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THE EUROPEAN SOCIETY FOR CLINICAL NUTRITION AND METABOLISM

Obesity
Assessment and Prevention

Module 23.2

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Key messages

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- Obesity is one of the major health problems of **today** and is **associated with** increased risk of several diseases both in frequency and severity
- The development of obesity is determined by **both** genetic and environmental factors
- Generally **breastfed infants** tend to have a lower BMI than formula-fed infants and behavioral and hormonal mechanisms may explain this difference
- **Sedentary behavior** (viewing television, playing video games, doing cognitive work, and listening to music) and reduced overall physical activity along with shorter sleep duration promote the **overconsumption** of dietary macronutrients leading to obesity

Key messages

- **Chronic overfeeding** seems to be the most important factor leading to obesity
- Maintenance of body weight is achieved when **energy intake is adjusted** to energy expenditure
- **Diet** and increased **physical activity** are the cornerstones for the prevention and treatment of obesity

Definition of Obesity

- **WHO** definition:

"A condition in which percentage body fat (PBF) is increased to an extent in which health and well-being are impaired"

- Classification of overweight and obesity

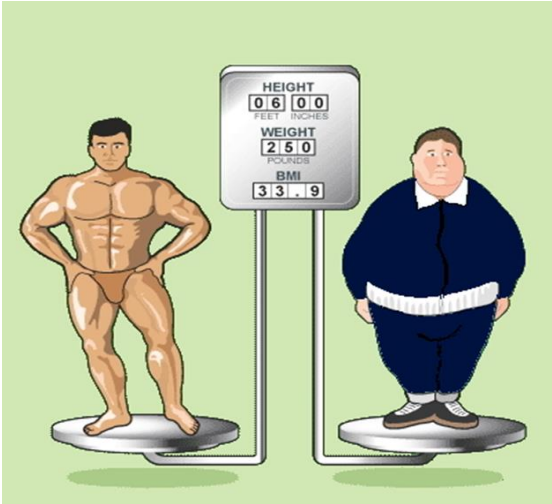
  >Body Mass Index (**BMI**)

Classification of obesity (WHO)

Category	BMI [kg/m²]	Risk for associated diseases
Very severely underweight	<15	Very high
Severely underweight	15.0 to 15.9	Elevated
Underweight	15.9 to 18,5	Low
Normal weight	18,5 – 24,9	Low
Overweight	25 – 29,9	Slightly elevated
Obesity grade I Obesity grade II Obesity grade III	30 – 34,9 35 – 39,9 ≥40	Elevated High Very high

Limitations of BMI

- Not representative of **body composition** (body fat, fat free mass)
- **Crude estimation** of obesity and undernutrition
- BMI≥30 kg/m^2 **may not mean obesity** but metabolic disorder (e.g. oedema, ascites etc.)



Assessing obesity

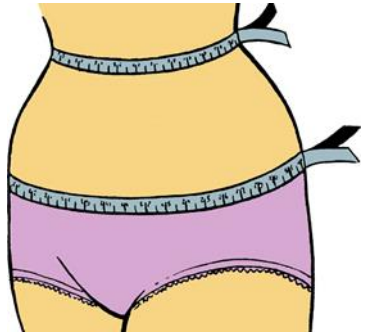
- Body fat **BF**
- Fat free mass **FFM**
- Sceletal muscle mass **SMM**
- Metabolicaly active body cell mass **BCM**
- **Bone** mass
- Total amount of **water**

Assessing obesity tools

- **BMI**
- **Genetic/metabolic** factors

- Waist circumferences (**WCF**) (measure of **visceral fat** deposit)

  ≥ 102 cm in men & ≥88 cm in women



- Waist-to-hip ratios

  >0.95 in men & >0.8 in women

- Percentage body fat (**%BF**)
- Bioelectrical impedance analysis (**BIA**)

Assessing obesity tools

- **DEXA** scan
- **CT / MRI**
- **REE** prediction
- More techniques:

  (bioimpedance spectroscopy **BIS**, dilution technique, total body potassium **TBP**, air displacement plethysmography **ADP**, hydrostatic weighing, 3-dimensional photonic scanning **3DPS**, quantitative magnetic resonance **QMR**, near-infrared interactance **NII**)

Bioelectrical impedance analysis (BIA) in obesity

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- BIA measures **body impedance** via electrodes
- Predict total body water (**TBW**), fat-free mass (**FFM**) and indirectly **fat mass**

➢ Single frequency BIA (**SF-BIA**) not be used for body composition > theory that

"*human body is a cylinder with constant resistivity*"

➢ **Segmental BIA** (tetra- and eight-polar-BIA)

> human body has complex shape

> combines several impedance measures

> overestimate %BF in obese

Bioelectrical impedance analysis (BIA) in obesity

- Multi-frequency BIA (**MF-BIA**)

  > use multiple electric frequencies

  > accurate to **TBW** and extra cellular water (**ECW**)

  > overestimate %BF in obese

  > underestimate total and truncal fat

- **Fatness-specific BIA**

  > validated for **use in obesity**

  > more research needed

DEXA in obesity (Dual-energy X-ray absorptiometry)

- Measures **bone mineral fat**, **fat tissue**, **fat-free soft tissue**
- **Uses** :
  - Determine abdominal obesity
  - Predict intraabdominal fat
  - Assess regional body composition (gynoid or android obesity)
- **Limitations** :
  - High cost
  - Appropriate trained staff
  - Not for severely obese (DEXA tables width 60 cm and support ≤ 150kg)

CT/MRI in obesity

- **CT:**
  - Measures muscle mass, visceral organ volumes, visceral adipose tissue
  - High radiation
  - High cost
- **MRI:**
  - Measures body composition
  - Examine regional fat
  - Limited size of MRI machine
  - High cost

REE in obesity (Resting energy expenditure)

- Different equations exist for calculate REE
- **Accuracy** of equations **varied**
- **Limited clinical practice**
- New predictive equations for severe obese needed

Overcoming anthropometric assessment

- Edmonton Obesity Staging System (**EOSS**)

- European Association for the Study of Obesity (**EASO**)

  > Obesity as adiposity-based chronic disease (**ABCD**)

EOSS System

- **Prognostic** system
- Classification of **obese population** in a 5-point scale linked to obesity comorbidities
  1. No apparent risk factors
  2. Obesity related subclinical risk factors
  3. Established obesity-related chronic disease
  4. Established end-organ damage
  5. Severe disabilities

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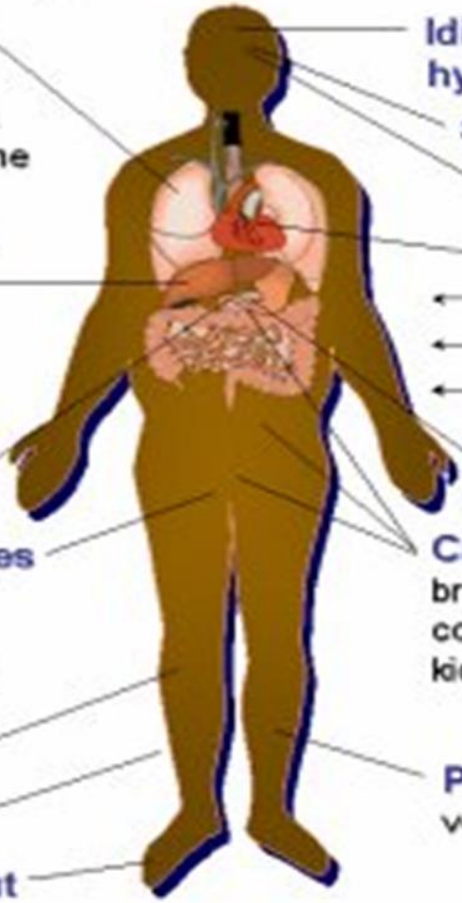
Medical Complications of Obesity



Pulmonary disease
abnormal function
obstructive sleep apnea
hypoventilation syndrome

Nonalcoholic fatty liver disease
steatosis
steatohepatitis
cirrhosis

Gall bladder disease

Gynecologic abnormalities
abnormal menses
infertility
polycystic ovarian syndrome

Osteoarthritis

Skin

Gout

Idiopathic intracranial hypertension

Stroke

Cataracts

Coronary heart disease

Diabetes

Dyslipidemia

Hypertension

Severe pancreatitis

Cancer
breast, uterus, cervix
colon, esophagus, pancreas
kidney, prostate

Phlebitis
venous stasis

Optimal BMI and mortality

- **High BMI (>25)** is associated with:
  - Cardiovascular diseases (CVD)
  - Hypertension
  - Diabetes mellitus (DM)
  - Stroke
  - Cancer (colon, endometrial cancer)
- Patients with **BMI>40** rarely live longer than 60 years
- Measure of **BMI change** is better than static BMI measurement
- **Optimum BMI: 20-22**

