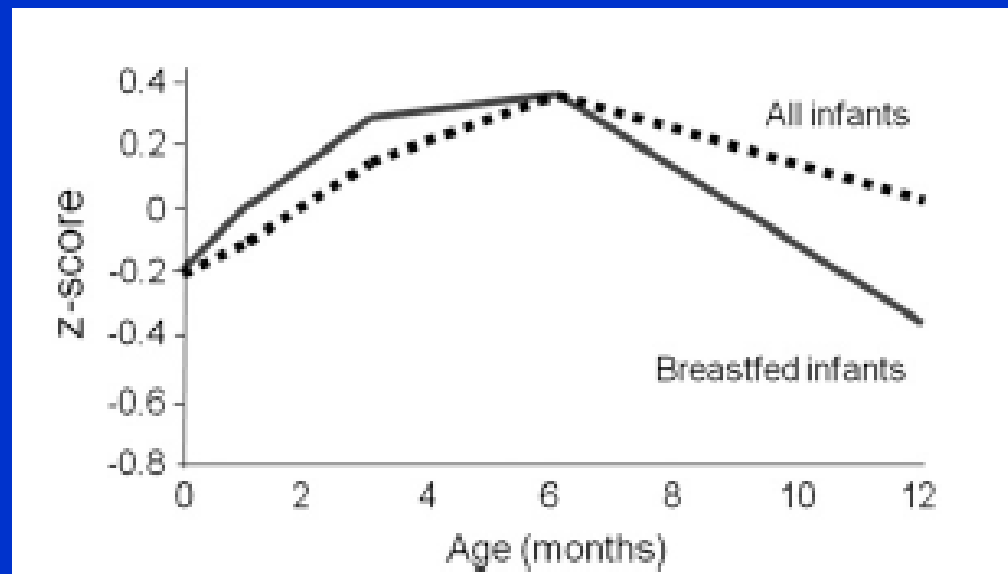


<http://www.sacn.gov.uk>

Breast fed vs non breast fed infants in Brazil

(Zscores according to CDC)

Weight for age



Victora et al., J Nutr 1998

Breast fed infant showed faster weight gain in the first 3 months, but a relative decline thereafter, and were leaner at 1 year

Clinical implication

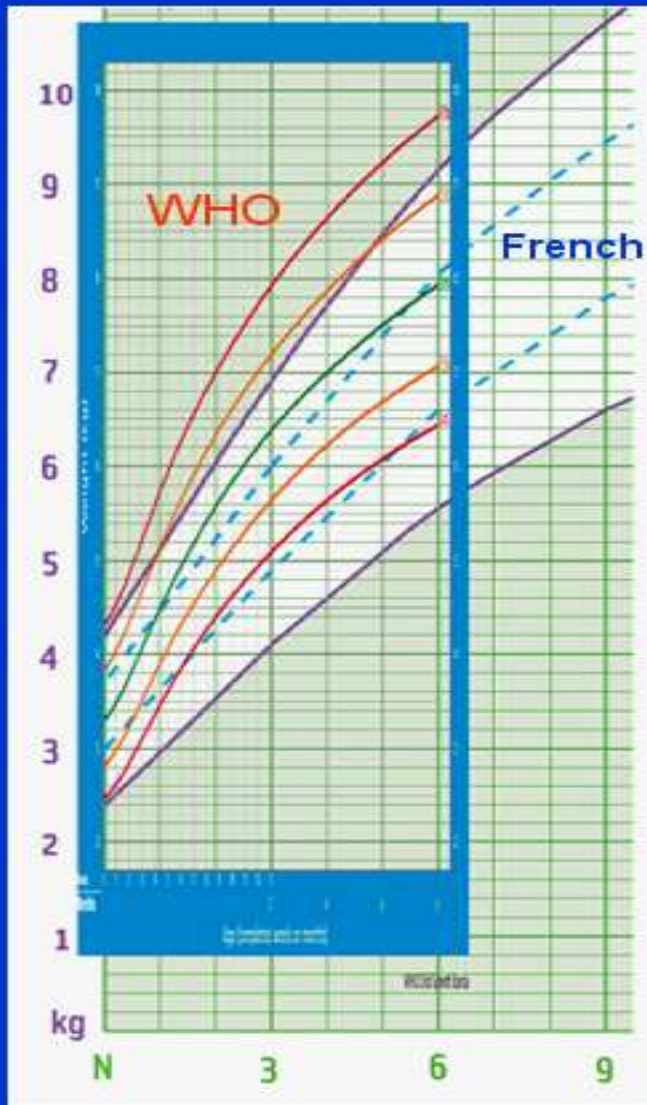
Consequences of the use of different references

