Nutrition in Metabolic syndrome

Prof. Nishan Sudheera Kalupahana

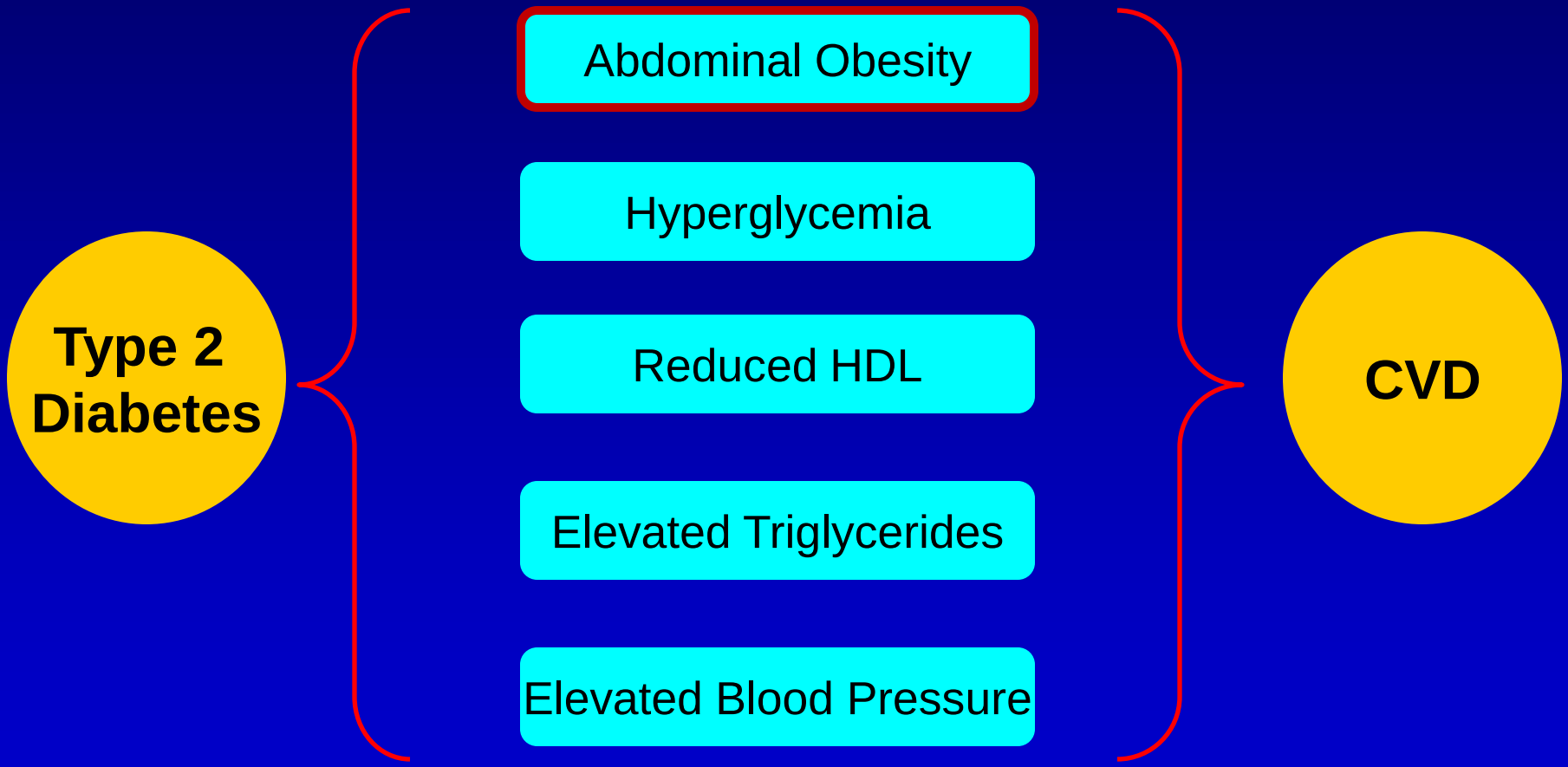
MBBS, MPhil, Ph.D. (USA)

Professor in Human Nutrition

Faculty of Medicine, University of Peradeniya, Sri Lanka

Adjunct professor, Texas Tech University, USA

Metabolic Syndrome



Obesity is an emerging problem in Asia

Obesity is a health problem in Sri Lanka

Jayawardana *et al. BMC Public Health* (2017) 17:27
DOI 10.1186/s12889-016-3963-3

BMC Public Health

RESEARCH ARTICLE Open Access

Lifestyle factors associated with obesity in a cohort of males in the central province of Sri Lanka: a cross-sectional descriptive study

N. W. I. A. Jayawardana[1], W. A. T. A. Jayalath[2], W. M. T. Madhujith[3], U. Ralapanawa[2], R. S. Jayasekera[4], S. A. S. B. Alagiyawanna[2], A. M. K. R. Bandara[5] and N. S. Kalupahana[6*]

Table 4 Prevalence (95% CI) of overweight and obesity according to BMI cut-offs for Asians

	Percent	CI
Overweight	31.8	29.68, 33.93
Obese	12.3	10.22, 14.46

CI confidence interval

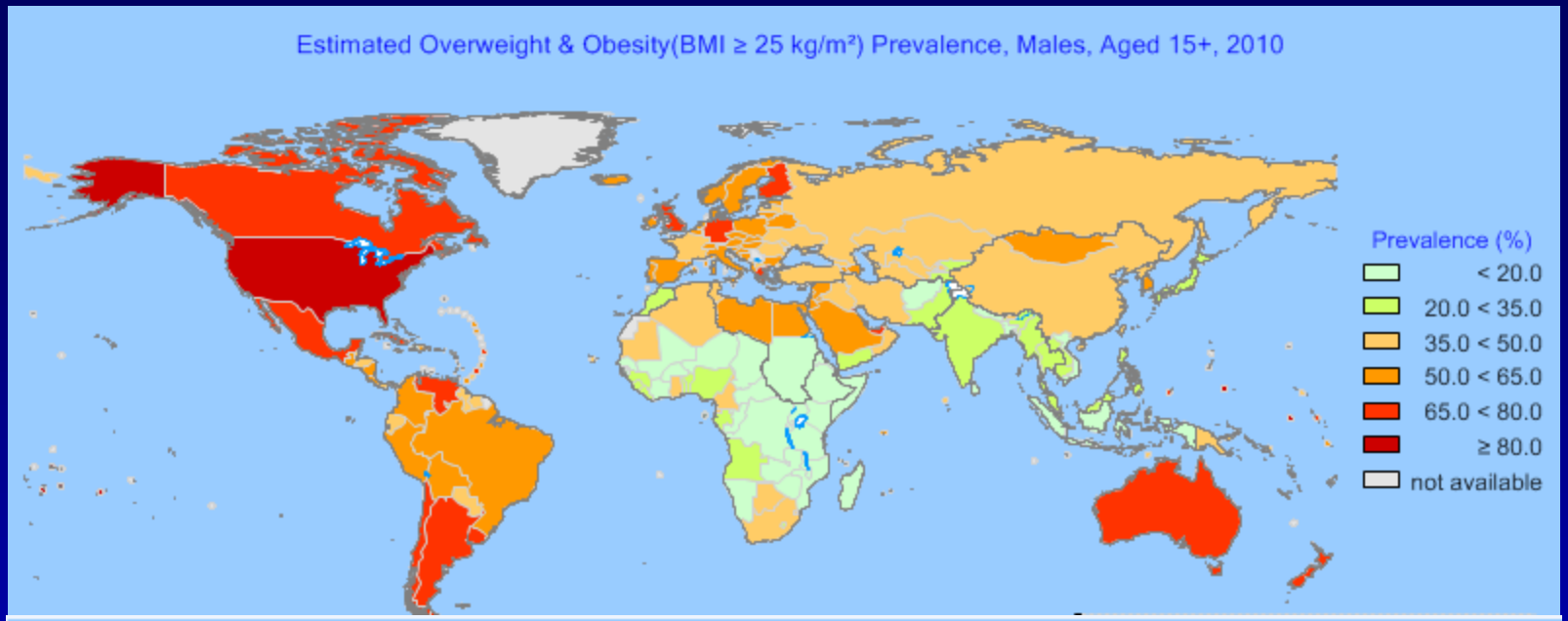
Sri Lanka: 44% (2017)

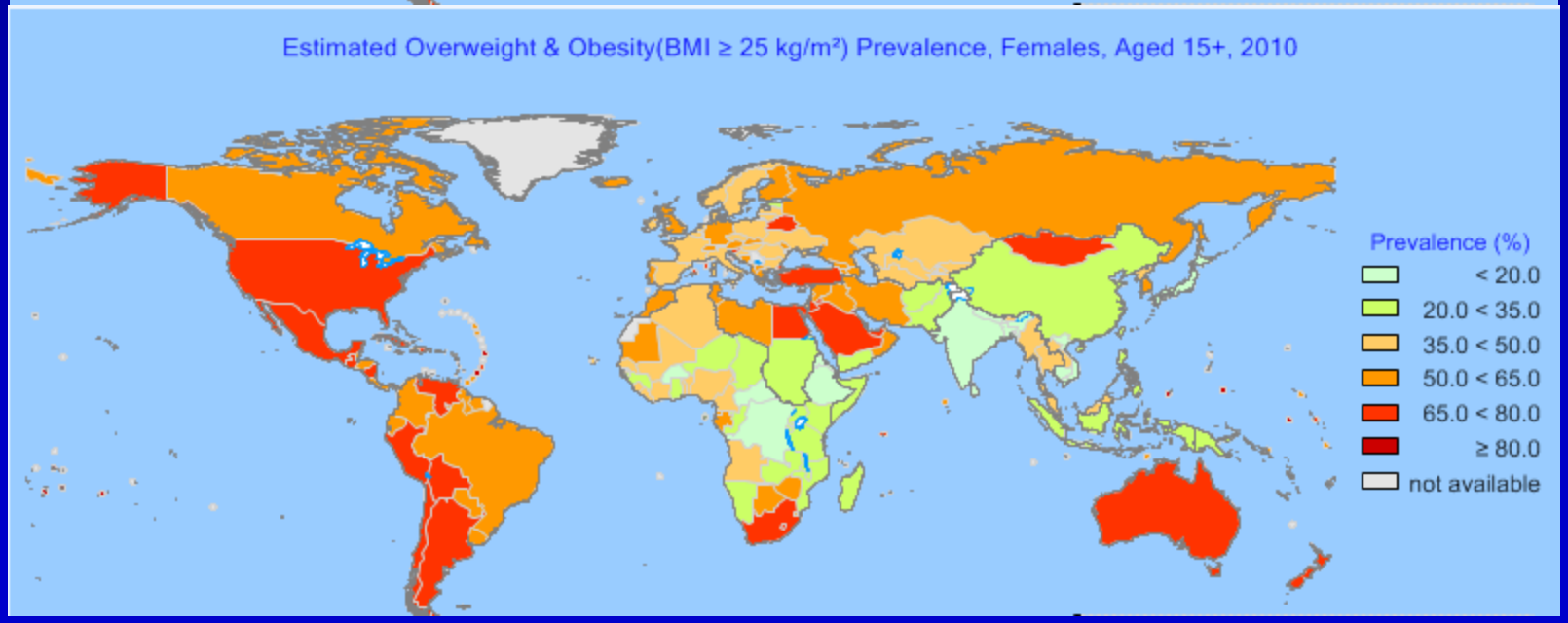
Obesity in India

Obesity		Abdominal Obesity
24.6	(Tamil Nadu)	26.6
16.6	(Maharashtra)	18.7
11.8	(Jharkhand)	16.9
31.3	(Chandigarh)	36.1

Pradeepa et al., Indian J Med Res. 2015

Obesity is a Global Health Problem





Source: World Health Organization global infobase

Prevalence of Metabolic Syndrome

USA – 22.9% (Sanchez et al., Journal of the American College of Cardiology, 2013)

China – 21.3% (Xi et al., Preventive Medicine, 2013)