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Obesity Paradox = Higher BMI → Longer survival

Explanation of obesity paradox

- Protection of obesity:
  - **Lower attenuation** of physical function in patients with chronic disease
  - **Reduction of oxidative stress** and inflammation
  - Lower levels of B-type natriuretic peptide → favourably regional sympathetic activity
  - Provision of favourable functional lipid profiles
  - **Secretion of adipokines** which provide cardiovascular benefits

Group of patients

- Elderly
- Cardiovascular disease patients
- Intensive Care Unit (ICU) patients
- Dialysis patients
- Cancer patients
- Patients with peripheral vascular disease
- Hospitalized individuals

Elderly

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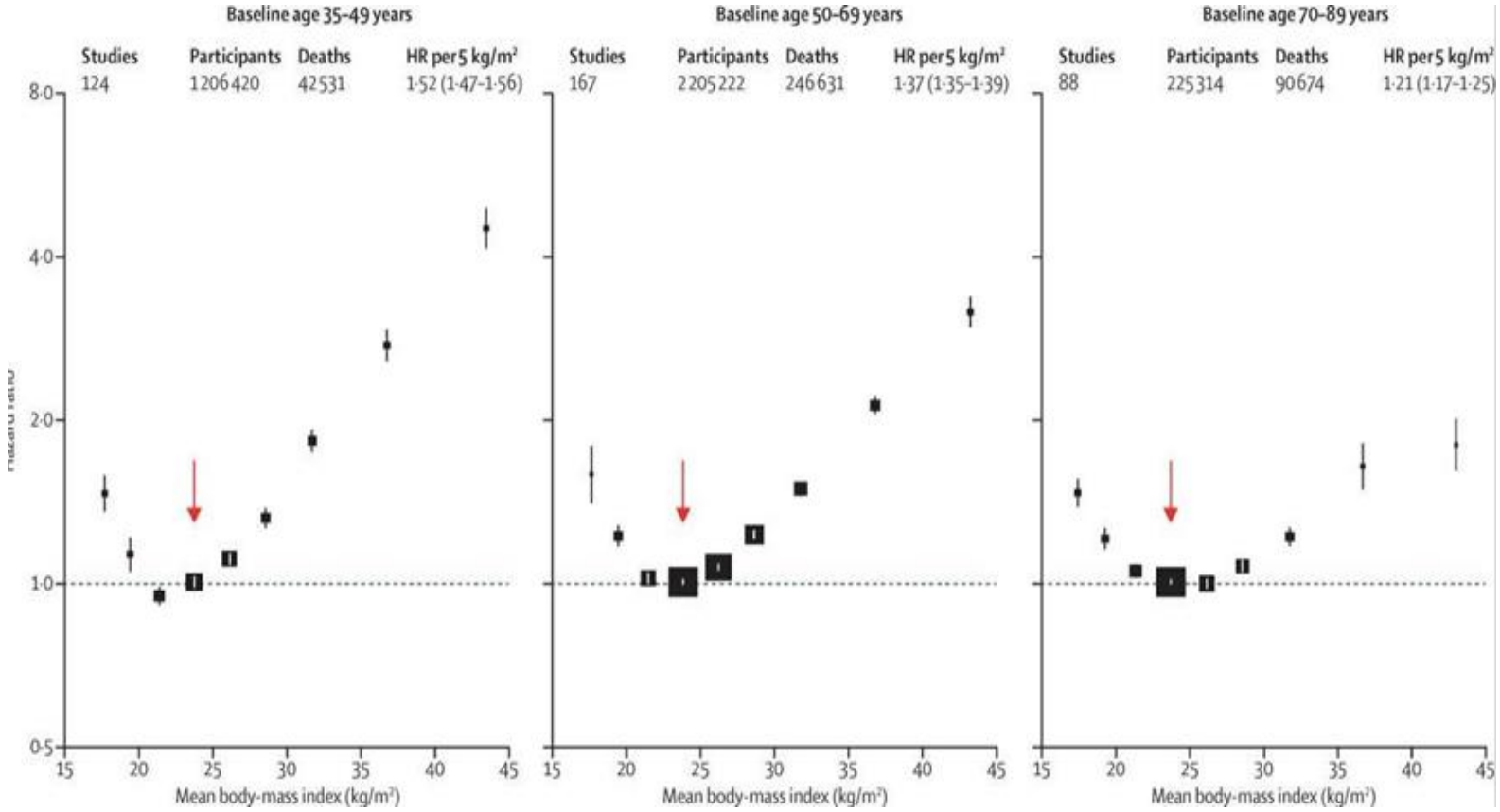
- Optimal **BMI** for people ≥65 years is **28**

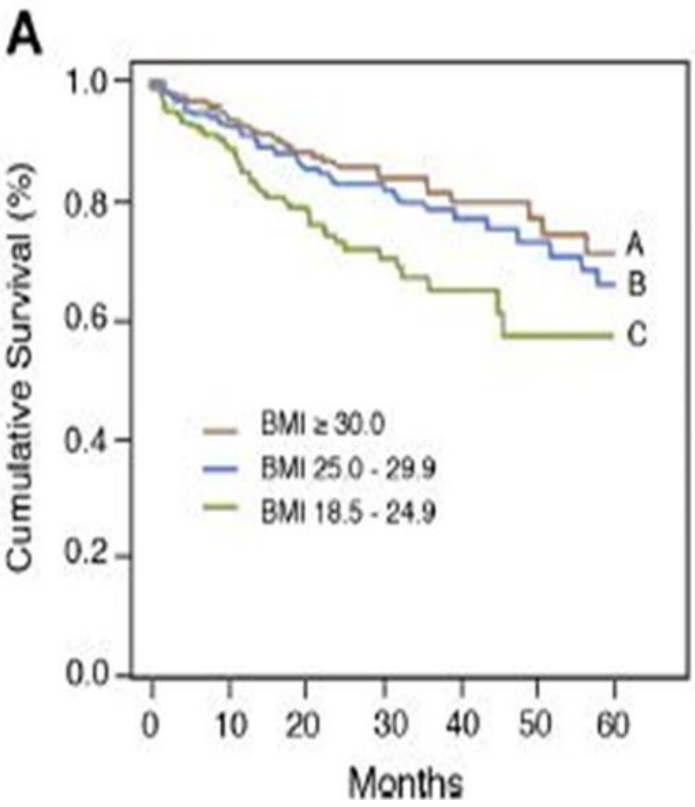


Optimal BMI in people according to their age group

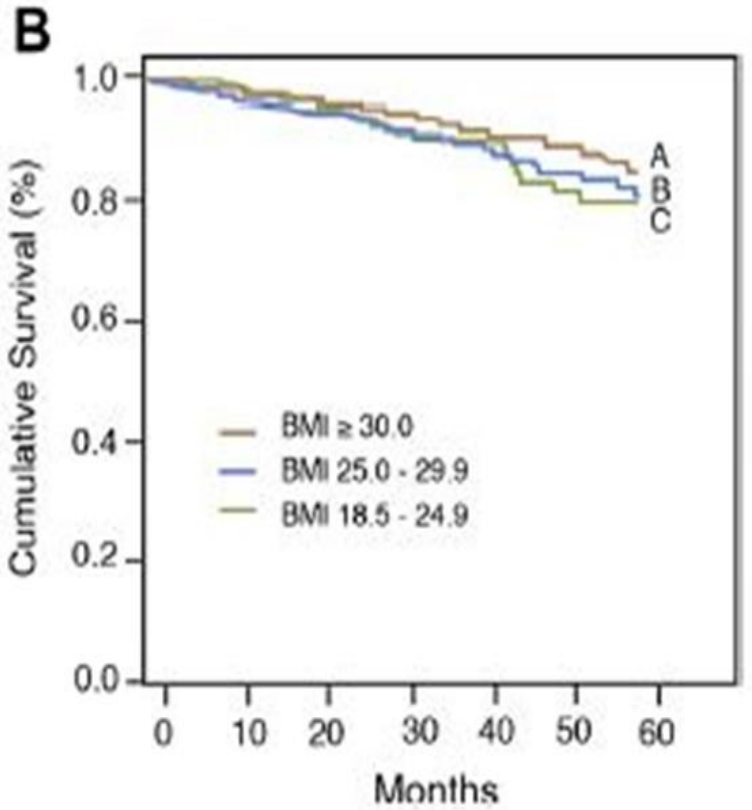
Cardiovascular disease patients

- When **Obesity and CVD coexist**, Class I **obesity patients** present **better prognosis** than normal/underweight patients
- **Lean mass** is associated with **improved cardiorespiratory fitness**
- Increased lean mass "**stronger**" than fat mass