(Bois et al. French study)

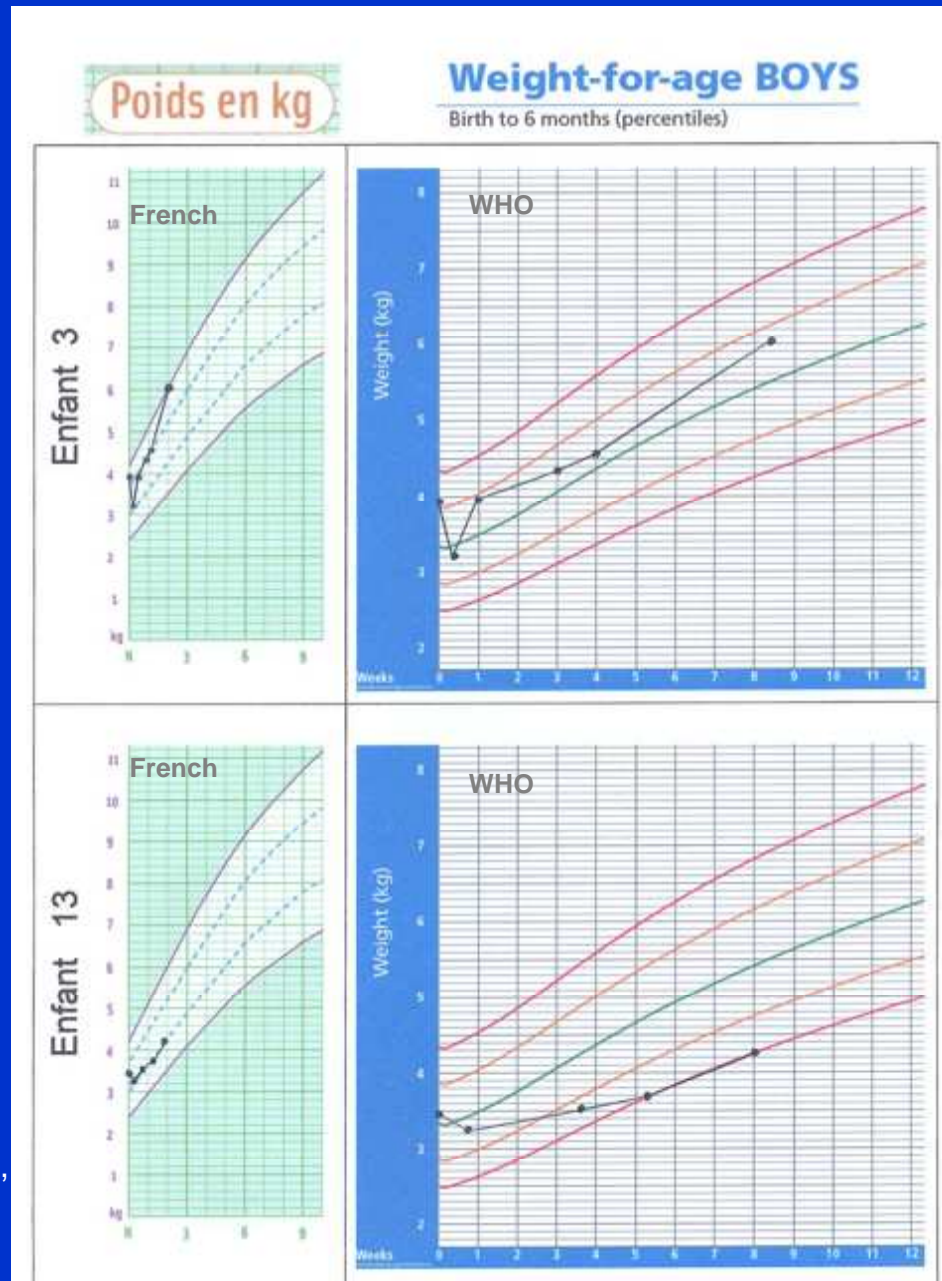
Can the use of different growth references influence the interpretation of the growth and the advices given to the parents?