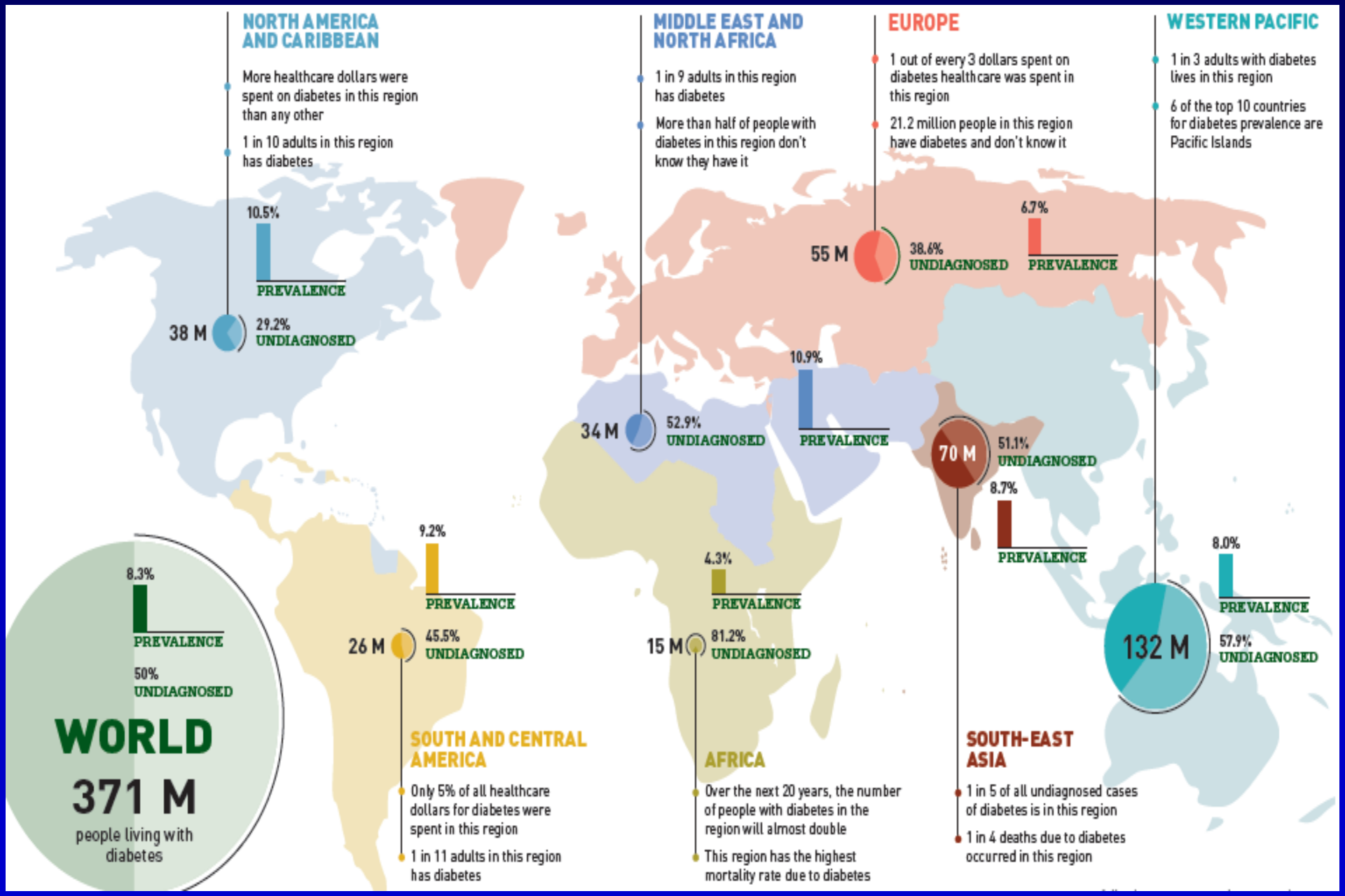
India – 31.6% (Gupta ., Int. J Cardiol, 2004)

Bangladesh (Urban) – 45% (Saquib et al., BMC Public Health, 2013)

Sri Lanka – 24.3% (Katulanda et al, Diabetol Met Syn, 2012)

Why do Asians have a similar / higher prevalence of metabolic syndrome compared to Western Populations, despite having a lower prevalence of obesity?

Diabetes Mellitus – A Global Challenge

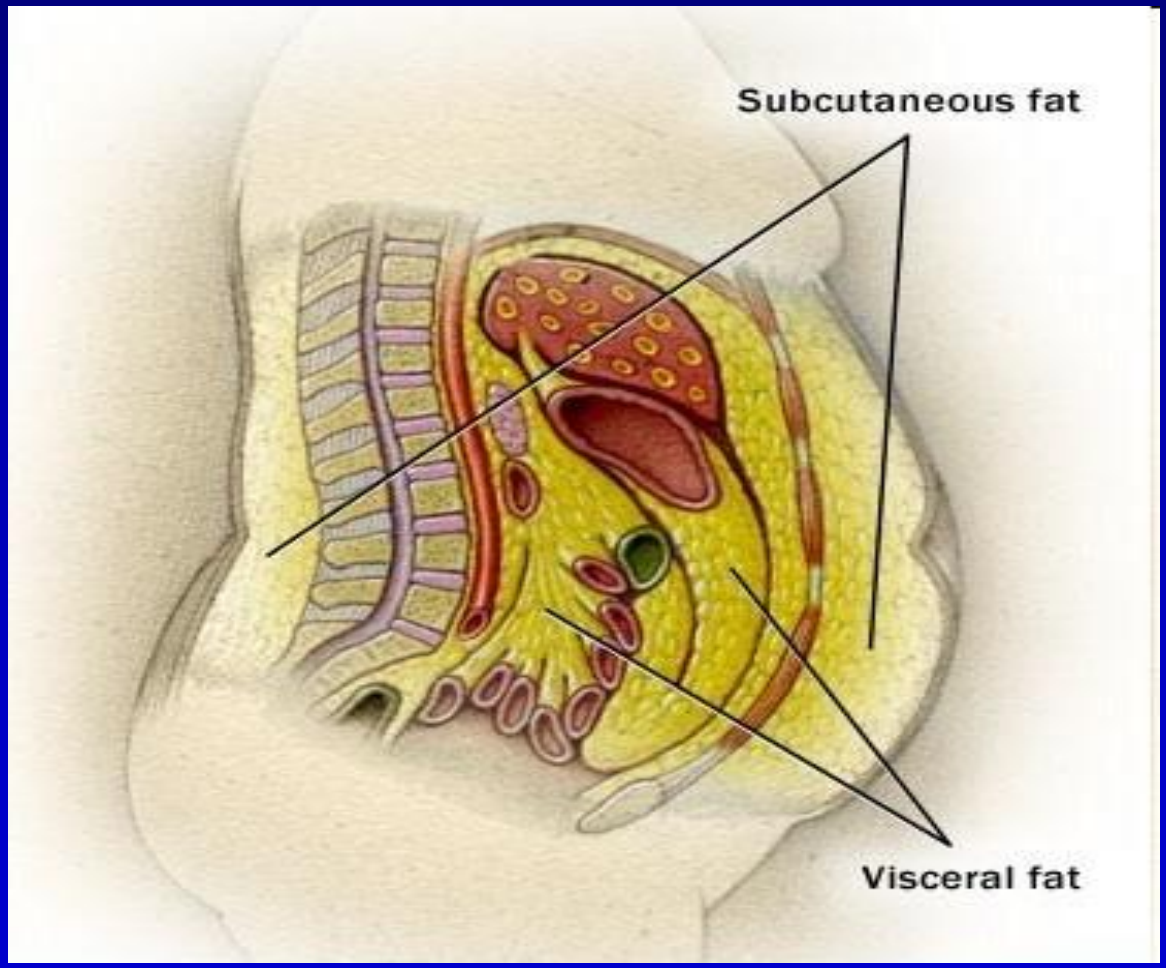


Outline

1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

Obesity

"Abnormal or excessive fat accumulation that may impair health" - WHO



Assessment - Body Mass Index (BMI)

BMI = Weight (kg) / Height^2 (m)^2

Normal: 18.5 - 24.9
Overweight: 25 – 29.9
Obese: >= 30

For Asians:
Normal: 18.5 - 22.9
Overweight 23 – 27.4
Obese ≥ 27.5

WHO, 2004

Consensus statement, 2009

Assessment - Body Mass Index (BMI)

BMI = Weight (kg) / Height^2 (m)^2

Normal: 18.5 – 22.9

Overweight: 23 – 24.9

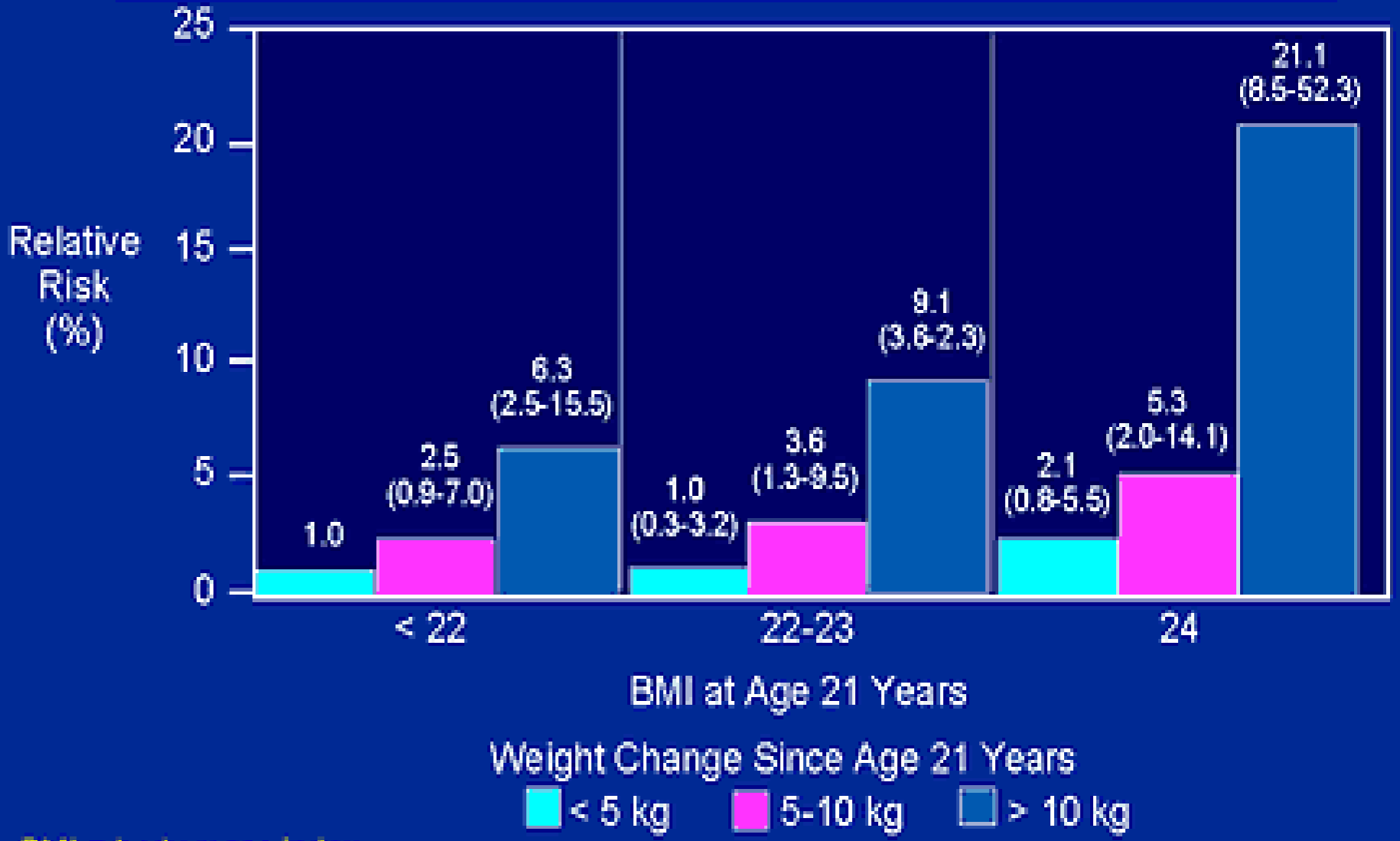
Obese ≥ 25

J Assoc Physicians India. 2009 Feb;57:163-70.

Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management.

Misra A[1], Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, Joshi SR, Sadikot S, Gupta R, Gulati S, Munjal YP; Concensus Group.

Weight Gain and Diabetes Risk



BMI = body mass index.

Chan JM et al. *Diabetes Care*. 1994;17:961-969.

Abdominal Obesity Cut-offs (for South Asians)

Waist Circumference :

≥ 90cm for men (35.4”)

≥ 80cm for women (31.5”)

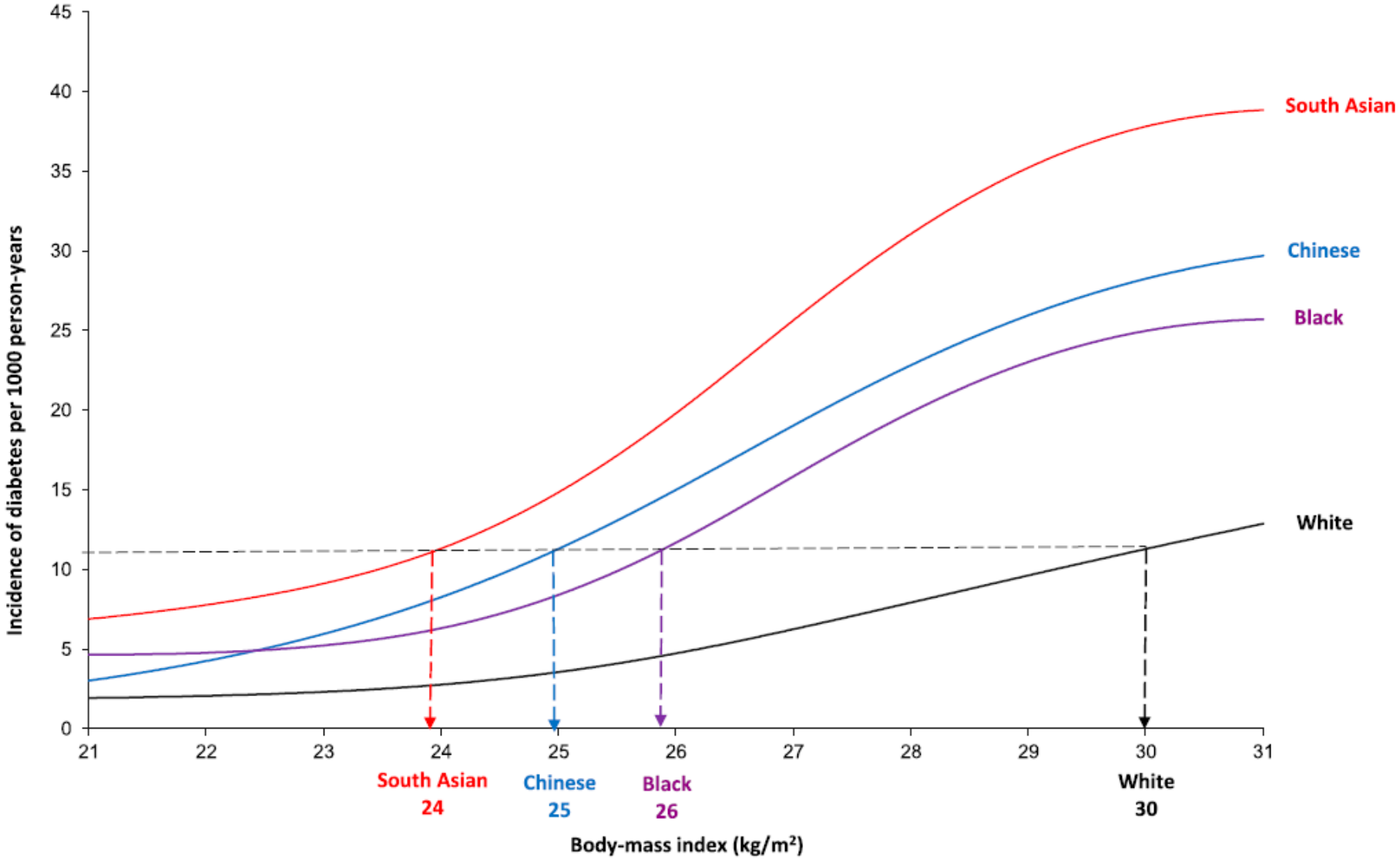
(Source: WHO, 2008)