Heart failure HF patients



Kaplan-Meier analysis plot according to BMI in the ***low fit group***



Kaplan-Meier analysis plot according to BMI in the ***fit group***

Pandey Curr Heart Fail Rep 2015

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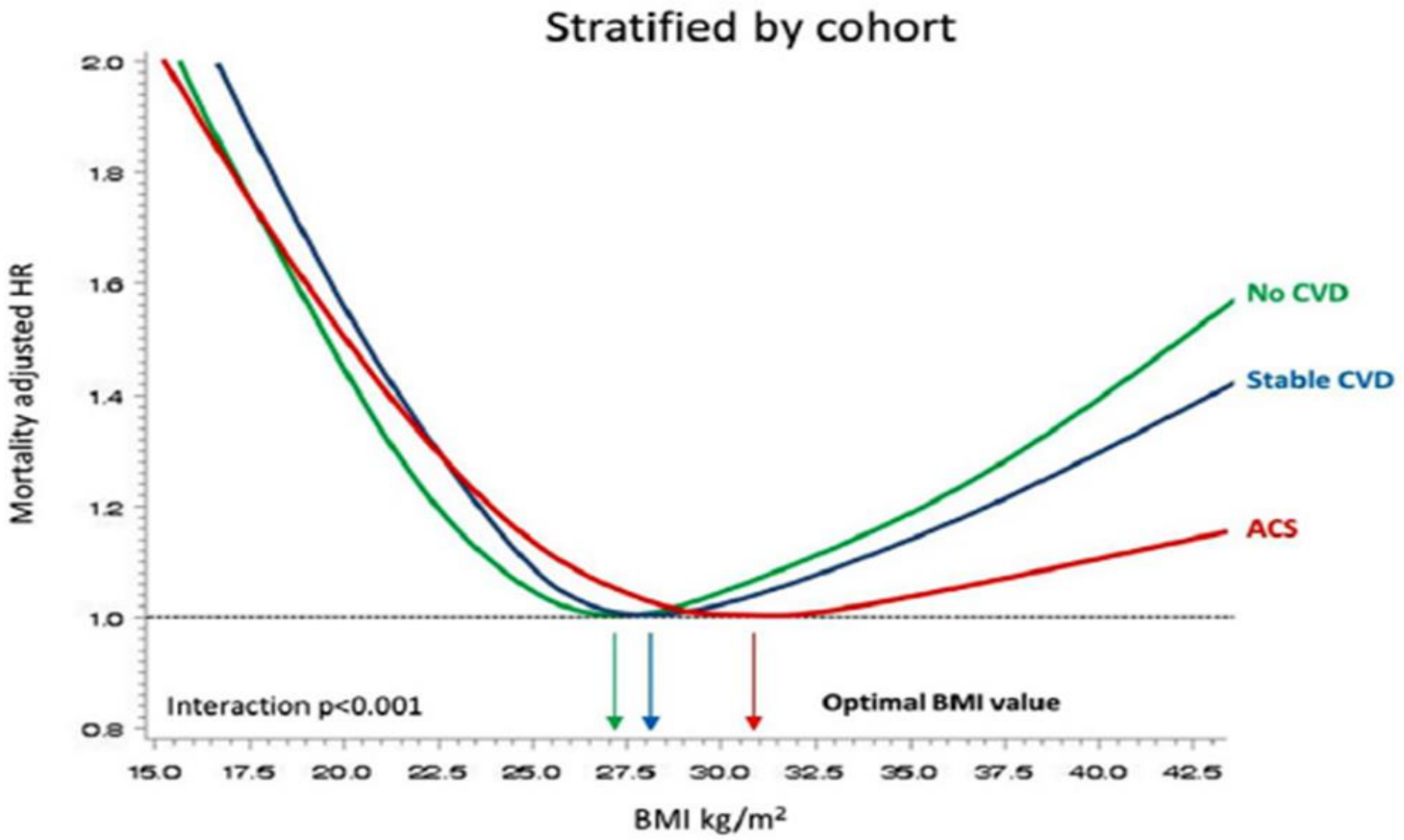
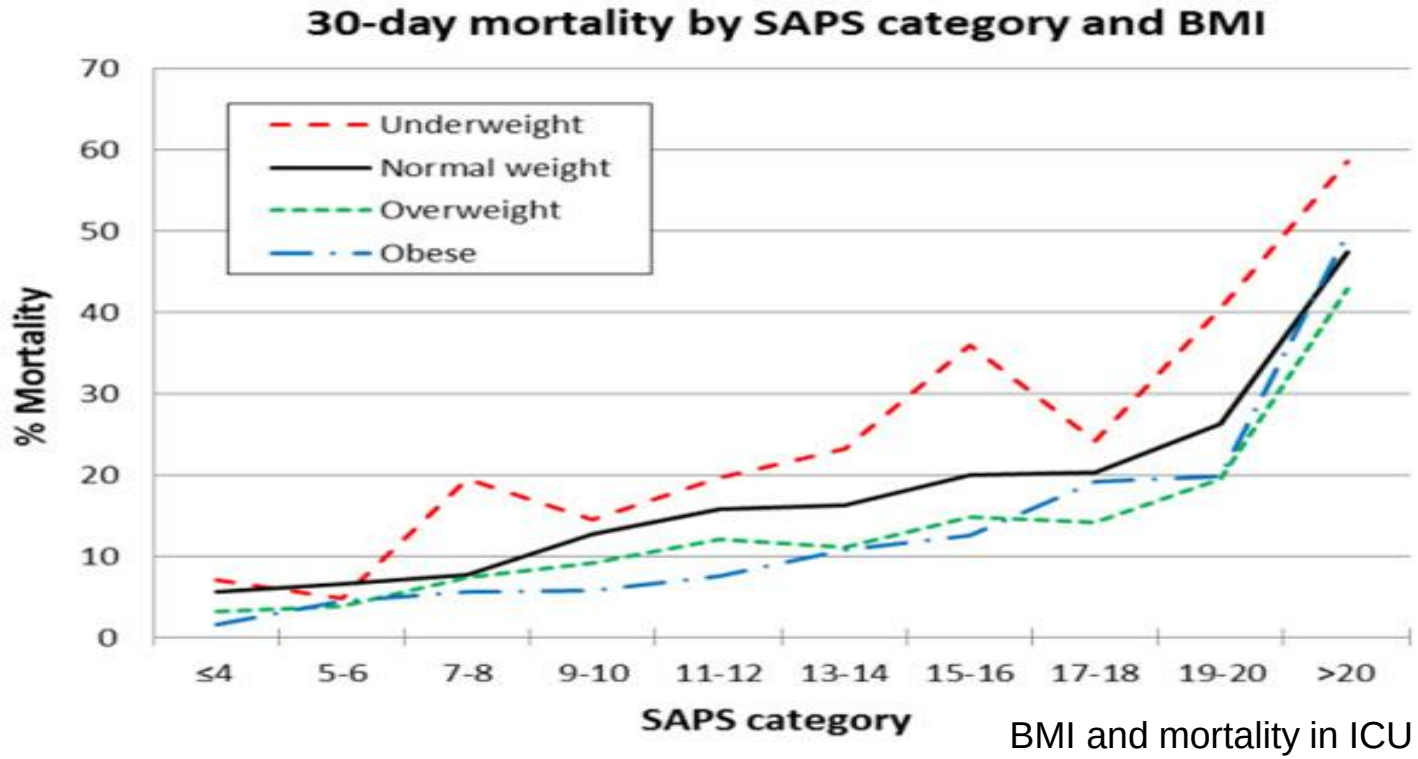