- Twenty-two physician retrospectively interpreted individual growth curves of 20 exclusively breast fed babies according to the French references or WHO standards.
- All curves were interpreted twice
- A statistically significant difference was recorded in the interpretations of the French and WHO curves

Superposition of the weight/age French and the WHO growth charts



Assessment of weight according to the French references and WHO Standards



Using French references:
weight gain overestimated
in 1/3 subjects

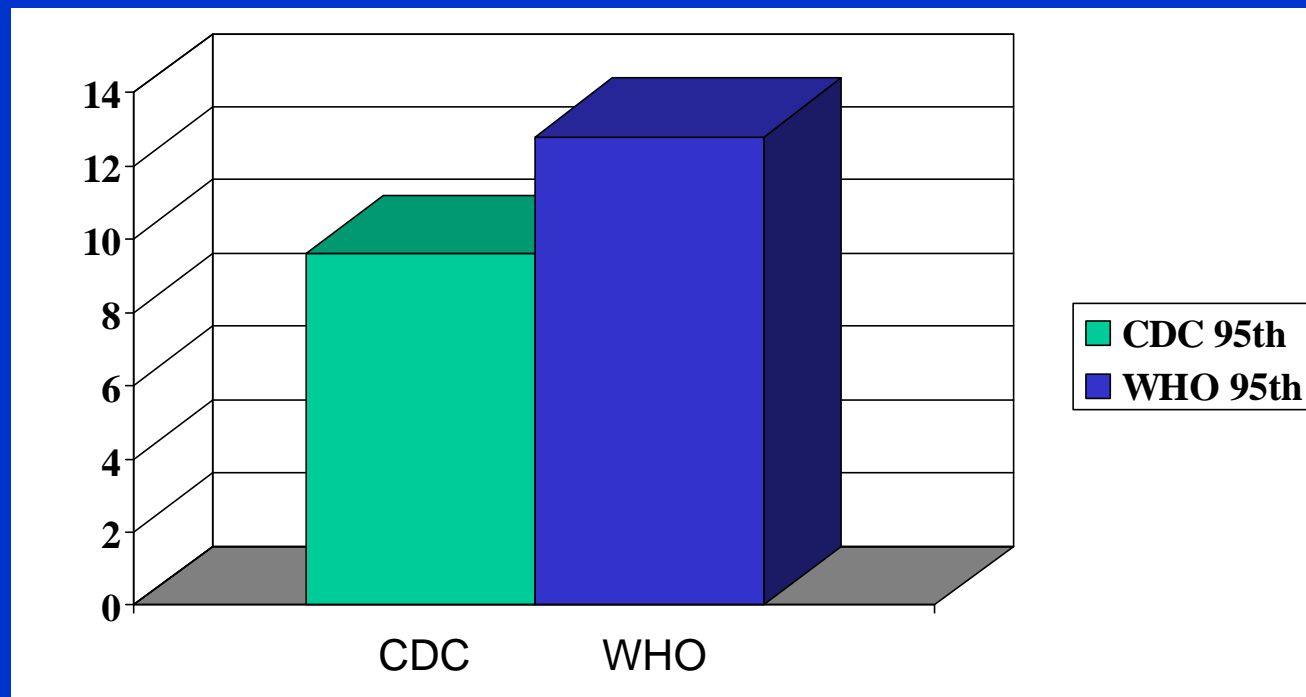
-> advice to restrict food intakes
(but not with WHO curves)

-> weight deficit was not taken
into account.
(but not with WHO curves)