Metabolic Syndrome (3 or more)

- Abdominal Obesity
- Triglycerides > 150mg/dl
- HDL Cholesterol
- - Men < 40 mg/dl
- - Women < 50 mg/dl
- Blood pressure > 130/85 mmHg
- Glycemia > 100mg/dl

Harmonizing the Metabolic Syndrome:
A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity

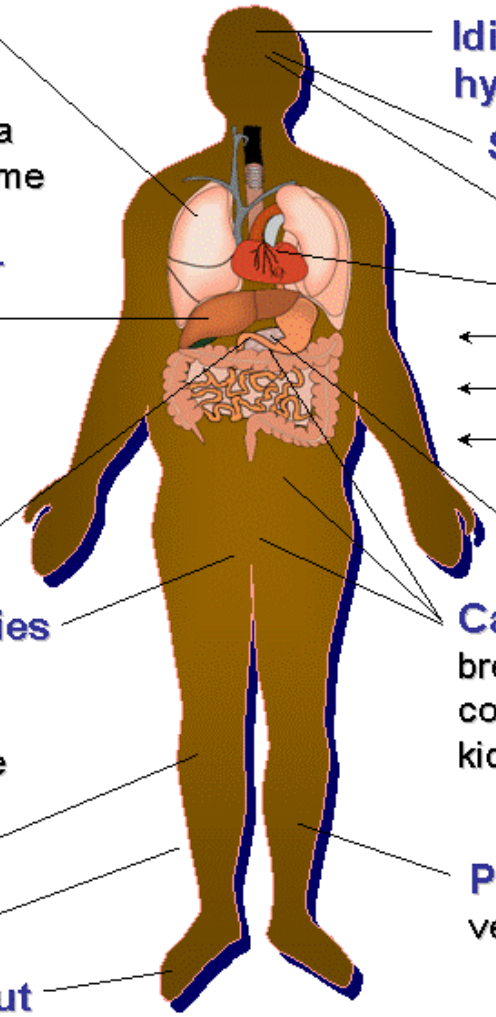
Obesity increases Diabetes Risk



Cohort study of 59,824 adults aged in Ontario, Canada. Followed for up to 12.8 years

Chiu et al., Diabetes Care, 2011

Co-morbidities 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

Outline

1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

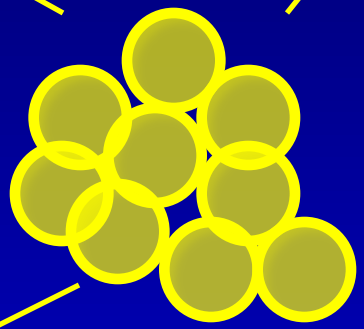
How does obesity lead to metabolic syndrome?

Metabolically Healthy

Metabolic Disorders

White adipose tissue stores energy

Pathophysiology of Metabolic Co-morbidities



Leptin

Halaas et al, *Science*, 1995

TNF-α

Hotamisligil et al, *Science*, 1993

Adiponectin

Liang et al, *JBC*, 1996

Agt / Ang II

Kalupahana et al., Obesity, 2012
Kalupahana et al., Obesity Reviews, 2011
Kalupahana et al., Crit Rev Bio Chem, 2012

IL-6

Mohamed-Ali al, *J Clin Endocrinol Metab*, 1997

MCP-1

Gerhardet et al, *Mol Cell Endocrinol*, 2001

PAI-1

van Hinsbergh et al, *Blood*, 1990

Visfatin

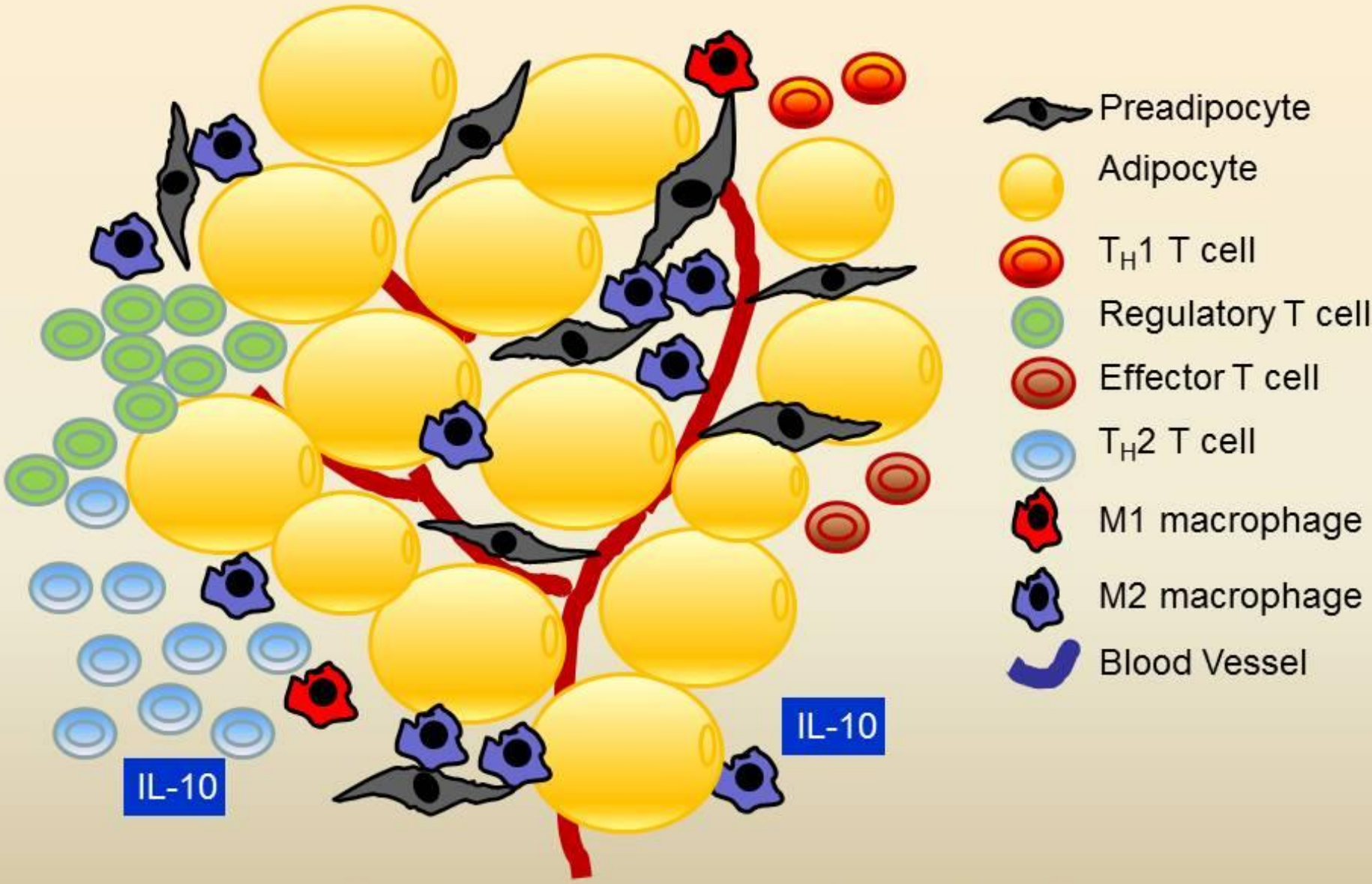
Fukuhara et al, *Science*, 2005

Resistin

Steppen et al, *Nature*, 2002

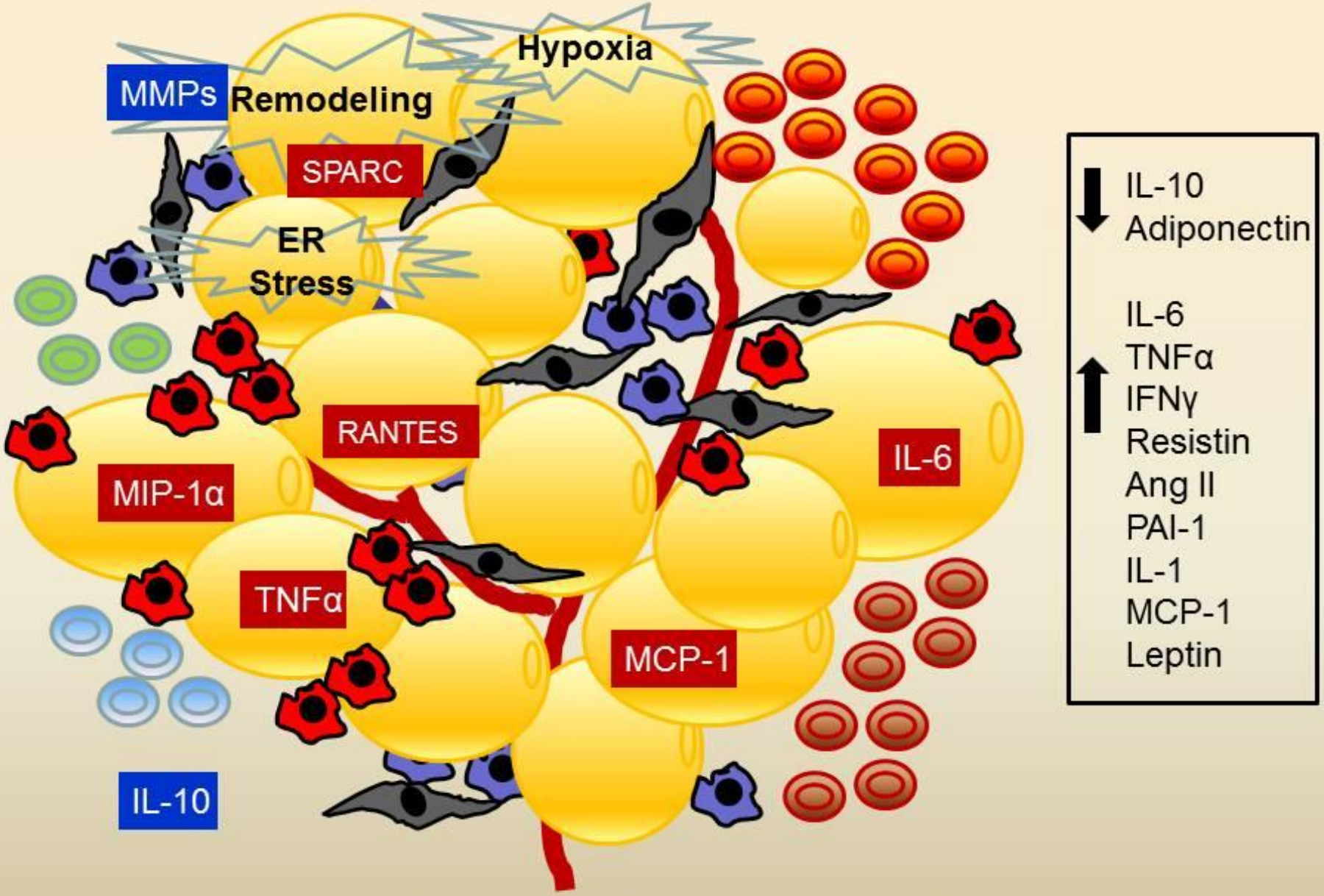
Adipocytokines

Adipose Tissue (Lean)