Lamelas Am J Cardiol 2018

ICU patients

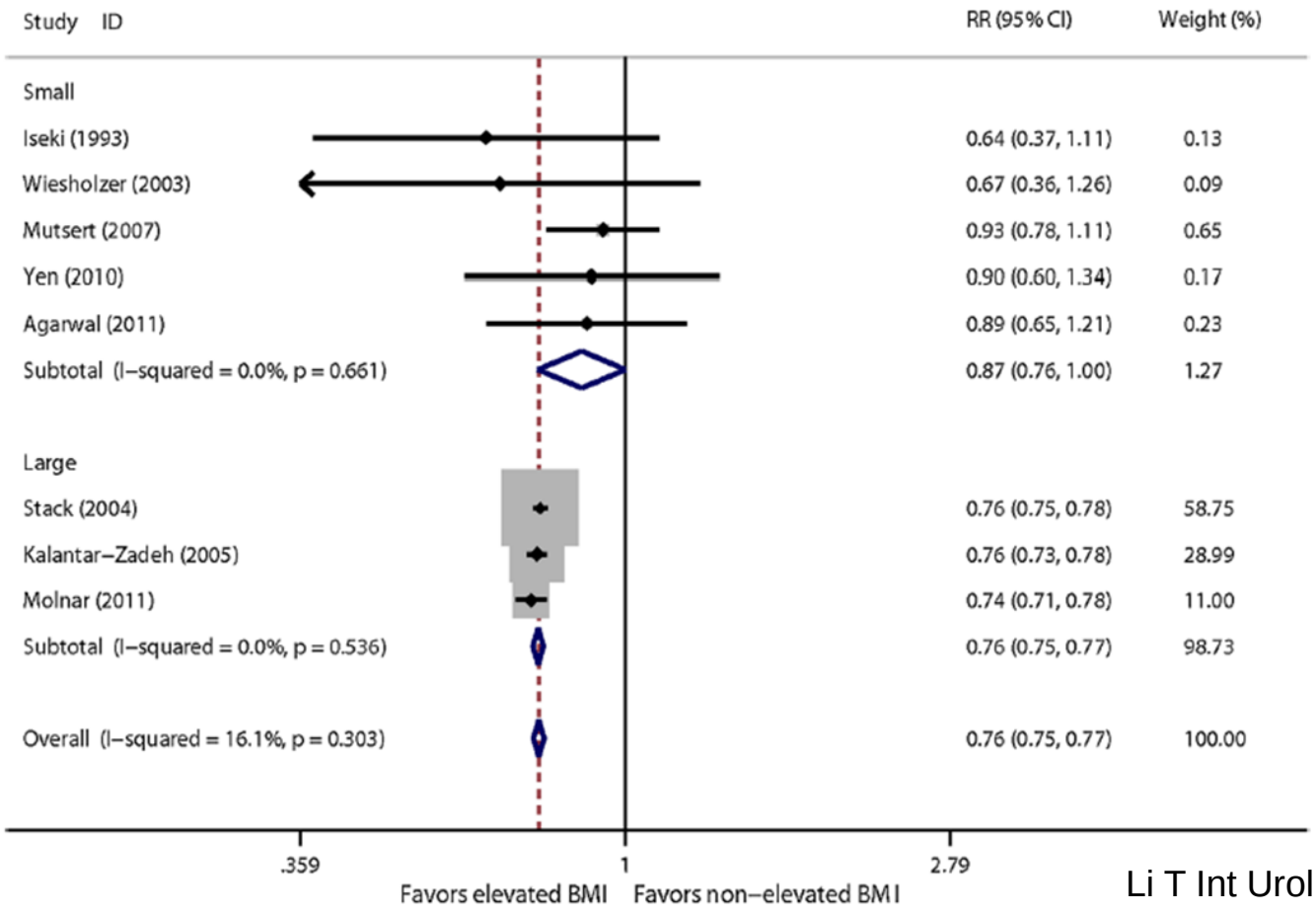
- Mortality of obese lower than normal/under weight patients
- Optimal BMI= 30



BMI and mortality in ICU

Dialysis patients

- **Protective** effect of **high BMI**
- Low BMI: risk factor for death



Li T Int Urol Nephrol. 2014

Cancer patients

- **Malnutrition** is associated with cancer and linked to **reduced survival**
- **Survival time** for obese/overweight is higher than normal/low weight patients
- Higher BMI **decrease** disease-related mortality
- Higher BMI **decrease** recurrence rate
- **Worst** prognosis for **sarcopenic** patients

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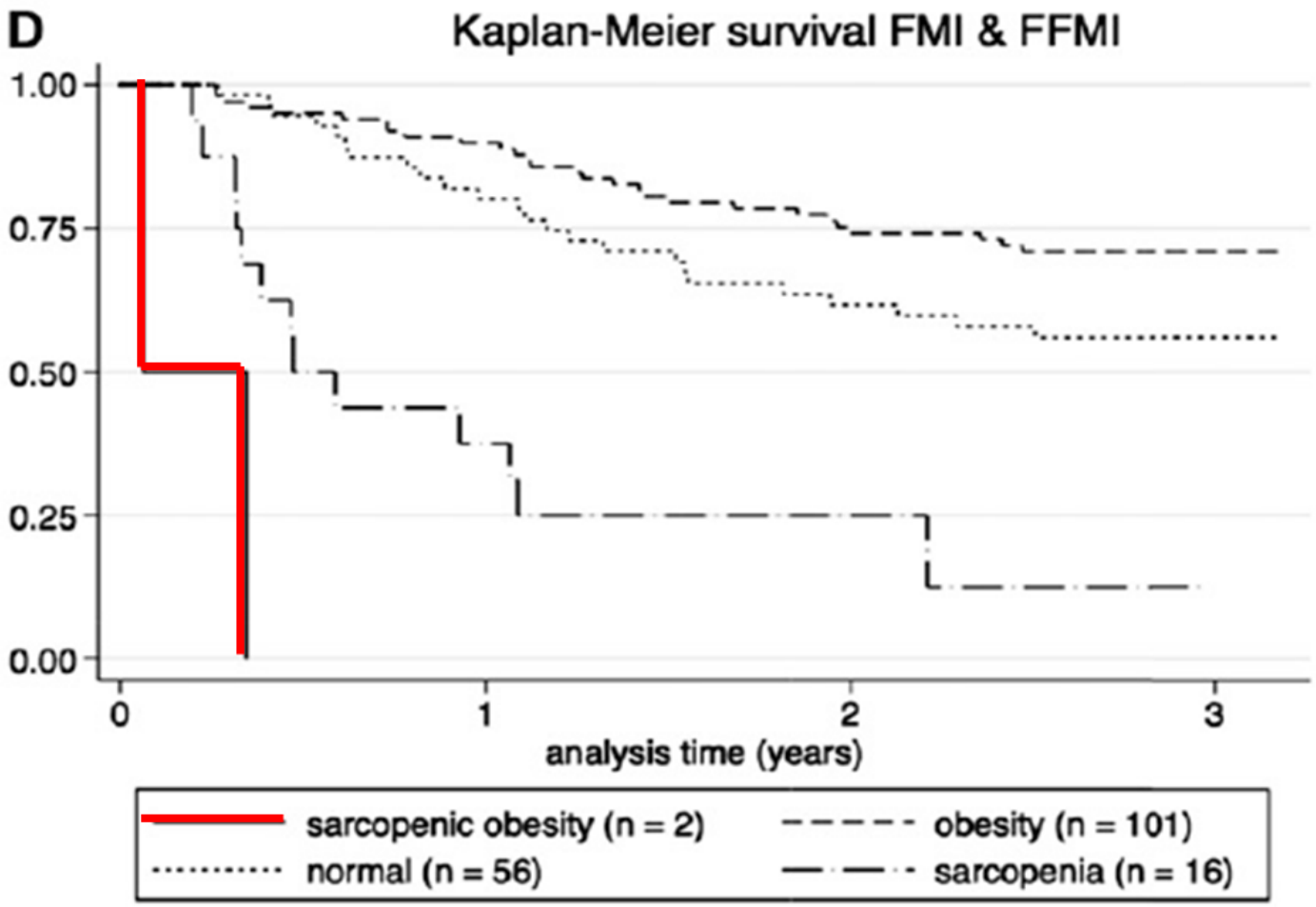

BMI sarcopenia and survival in cancer patients

Patients with peripheral vascular disease

- Underweight patients **double** risk of dying
- Overweight patients **half** risk of dying

Hospitalized individuals

- Optimal BMI **28-33** *(Higher than WHO)*

Early life Strategies

- Breastfed infants: lower BMI
- Lower protein intake leading to lower growth acceleration?
- High protein intake (>15%) → increased obesity and NCDs later in life

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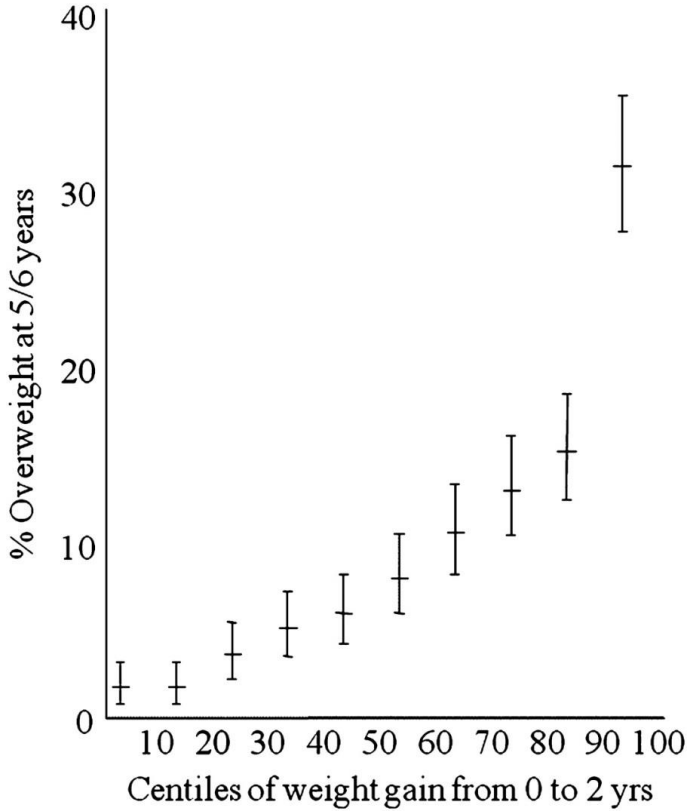
Higher weight gain from birth to age 2 y (centiles) is associated with a higher prevalence of overweight at school entry in 4235 children in Bavaria, Germany