Epidemiological implication

Overweight (Weight/Lenght) prevalence according to CDC and WHO definitions

Age 0-59 mo

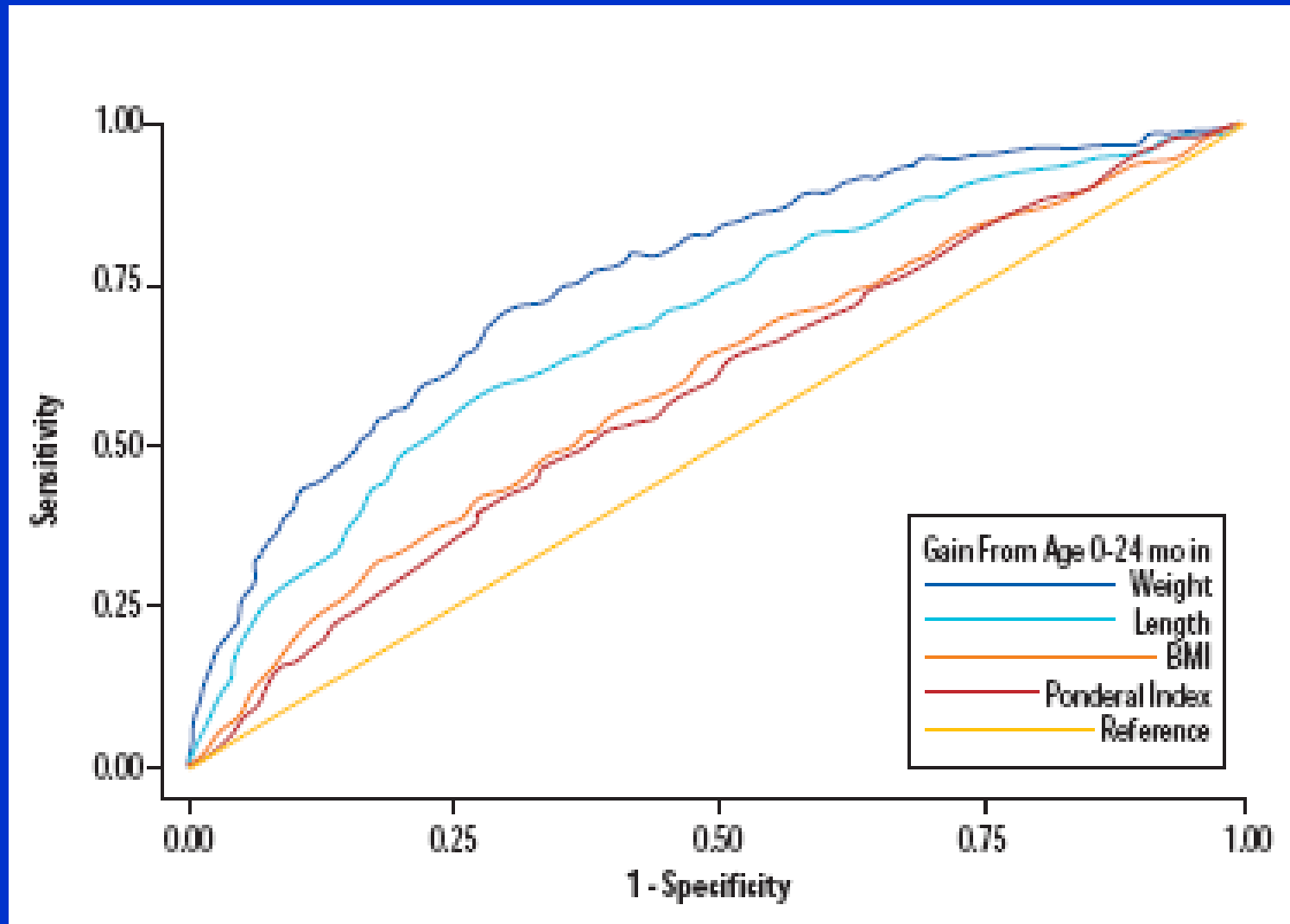


(Mei et al. J Pediatr 2008)

PLAN

- Growth studies
- WHO Standards
- Comparison between WHO standards/other references
- Comparison between growth parameters to predict adult body composition

Prediction of OW at school age by growth changes between 0 and 24 months (ROC Curve) from Toschke et al., 2004



MF R-C, Inserm

31

receiver operating characteristic (ROC) curve, is a graphical plot of the sensitivity vs. Specificity for a binary classifier system