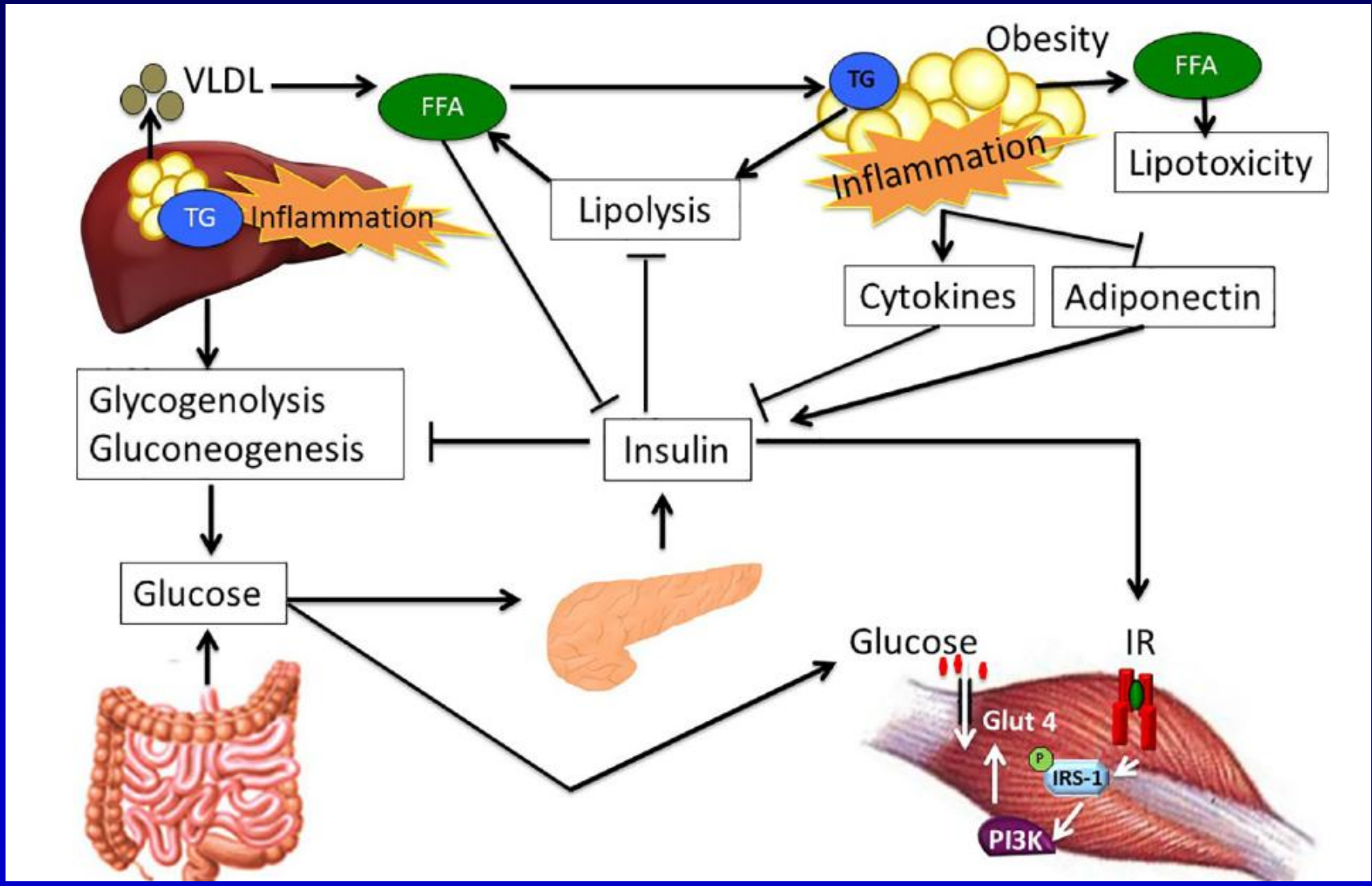
Kalupahana et al, *Advances in Nutrition*, 2011

Adipose Tissue (Obese)



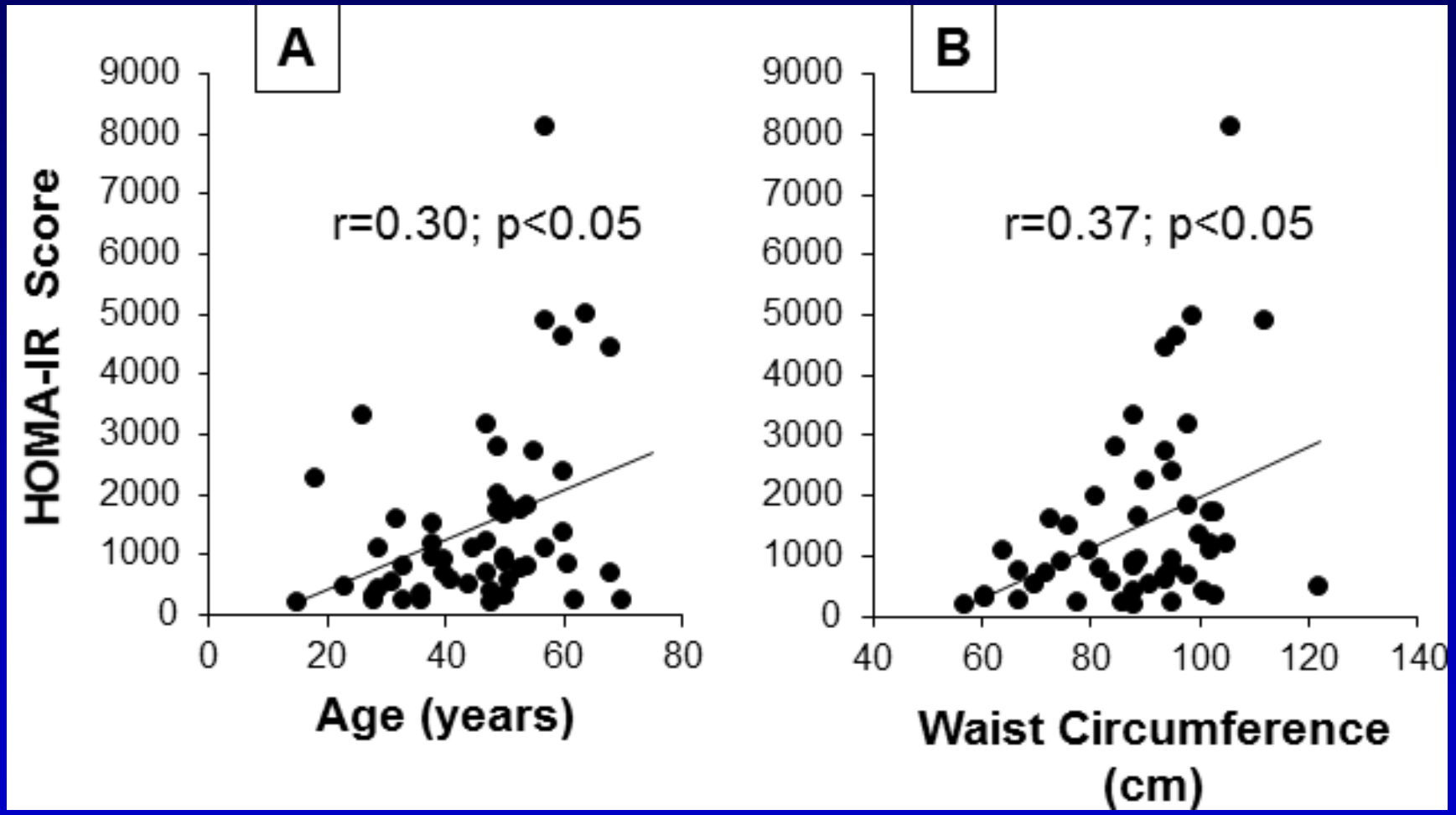
Kalupahana et al, *Advances in Nutrition,* 2011

Obesity and insulin resistance



Albracht and Kalupahana et al.,
Journal of Nutritional Biochemistry, 2018

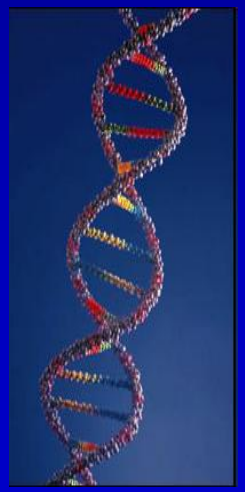
Obesity and insulin resistance

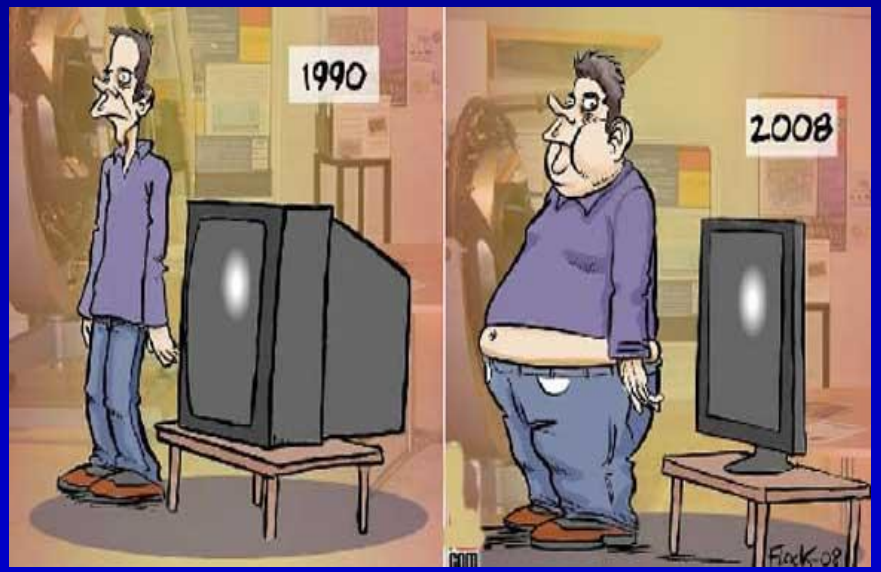


Wijetunga and Kalupahana et al.,
Nutrition and Diabetes, in press, 2018

Causes of Obesity

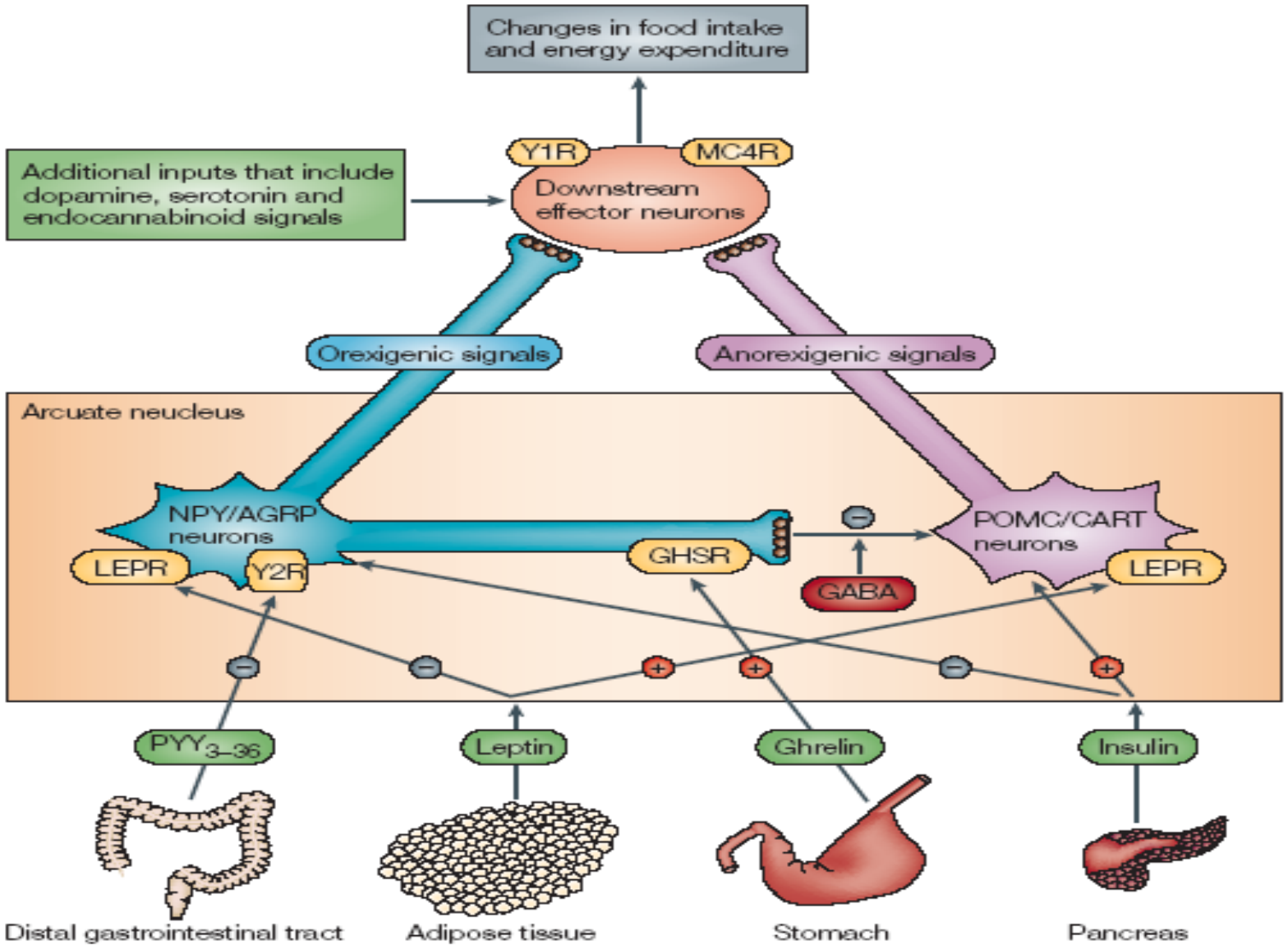
- Lifestyle
- Environmental
- Economic
- Genetic
- Medical causes
- Medications





Bell CG, Walley AJ, Froguel P. The genetics of human obesity. *Nat Rev Genet* 2005;6:221-34.

Physiological Regulation of Energy Balance



Bell CG, Walley AJ, Froguel P. The genetics of human obesity. *Nat Rev Genet* 2005;6:221-34.