Koletzko B et al. Am J Clin Nutr 2009

The early protein hypothesis

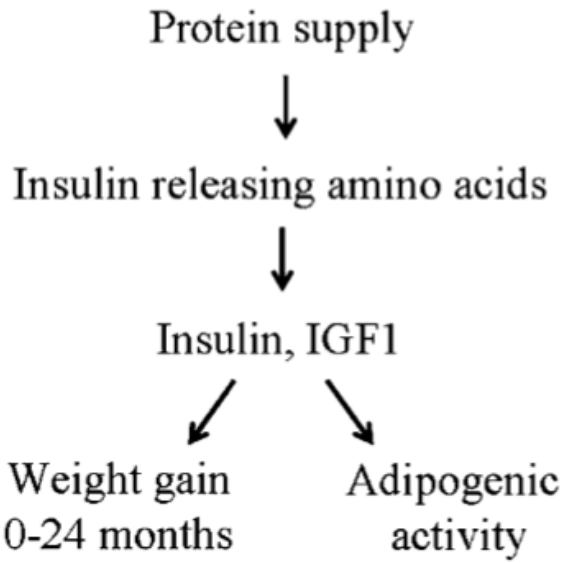


FIGURE 4. The early protein hypothesis: a high protein intake with infant formula feeding, in excess of metabolic requirements, might induce increased circulating concentrations of insulin-releasing amino acids, which in turn might stimulate the secretion of insulin and insulin-like growth factor I (IGF1), thereby inducing an increased weight gain during the first 2 y of life as well as increased adipogenic activity.

Koletzko B et al. Am J Clin Nutr 2009

Duration of breastfeeding

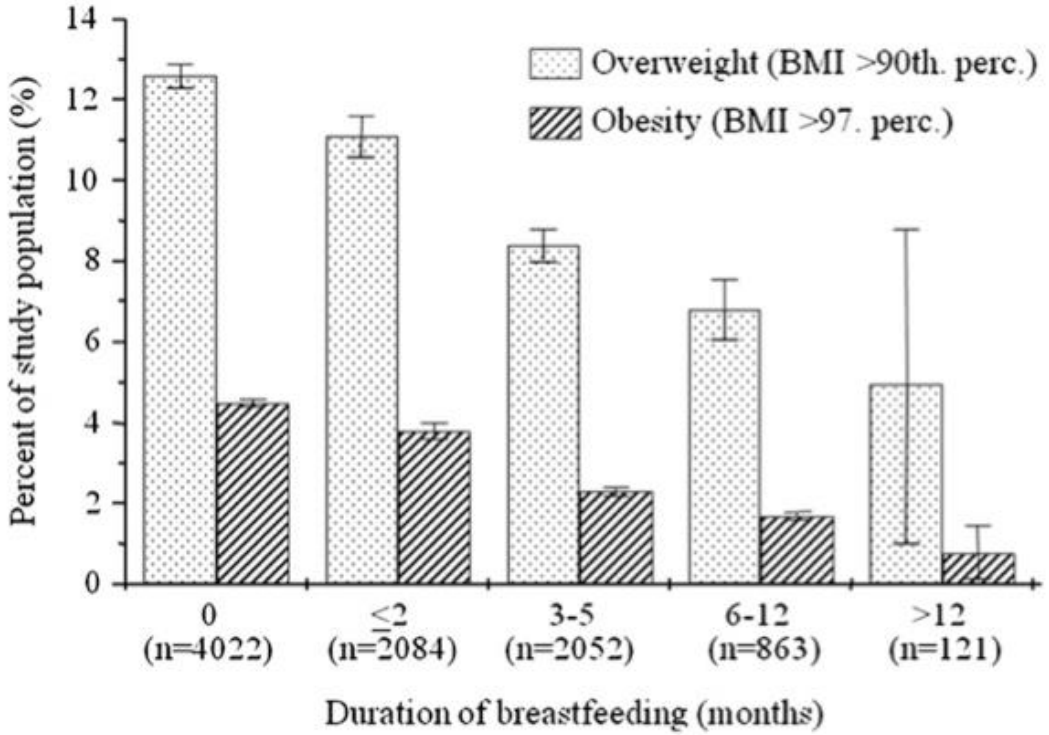


FIGURE 3. Longer duration of breastfeeding in infancy is associated with a lower prevalence of both overweight and obesity at school entry in 9357 children in Bavaria, Germany (39). perc., percentile.

von Kries R, et al., BMJ 1999

Obesity and health

- Targeting the ideal weight is **unrealistic** and **unnecessary**!
- **Moderate weight loss** (**5-10% BW**) demonstrates important functional effects (e.g. DM-2, some tumors, CVD, etc.)
- ?..ambitious goals → better outcomes..?

Obesity and mortality

- Weight gain was associated with a higher mortality risk in overweight/obese individuals.

- New findings indicate the associations of weight gain with mortality risk depend on **baseline BMI status**

Am J Epidemiol. 2013 Dec 1;178(11):1591-9. doi: 10.1093/aje/kwt179. Epub 2013 Sep 7.

Obesity and mortality risk: new findings from body mass index trajectories.

Zheng H, Tumin D, Qian Z.

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Body Mass and Weight Change in Adults in Relation to Mortality Risk

Kenneth F. Adams*, Michael F. Leitzmann, Rachel Ballard-Barbash, Demetrius Albanes, Tamara B. Harris, Albert Hollenbeck, and Victor Kipnis

* Correspondence to Dr. Kenneth F. Adams, Minnesota Cancer Surveillance System, Minnesota Department of Health, 85 East 7th Place, P.O. Box 64882, St. Paul, MN 55164-0882 (e-mail: kenneth.adams@state.mn.us).

Table 6. Total Mortality Risk Among Never Smokers in Relation to Age at Which Body Mass Index[a] First Reached or Exceeded 25.0 (for 4 Age Points) as Compared With Maintenance of a Body Mass Index Under 25.0 at All 4 Ages, by Gender, National Institutes of Health-AARP Diet and Health Study, 1996–2009

Time at Which BMI First Exceeded Threshold (BMI ≥25.0)	No. of Deaths	Multivariate Hazard Ratio[b]	95% Confidence Interval	Adjusted Death Rate[c]	Average BMI[d] (SD)
Men	6,068				
BMI <25.0 at all 4 ages		1.0	Reference	7.9	21.7 (1.4)
Baseline		0.98	0.88, 1.08	8.0	22.0 (1.4)
Age 50 years		1.12	1.04, 1.22	9.4	23.4 (1.0)
Age 35 years		1.32	1.23, 1.42	10.9	25.9 (1.6)
Age 18 years		1.68	1.55, 1.82	13.8	28.6 (2.8)
Women	4,265				
BMI <25.0 at all 4 ages		1.0	Reference	5.8	20.7 (1.4)
Baseline		0.96	0.88, 1.06	5.8	21.6 (1.3)
Age 50 years		1.26	1.16, 1.37	7.8	23.4 (1.2)
Age 35 years		1.68	1.54, 1.84	10.8	26.8 (2.1)
Age 18 years		2.04	1.83, 2.28	12.7	28.7 (3.8)

Abbreviations: BMI, body mass index; SD, standard deviation.

[a] Weight (kg)/height $(m)^2$.

[b] All analyses adjusted for age (in the baseline hazard of the Cox regression) and the following covariates: race/ethnicity, education, physical activity, and alcohol consumption (see Table 3 for definitions).

[c] Total number of deaths per 1,000 person-years; adjusted for age and gender using the Mantel-Haenszel method.

[d] Average BMI was calculated as the weighted average of BMIs at 18, 35, and 50 years of age.

Best combination: low BMI at adulthood entry + maintenance within a healthy range

Obesity and lifestyle

- Sedentary behavior (e.g. TV, VG, cognitive work, etc.) → ↓ physical activity, ↓ sleeping time → overconsumption of kcal (fats and CHO)

OB/OW in BOTH young and adult age

Unhealthy dietary behaviors

Obesity and lifestyle

- Commercials favoring less healthy products
- Additional taxation?