Growth parameters

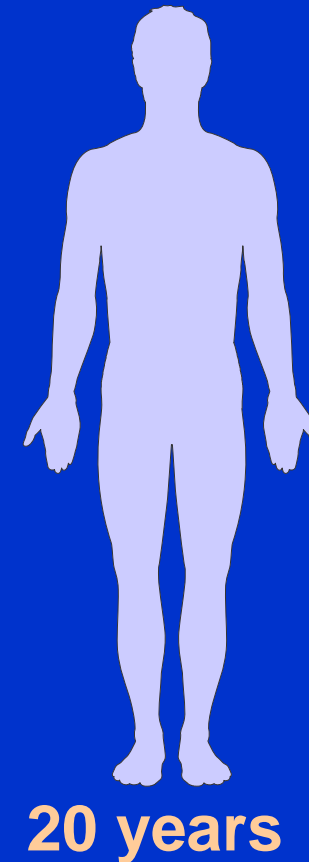
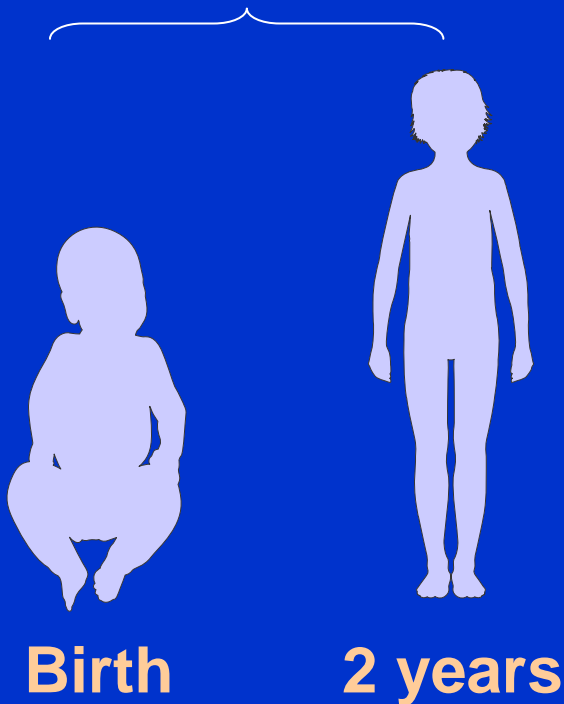
- As weight gain also includes length gain, high weight increase can result from high length gain.
- We have tested different growth parameters

Growth parameters (0-2y) and body composition at 20y

- Δ Length
- Δ Weight
- Δ Weight (adjusted for length)
- Δ BMI



Body composition



Growth parameters (0-2y) and body composition at 20y

n=74, boys and girls	Δ 0-2y			
	Δ Length	Δ Weight	Δ Weight adjusted for Δ Length	Δ BMI
Measurements at 20 yrs	r^1	r^1	r^1	r^1
Weight	0.37**	0.51***	0.39**	0.35**
BMI	0.22	0.34**	0.28*	0.29*
Sub-scapular skinfold	0.27*	0.31*	0.18	0.29*
Fat Body Mass (BIA)	0.28*	0.42**	0.32*	0.33**
Fat Body Mass (%)	0.23	0.32*	0.22	0.27*

¹ correlation coefficient adjusted for gender

*p<0.05; **p<0.01; ***p<0.001

Péneau S, Deheeger, Bellisle, Rolland-Cachera MF. *Int J Pediatr Obes* 2008 ;3(Suppl 2):43.

Growth parameters (0-2y) and body composition at 20y

n=74, boys and girls	Δ 0-2y			
	Δ Length	Δ Weight	Δ Weight adjusted for Δ Length	Δ BMI
Measurements at 20 yrs	r^1	r^1	r^1	r^1
Weight	0.37**	0.51***	0.39**	0.35**
BMI	0.22	0.34**	0.28*	0.29*
Sub-scapular skinfold	0.27*	0.31*	0.18	0.29*
Fat Body Mass (BIA)	0.28*	0.42**	0.32*	0.33**
Fat Body Mass (%)	0.23	0.32*	0.22	0.27*

¹ correlation coefficient adjusted for gender

*p<0.05; **p<0.01; ***p<0.001

Péneau S, Deheeger, Bellisle, Rolland-Cachera MF. *Int J Pediatr Obes* 2008 ;3(Suppl 2):43.

Conclusion

Conclusion

We have examined the implication of the use of

- Different references
- Different anthropometric parameters

to assess early growth

Conclusion

Comparison between WHO Standards and other references:

1 - 6 months: -> Marked differences: WHO longer length and heavier

> 6 months -> WHO represents a relatively lean population

Differences: feeding practice, secular trends

Growth patterns of breast-fed infants are closer to WHO standards than to other references

WHO standards are particularly adapted for breast fed infants

Conclusion

- **Clinical implication**

different references -> different interpretations of the child growth and then different advices given to parents

- **Epidemiology**

prevalence vary according to the reference used

→ Use several definitions (WHO, IOTF, CDC, National)

Conclusion

Growth parameters to predict adult measurements

- Weight gain has the highest correlations
- Weight gain adjusted for length gain
-> similar correlations as with length and BMI gain.

The different parameters may predict different health risks (obesity, CVD or cancer)

Conclusion

Because of the differences presented here, in studies investigating the consequences of early growth, it is important to be aware of the implications of using

the different references or
different growth parameters

Thank you!