Genetics of Obesity

1. Monogenic form of obesity

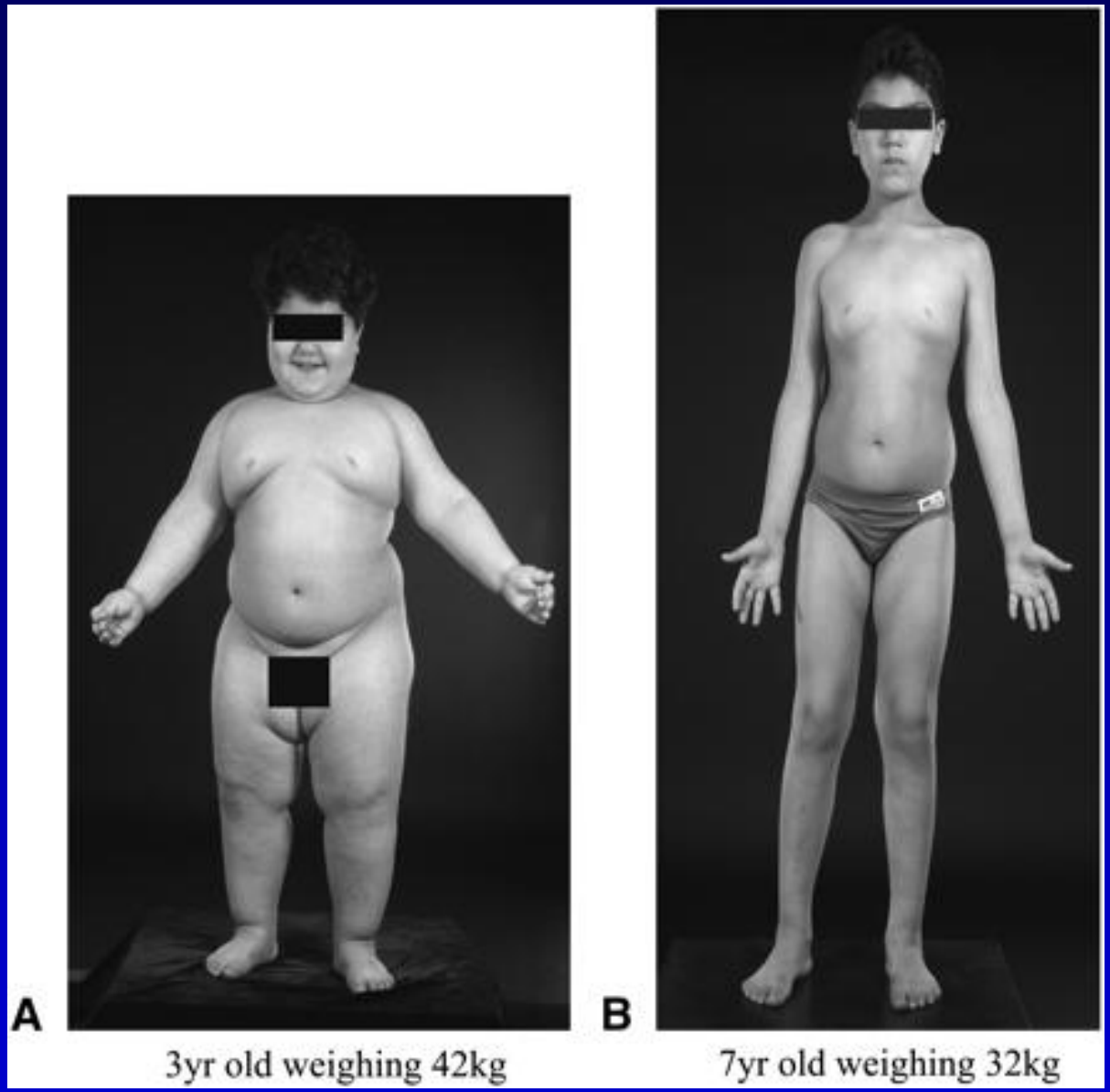
   e.g. leptin, leptin receptor, carboxypeptidase E, agouti, melanocortin 4 receptor, AGRP, POMC

2. Syndromic obesity

   e.g. Prader-Willi syndrome

3. Polygenic forms

Leptin and Obesity



Farooqi and O'Rahilly AJCN, 2008

Outline

1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

Management of the Obese Patient

- Weight loss
- Management of co-morbidities

Benefits of Weight loss

- Strong benefit in glycemic control

- Increases HDL and reduces TG and BP

- Improves fertility

- Resolves NAFLD

- Benefits on mechanical problems (osteoarthritis, back pain, nerve compressions etc.)

Lifestyle Interventions Summary

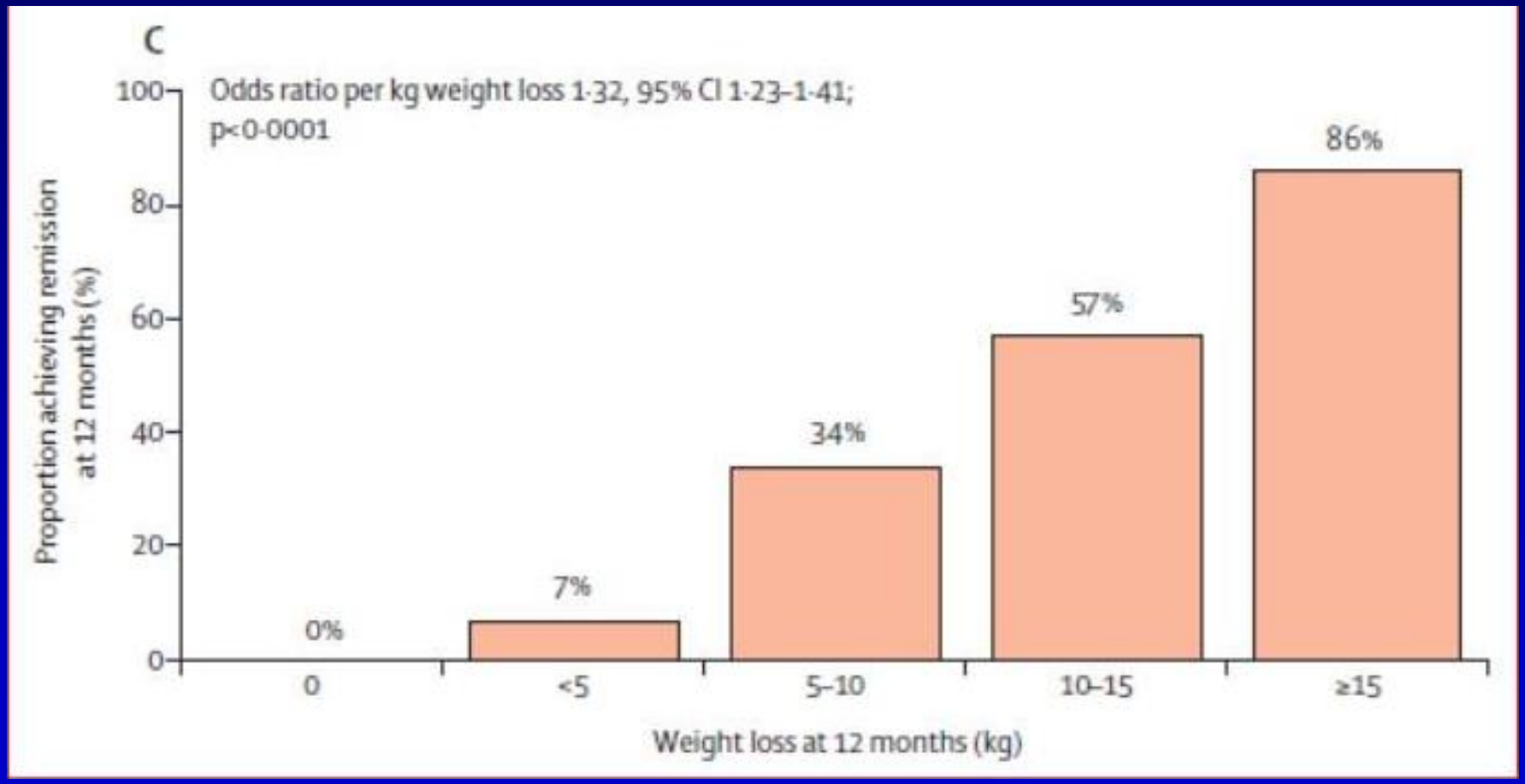
- Lifestyle intervention continues to have an effect; most drugs do not

Lifestyle

Study		N	Intervention	Treatment	Risk Reduction
Da Qing	IGT	577	Lifestyle	6 years 20 years	**34% - 69%**
Finnish DPS	IGT	523	Lifestyle	3+ years 7 years	**58%**
DPP	IGT	3324	Lifestyle	3 years	**58%**

Diabetes Care. 1997;20:537-544; *N Engl J Med*. 2002;344:1343-1350; *N Engl J Med. 2002*;346;393-403; *Diabetes Care*. 2011;34:1265-1269; *Lancet*. 2002;359(9323): 2072-2077 *N Engl J Med*. 2011;364:1104-1115.

Reversal of Diabetes by Weight Loss (DiRECT Trial)



Lean et al., *Lancet*, 2017

Overweight / Obesity Management Guidelines

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

2013 AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society

Michael D. Jensen, Donna H. Ryan, Caroline M. Apovian, Jamy D. Ard, Anthony G. Comuzzie, Karen A. Donato, Frank B. Hu, Van S. Hubbard, John M. Jakicic, Robert F. Kushner, Catherine M. Loria, Barbara E. Millen, Cathy A. Nonas, F. Xavier Pi-Sunyer, June Stevens, Victor J. Stevens, Thomas A. Wadden, Bruce M. Wolfe and Susan Z. Yanovski

Circulation. published online November 12, 2013;

Overweight / Obesity Management Guidelines

- **Measure** height and weight and calculate **BMI annually** or more frequently

- Advise overweight and obese adults that the **greater the BMI, the greater the risk of CVD, type-2 diabetes, and all-cause mortality**

- Measure **waist circumference annually** or more frequently in overweight and obese adults

Jensen et al, *Circulation*, 2013

Who should lose weight?

- Overweight + 1 or more CVD risk factors

(diabetes, pre-diabetes, hypertension, dyslipidemia, elevated waist circumference)

or

- Obese

- If normal weight or overweight without CVD risk factors – avoid weight gain

Jensen et al, *Circulation*, 2013

Weight loss - Steps

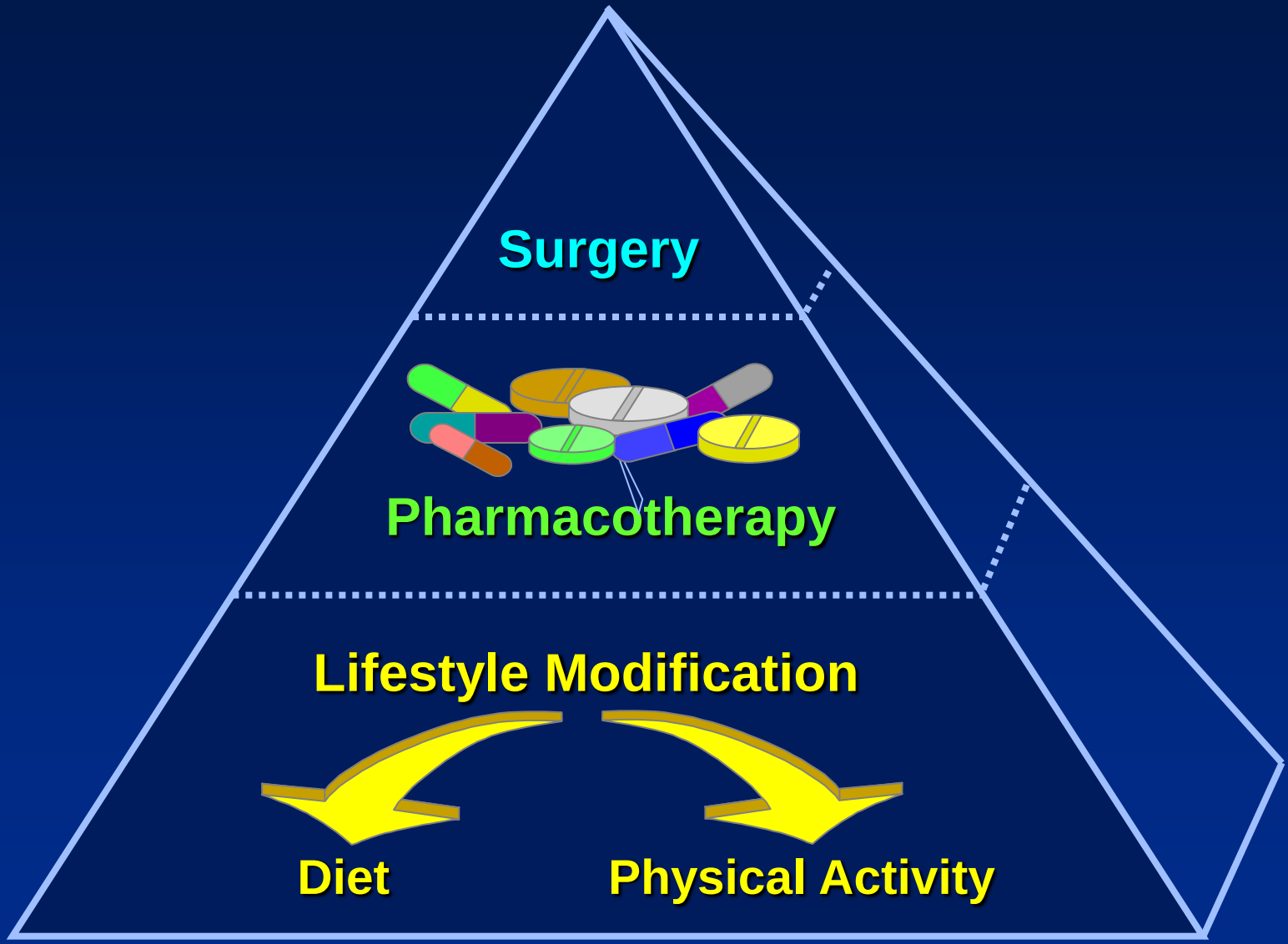
- Assess Readiness to Make Lifestyle Changes
- Goal: **5% to 10%** of baseline weight in **6 months**
- 500 kcal/day or 750 kcal/day energy deficit
- Comprehensive lifestyle intervention, preferably with a trained interventionist or nutrition professional