Comans *et al. BMC Public Health* 2013, **13**:1182
http://www.biomedcentral.com/1471-2458/13/1182

BMC Public Health

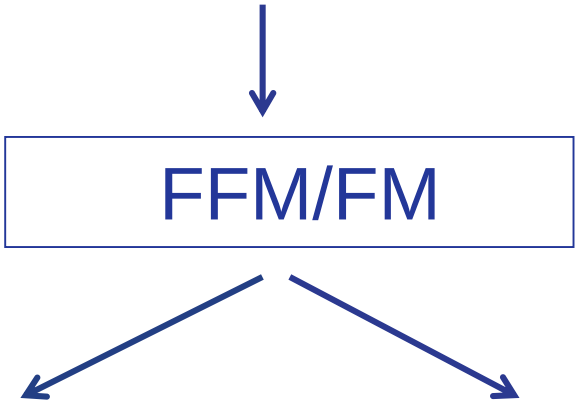
STUDY PROTOCOL Open Access

The cost-effectiveness and consumer acceptability of taxation strategies to reduce rates of overweight and obesity among children in Australia: study protocol

Tracy A Comans[1,2*], Jennifer A Whitty[1,2], Andrew P Hills[3,4], Elizabeth Kendall[1], Erika Turkstra[1,2], Louisa G Gordon[1,2], Josh M Byrnes[1,2] and Paul A Scuffham[1,2]

Weight gain vs. weight maintenance

- Maintenance: neutral energy balance!
- For previously OW → tendency for regain
- Easier if: lower FM, higher FFM



Main determinant of BEE

Metabolic health

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Effect of nutrients on obesity

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- Protein intake
- CHO intake
- Fat intake
- Other…

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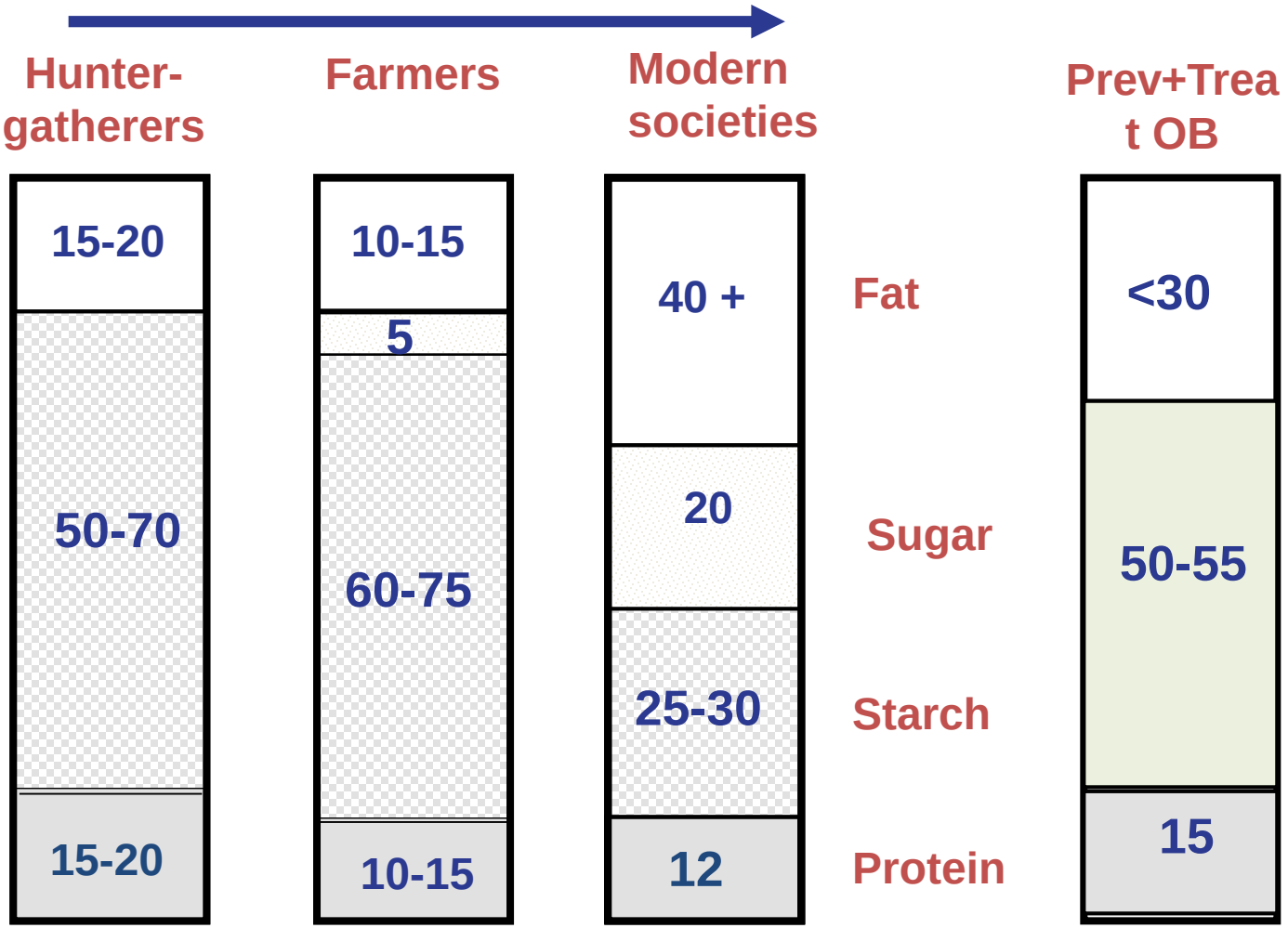


	Hunter-gatherers	Farmers	Modern societies
Salt (g/day)	1	5-15	10-20
Fibers (g/day)	40	60-120	20

Source: WHO Report (2003)

Effect of proteins on obesity

- Have the strongest satiety effect
- Absolut Pr intake more important than %Pr (10-15% WHO)
- 20-30% may decrease ad libitum food intake
- Higher chance of maintenance (?)

Int J Obes (Lond). 2014 Mar 28. doi: 10.1038/ijo.2014.52. [Epub ahead of print]

Weight loss maintenance in overweight subjects on ad libitum diets with high or low protein content and glycemic index: the DIOGENES trial 12-month results.

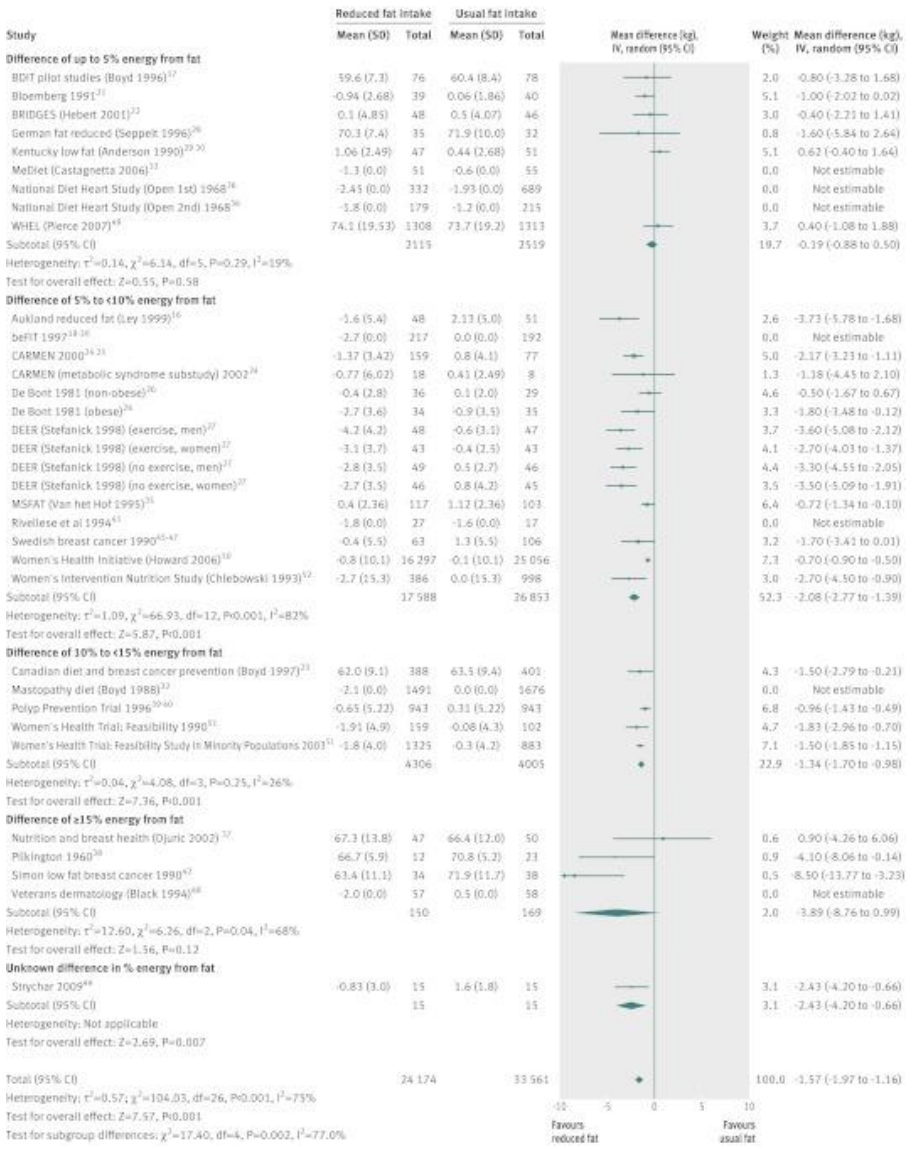
Aller EE[1], Larsen TM[2], Claus H[3], Lindroos AK[4], Kafatos A[5], Pfeiffer A[6], Martinez JA[7], Handjieva-Darlenska T[8], Kunesova M[9], Stender S[10], Saris WH[1], Astrup A[2], van Baak MA[1].

Effect of fats on obesity

- Meta-analysis with regard to lower % fat (74.000 participants, 33 RCTs, %28-43, duration 6 m to >8 y)

- ➢ small but ss and clinically meaningful sustained reduction for OW/OB
- ➢ reduction BW, BMI, WC (both healthy and in risk)
- ➢ but also v.v. for children and adults

Hooper, L., et al., BMJ, 2012



Effect of fats on obesity

Overall → long term effects on weight loss

of low fat diets not yet established

Cochrane Database Syst Rev. 2002;(2):CD003640.

Advice on low-fat diets for obesity.

Pirozzo S[1], Summerbell C, Cameron C, Glasziou P.

Author information

Update in

Cochrane Database Syst Rev. 2008;(3):CD003640.

Effect of dietary sugars on obesity

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- Debate on their role on OW/OB

Obes Rev. 2009 Mar;10 Suppl 1:9-23. doi: 10.1111/j.1467-789X.2008.00561.x.

Consumption of sugars and body weight.

van Baak MA[1], Astrup A.

- Obvious "track" to OW/OB:

  ↑CHO → positive energy balance

BMJ. 2012 Jan 15;346:e7492. doi: 10.1136/bmj.e7492.

Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies.

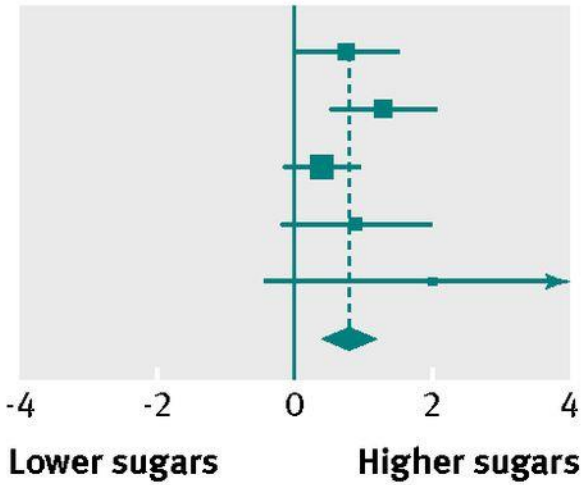
Te Morenga L[1], Mallard S, Mann J.

Effect of reducing intake of free sugars on measures of body fatness in adults

Study	Mean difference	Standard error	Mean difference (95% CI)	Weight (%)	Mean difference (95% CI)
Gatenby 1997[28]	0.75	0.39		22.5	0.75 (-0.02 to 1.52)
Mann 1972[30 31]	1.30	0.38		23.3	1.30 (0.55 to 2.05)
Paineau 2008[33]	0.40	0.27		38.4	0.40 (-0.13 to 0.93)
Saris 2000[39]	0.90	0.54		13.0	0.90 (-0.16 to 1.96)
Smith 1996[41]	1.99	1.23		2.8	1.99 (-0.42 to 4.40)
Total (95% CI)				100.0	0.80 (0.39 to 1.21)

Test for heterogeneity: $\tau^2=0.04$, $\chi^2=4.85$, df=4, P=0.30, $I^2=17\%$

Test for overall effect: z=3.85, P<0.001



Te Morenga L et al. BMJ 2013;346:bmj.e7492

Effect of dietary sugars on obesity

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- Sugar sweetened beverages (SSB)
  - largest source of added sugar in U.S.A.
  - top source of energy intake in U.S.A.
- **↓ SSB → ↓ OW/OB prevalence**

Prevention through limitation of SSB favorable than reducing OB

Am J Clin Nutr. 2013 Oct;98(4):1084-102. doi: 10.3945/ajcn.113.058362. Epub 2013 Aug 21.

Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis.

Malik VS[1], Pan A, Willett WC, Hu FB.

Effect of dietary sugars on obesity

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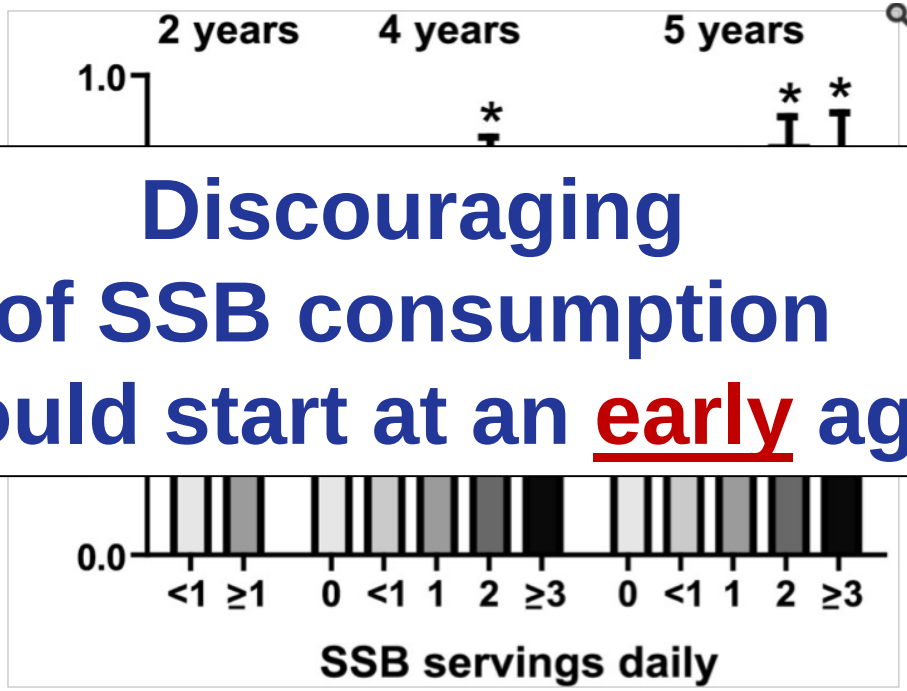
- Similar results also for children



Discouraging of SSB consumption should start at an early age

Pediatrics. 2013 Sep;132(3):413-20. doi: 10.1542/peds.2013-0570. Epub 2013 Aug 5.

Sugar-sweetened beverages and weight gain in 2- to 5-year-old children.

DeBoer MD[1], Scharf RJ, Demmer RT.

Effect of dairy products on obesity

- Despite several observational and experimental studies: results are inconsistent.

- Recent data do not support an increased consumption for weight loss or fat loss

(long term studies, studies with no energy restriction)

Am J Clin Nutr. 2012 Oct;96(4):735-47. Epub 2012 Aug 29.

Effects of dairy intake on body weight and fat: a meta-analysis of randomized controlled trials.

Chen M[1], Pan A, Malik VS, Hu FB.