Jensen et al, *Circulation*, 2013

Outline

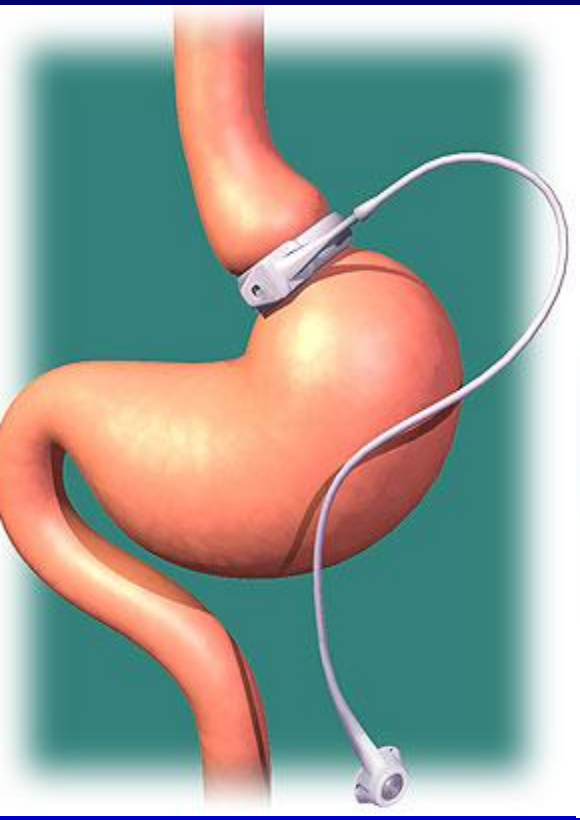
1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

Obesity Treatment Pyramid

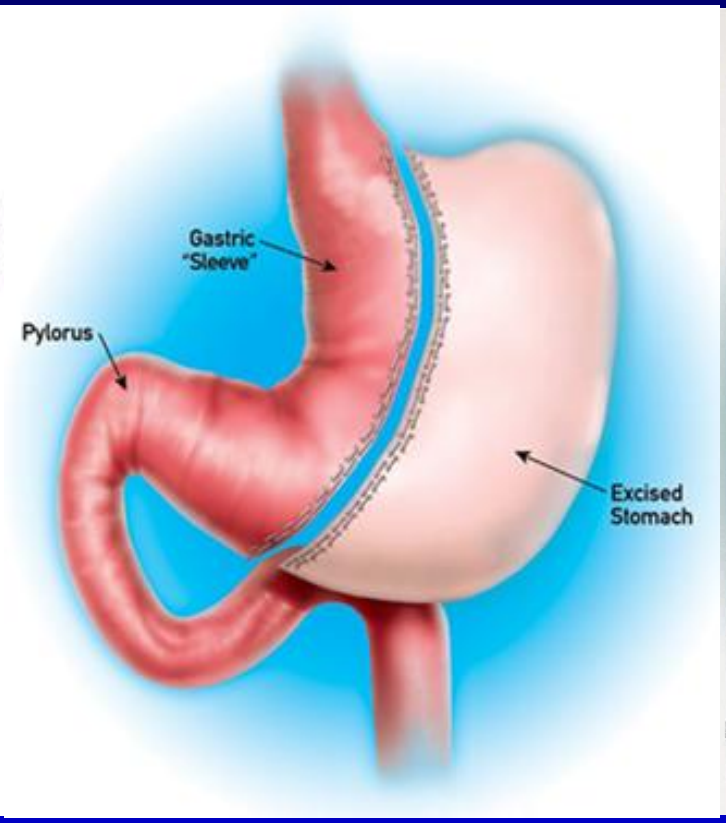


Surgical Management

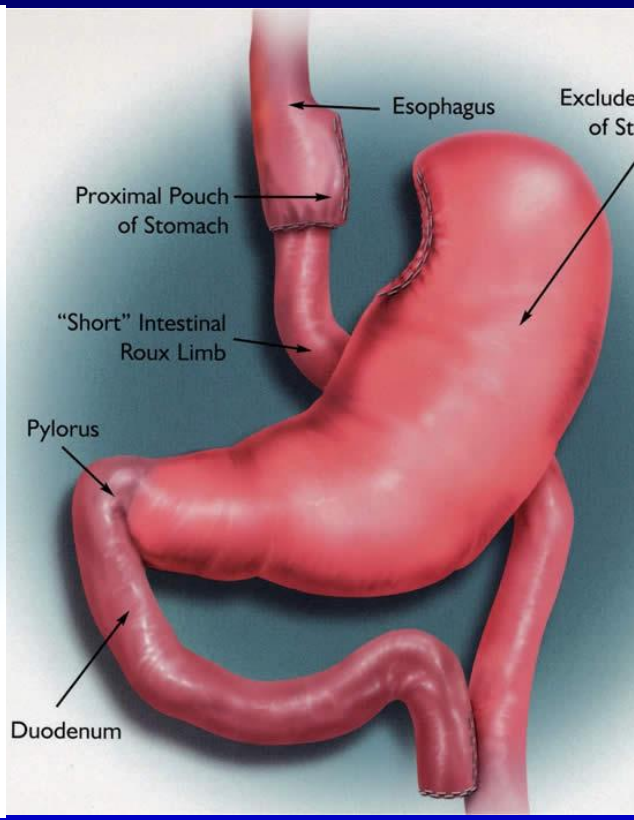
Lap Band



Sleeve Gastrectomy



Gastric Bypass



Low — Effectiveness — High

Risk

Pharmacotherapy

- Central Acting : Phentermine
- Local Acting: Orlistat
- Combination therapy:
  - phentermine + topiramate
- “Off-label” use: Metformin

The Washington Post

TUESDAY, MAY 7, 1996

HEALTH

Sorry, Cathy, The New Diet Drug Won't Work All By Itself

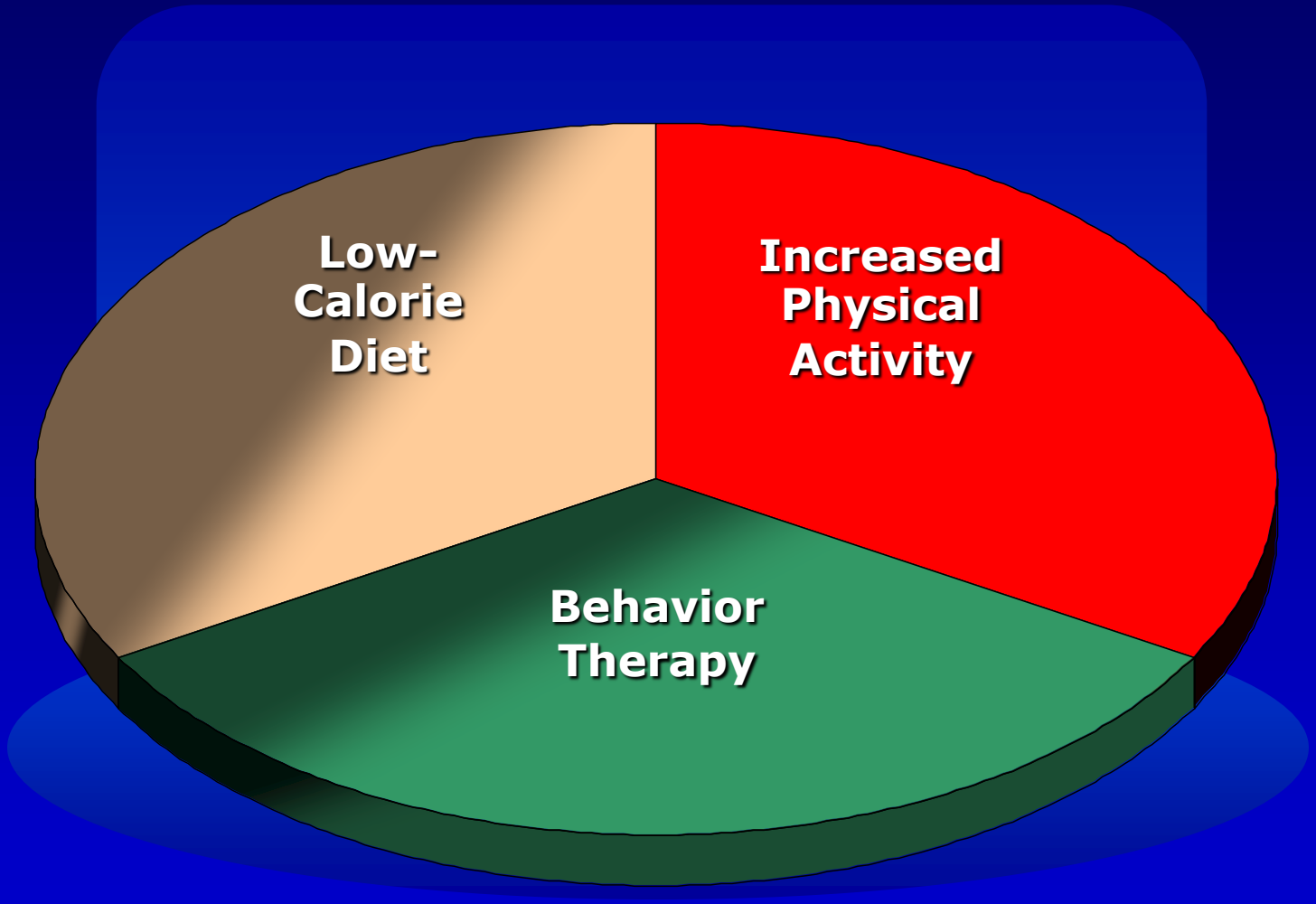
(You Still Have to Exercise and Watch What You Eat)

■ Winemakers Want New Labels To Tout Health Benefits

■ Is Detoxification Counterproductive For Some Psychiatric Patients?

■ Any Way You Slice It, The Onion's Got Appeal

Lifestyle Modification

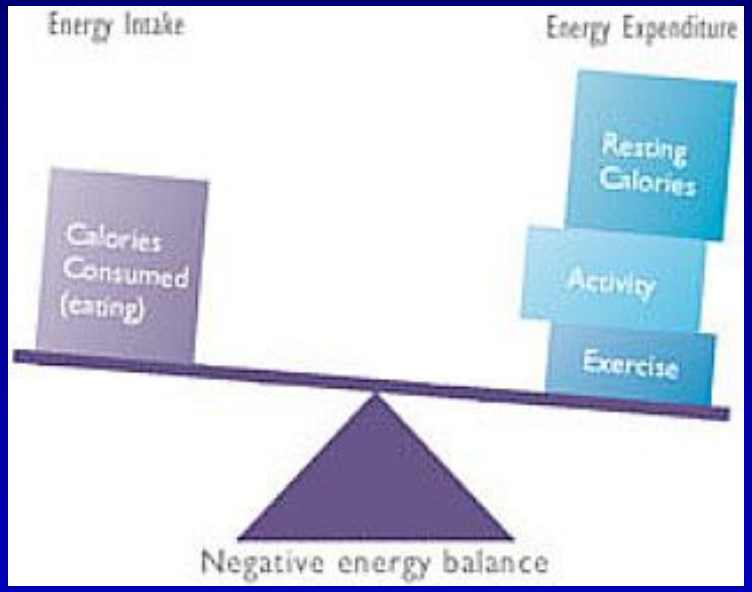


Outline

1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

Dietary Interventions to treat Obesity

1. Low-calorie diet



fitness.ksc.nasa.gov/articles/metabolism.php

2. Macronutrient composition:

- Low-fat diets
- Low carbohydrate diets

Diets of Varying Macronutrient Composition

1. Zone diet: Proteins, favorable carbohydrates, and fats in a ratio of 30-40-30

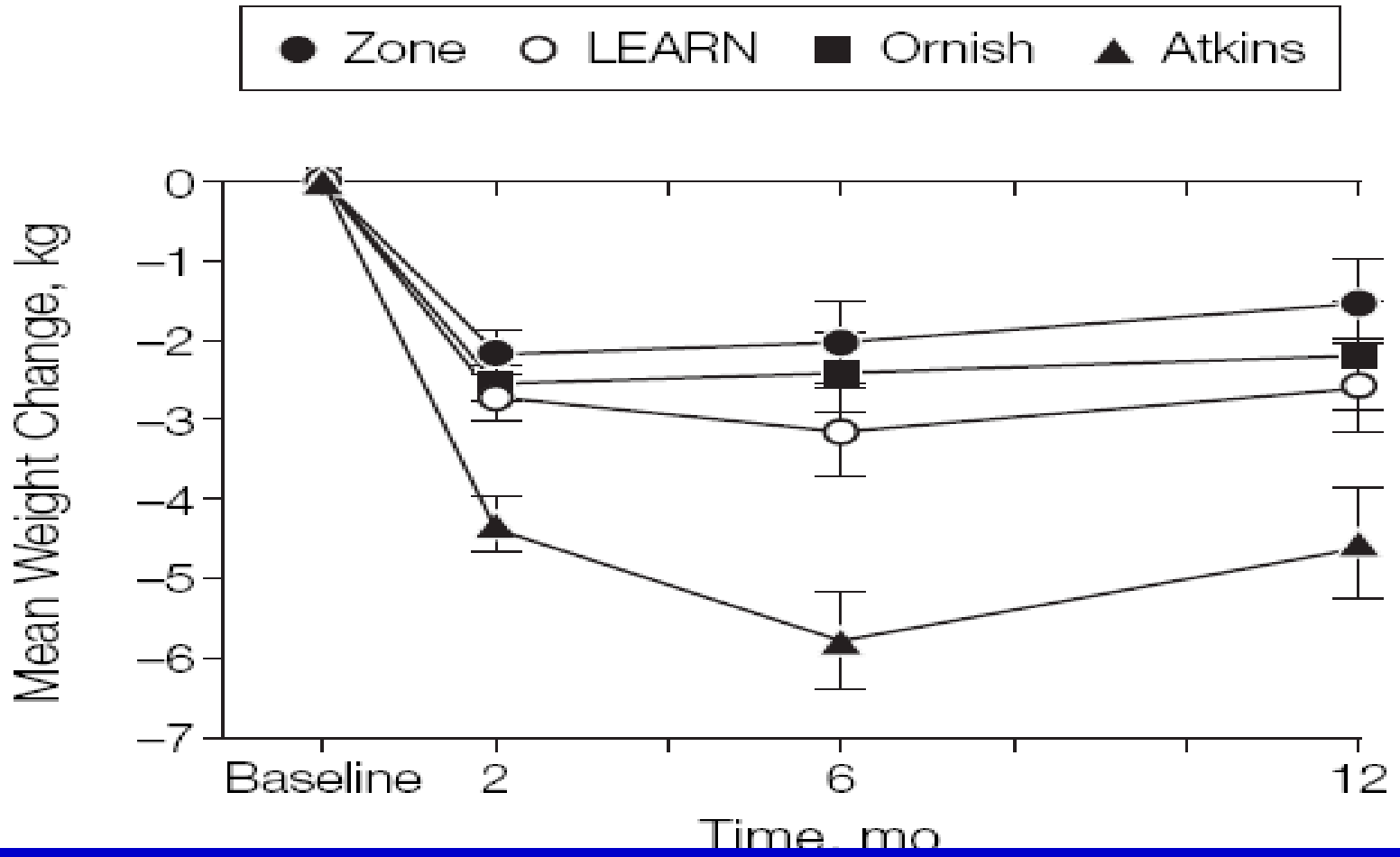
2. LEARN diet - 55% to 60% energy from carbohydrate and less than 10% energy from saturated fat. LEARN stands for Lifestyle, Exercise, Attitudes, Relationships, and Nutrition

3. Atkin's diet: <20g of carbohydrates per day

4. Ornish diet: <10% calories from fat – vegan diet

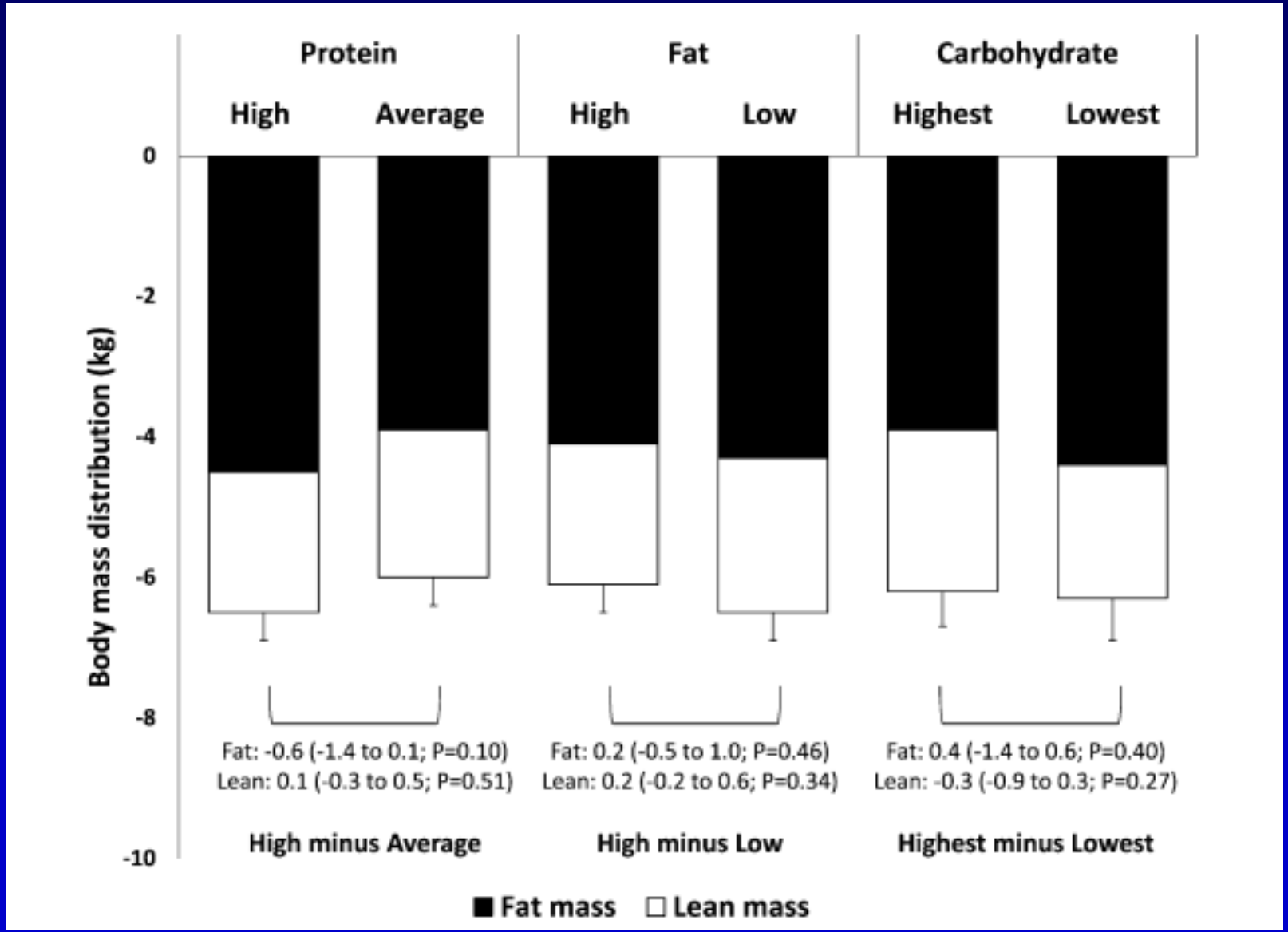
Effects of Macronutrient Composition on Weight Loss

Figure 2. Weight Change Relative to Baseline



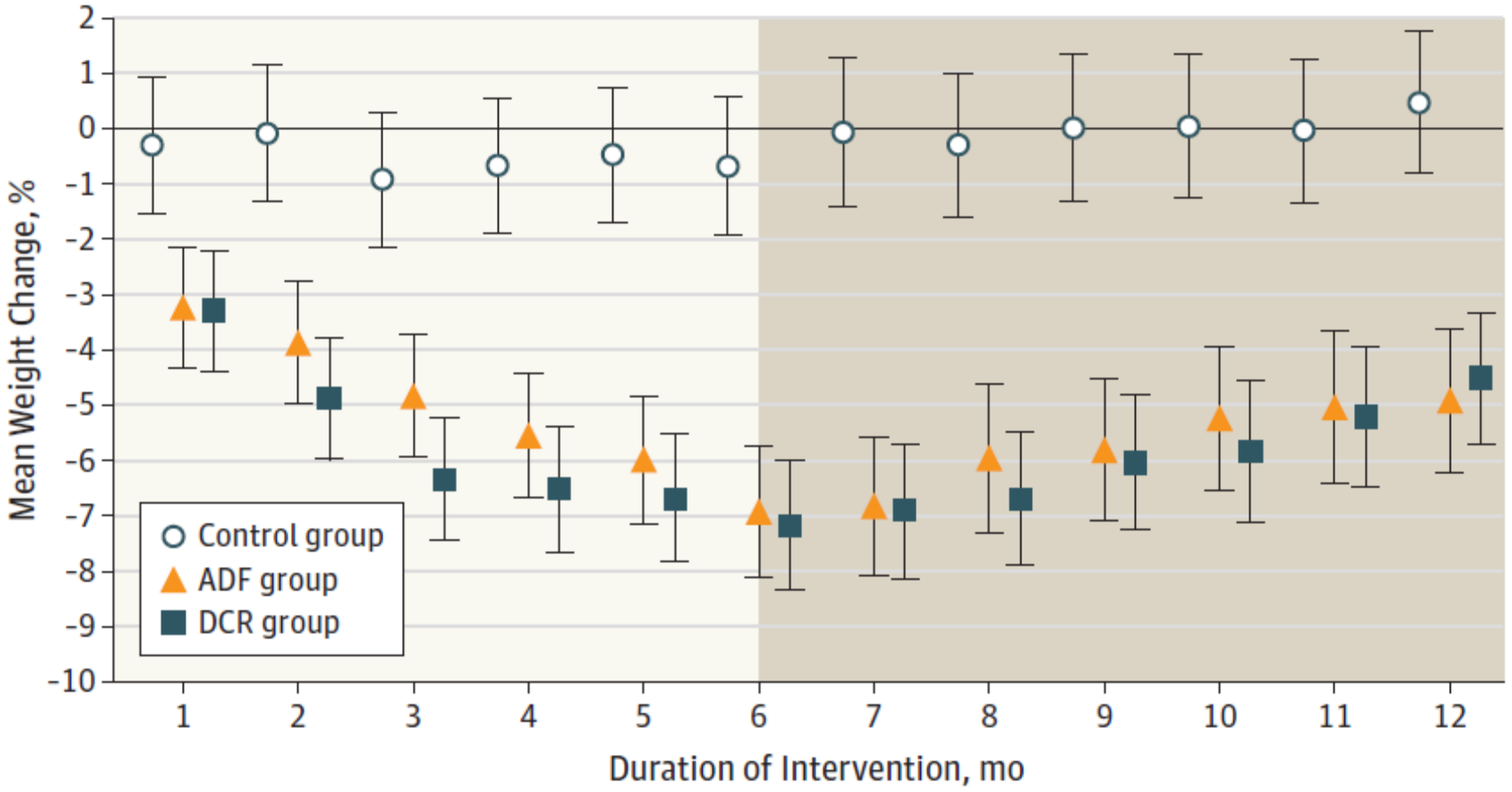
Gardner et al. Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women: the A TO Z Weight Loss Study: a randomized trial. JAMA. 2007 Mar 7;297(9):969-77

Energy Restriction is More Important Than Macronutrient Composition for Weight Loss



Souza et al., *American Journal of Clinical Nutrition*, 2012

Alternate day fasting



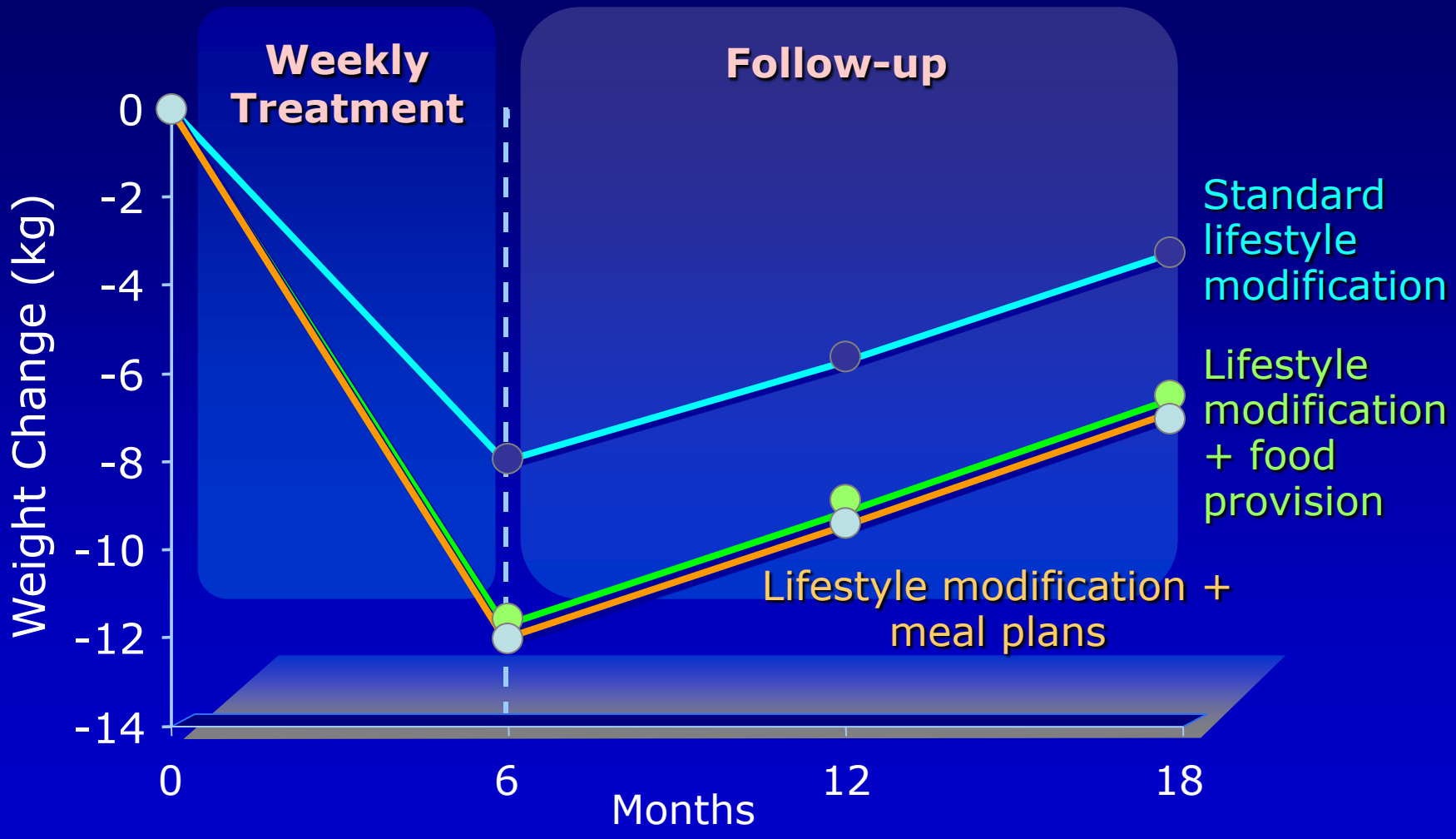
JAMA Internal Medicine | Original Investigation