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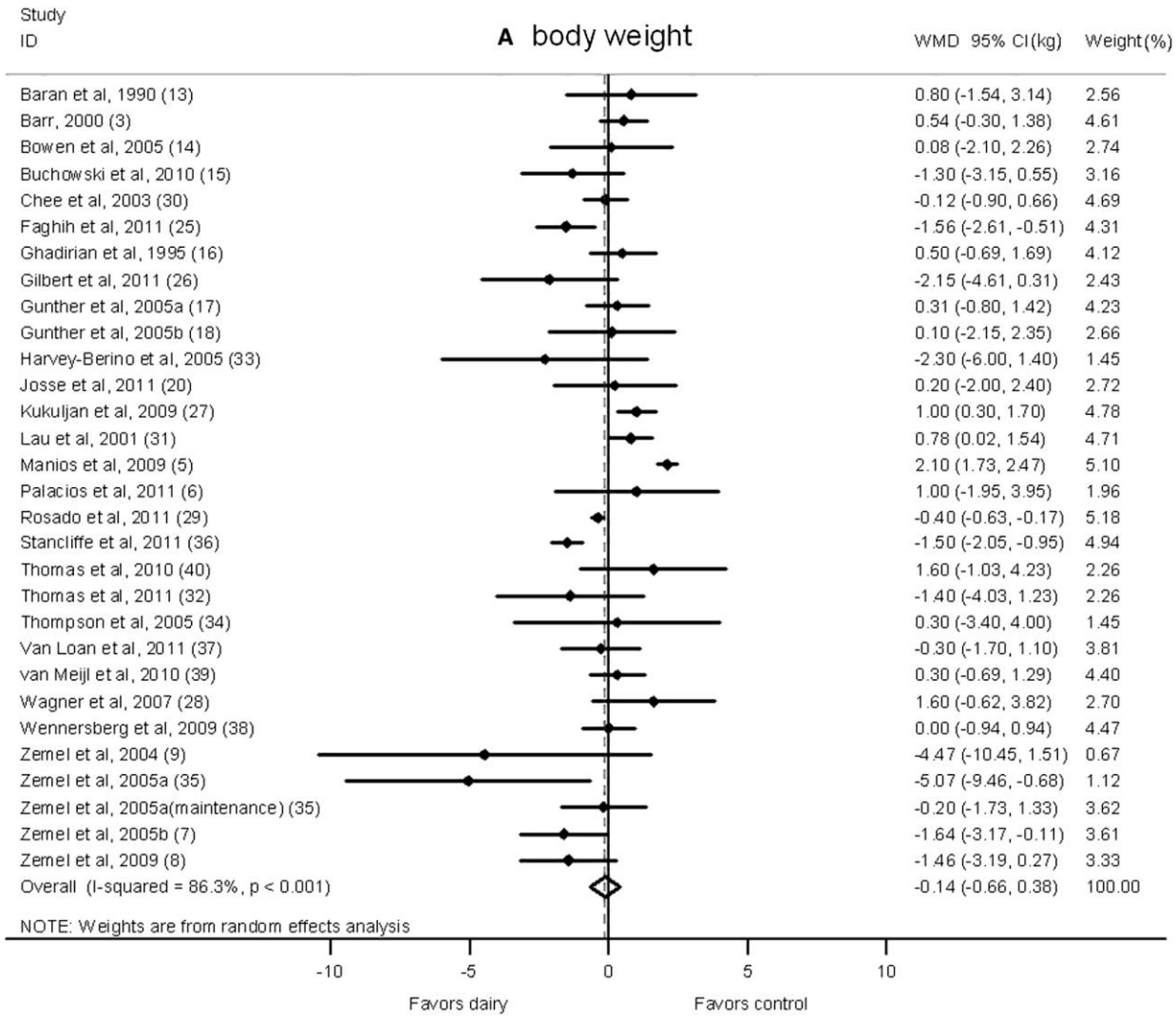

Chen M et al. Am J Clin Nutr 2012

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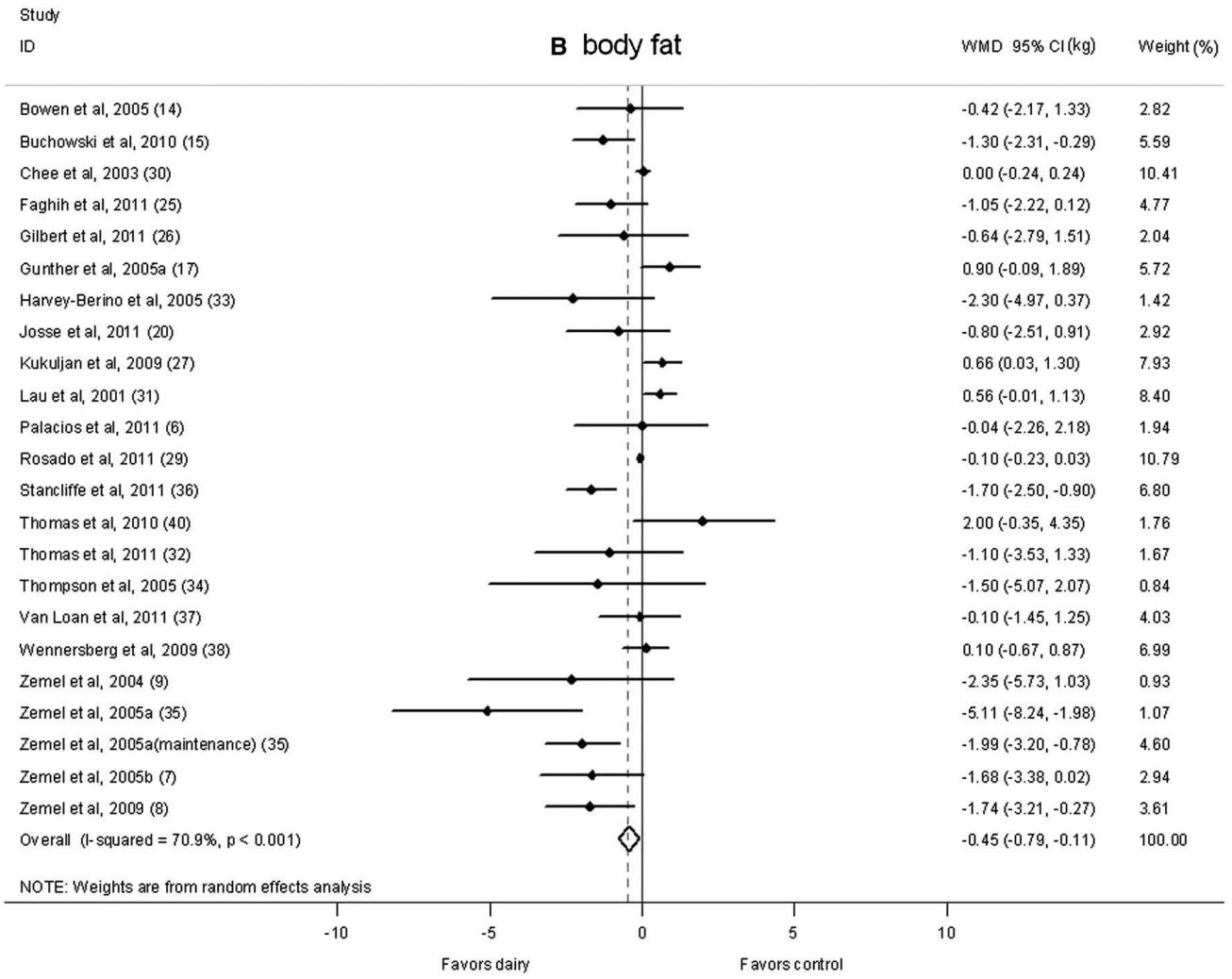

Chen M et al. Am J Clin Nutr 2012

Effect of dietary salt on obesity

- Analyses of Fluid Consumption (g/d) and Dietary Salt Intake (g/d) in Australian Children Aged 2 to 16 Years, by Gender and Age Group (n = 4283)
- +1 g/d salt □ + 46 g/d fluids*

* NOT always water!

- +1 g/d salt □ + 17 g/d SSB

- Salt reduction strategies may also be useful in childhood obesity prevention

Pediatrics. 2013 Jan;131(1):14-21. doi: 10.1542/peds.2012-1628. Epub 2012 Dec 10.

Dietary salt intake, sugar-sweetened beverage consumption, and obesity risk.

Grimes CA[1], Riddell LJ, Campbell KJ, Nowson CA.

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Effect of glycemic index on obesity

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Suggestion:

- low GI (gl. index) or GL (gl. load) → higher weight loss

OW/OB benefit more in wt loss and blood lipid profiles

- Seems to be an **effective** method
- Is easy to incorporate into lifestyle

Cochrane Database Syst Rev. 2007 Jul 18;(3):CD005105.

Low glycaemic index or low glycaemic load diets for overweight and obesity.

Thomas DE[1], Elliott EJ, Baur L.

Key messages

- Obesity is one of the major health problems of **today** and is **associated with** increased risk of several diseases both in frequency and severity

- The development of obesity is determined by **both** genetic and environmental factors

- Generally **breastfed infants** tend to have a lower BMI than formula-fed infants and behavioral and hormonal mechanisms may explain this difference

- **Sedentary behavior** (viewing television, playing video games, doing cognitive work, and listening to music) and reduced overall physical activity along with shorter sleep duration promote the **overconsumption** of dietary macronutrients leading to obesity

Key messages

- **Chronic overfeeding** seems to be the most important factor leading to obesity
- Maintenance of body weight is achieved when **energy intake is adjusted** to energy expenditure
- **Diet** and increased **physical activity** are the cornerstones for the prevention and treatment of obesity

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Summary

- **Diet AND physical activity are the cornerstones for BOTH prevention and treatment of obesity**
- **Targeting normal weight is unrealistic an unnecessary**
- **Overall a balanced diet, with a lower glycemic load, as part of a healthier lifestyle also helps for the maintenance**

Take home message

- …a continuation of the conditions that promoted weight loss also promote a better degree of maintenance of the lower weight…