Effect of Alternate-Day Fasting on Weight Loss, Weight Maintenance, and Cardioprotection Among Metabolically Healthy Obese Adults

A Randomized Clinical Trial

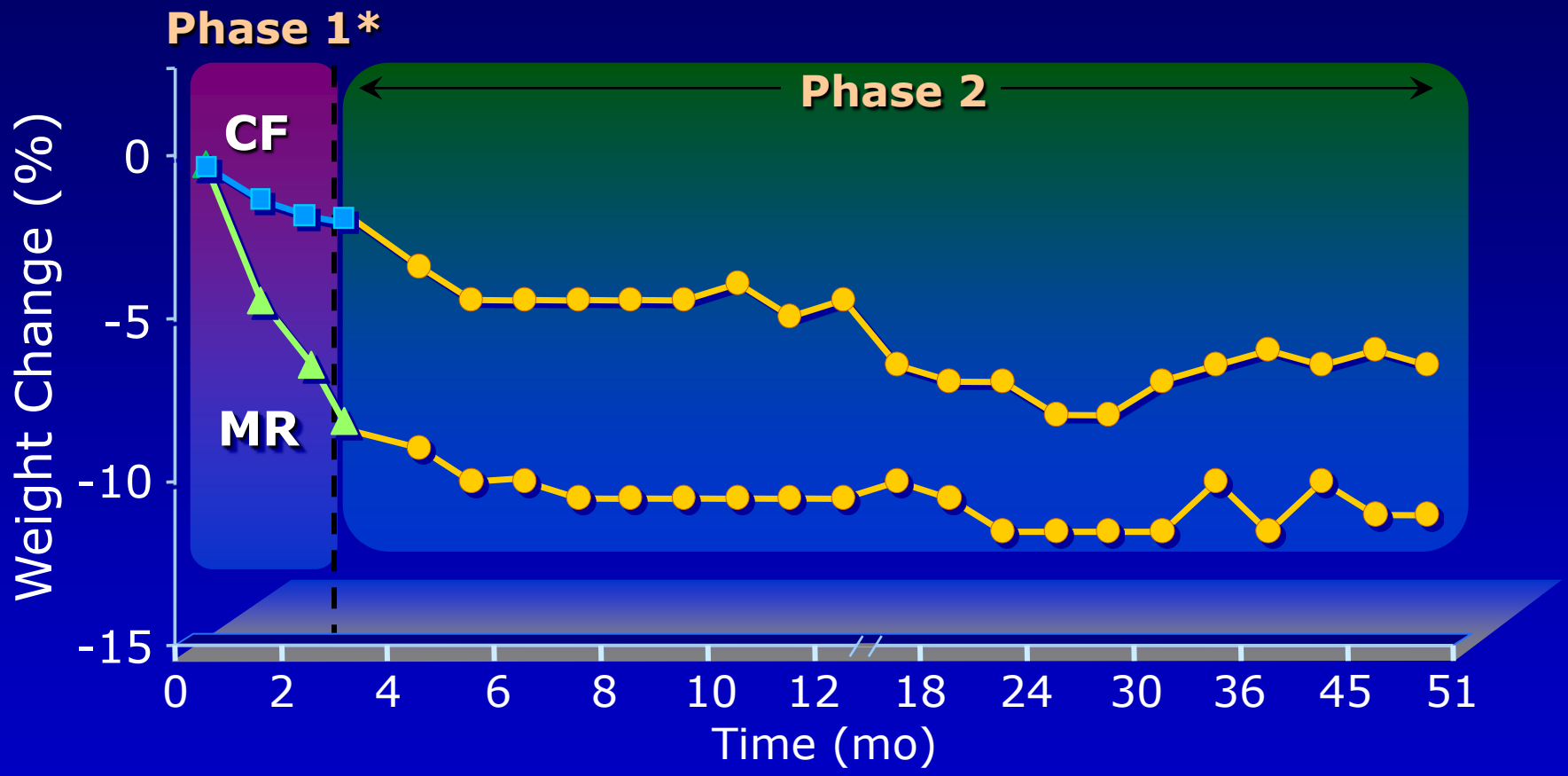
John F. Trepanowski, PhD; Cynthia M. Kroeger, PhD; Adrienne Barnosky, MD; Monica C. Klempel, PhD; Surabhi Bhutani, PhD; Kristin K. Hoddy, PhD, RD; Kelsey Gabel, MS, RD; Sally Freels, PhD; Joseph Rigdon, PhD; Jennifer Rood, PhD; Eric Ravussin, PhD; Krista A. Varady, PhD

Structured Meal Plans Enhance Weight Control



Wing RR, et al. *Int J Obes Relat Metab Disord.* 1996;20:56-62.

Meal Replacements Enhance Initial and Long-Term Weight Loss



*1200–1500 kcal/d diet prescription
CF = conventional foods; MR = replacements for 2 meals, 2 snacks daily;

Reproduced with permission from Ditschuneit HH, et al. *Am J Clin Nutr.* 1999; 69:198-204 and from Fletchner-Mors M, et al. *Obes Res.* 2000;8:399-402.

Very low calorie diet - DiRECT Trial

Randomised trial at 49 primary care practices in Scotland and England

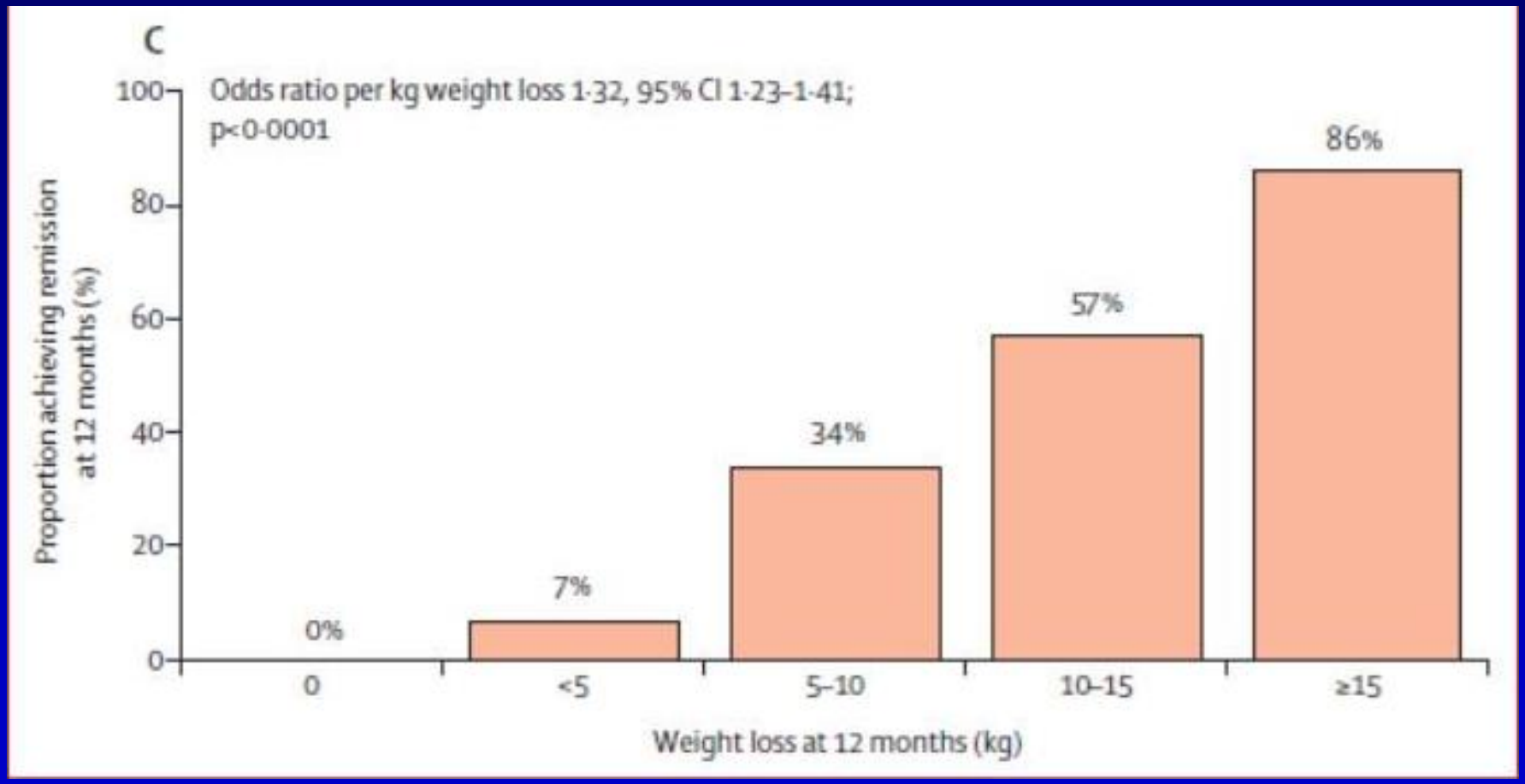
Inclusion criteria

- 20–65 years old
- T2DM diagnosis ≤ 6 years
- BMI 27–45 kg/m^2
- HbA1c ≥6.0%
  - If ≤ 6.5%, still on ADM

Intervention

- Total meal replacement (825-853 kcal/day) for 3 m
- Low energy diet (59% CH/13% F/26% P/2% Fibre) – extended to 5 months
- Food reintroduction: 2–8 weeks (≈50% CHO, 35% F, 15% P) + increased physical activity (15,000 steps/day)

Reversal of Diabetes by Weight Loss (DiRECT Trial)



Lean et al., *Lancet*, 2017

Physical Activity Recommendations

Minimize sedentary time

Moderate-intensity physical activity 150 min / wk (2.5 hours)

300min / wk for weight loss

Strength training twice a week

Behavior Therapy

Goal-setting

- Weight-loss goal
- Physical activity goal

Self monitoring

- Body weight
- Food diary

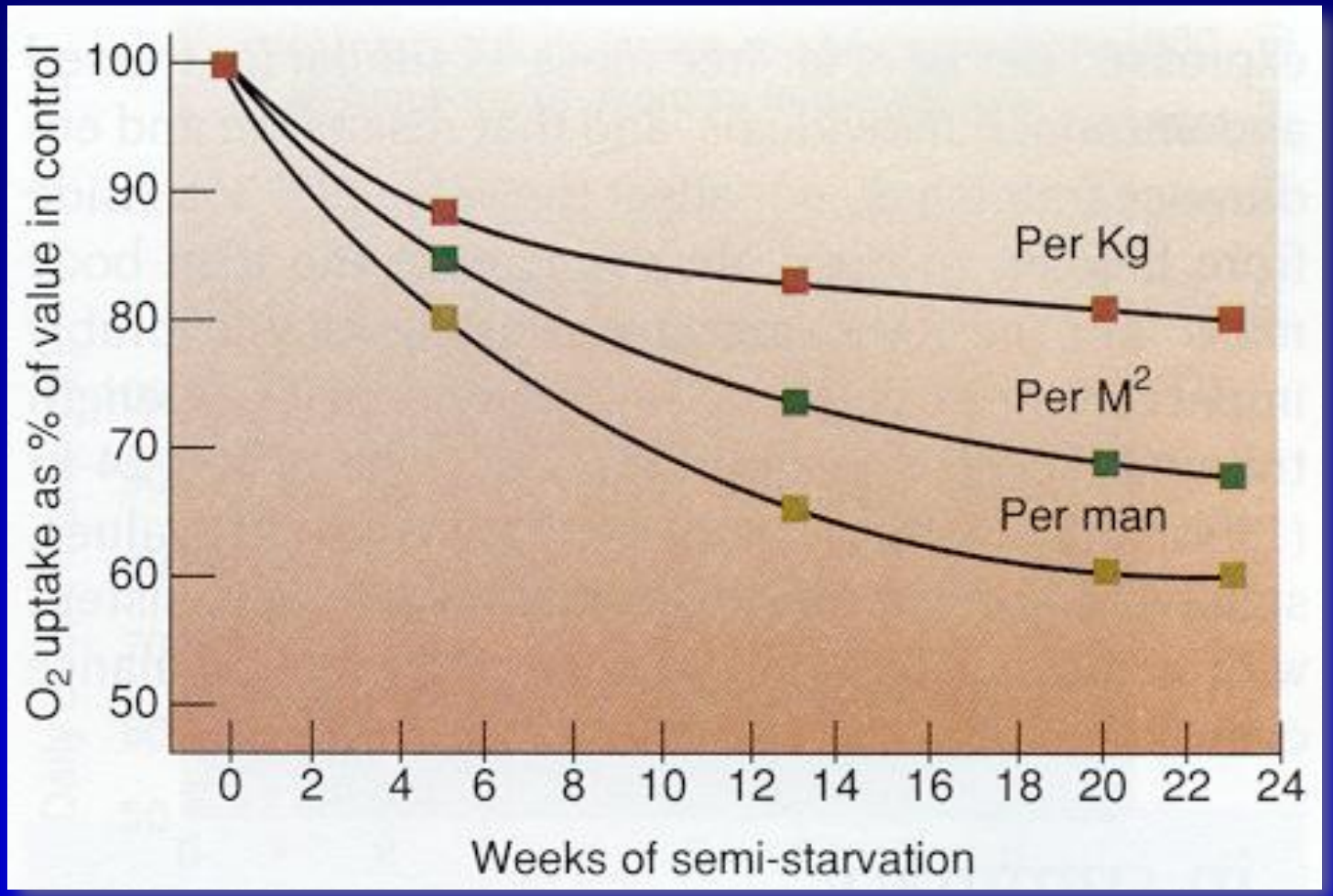
Stimulus control, stress management, coping strategies

Exercise and Weight Loss

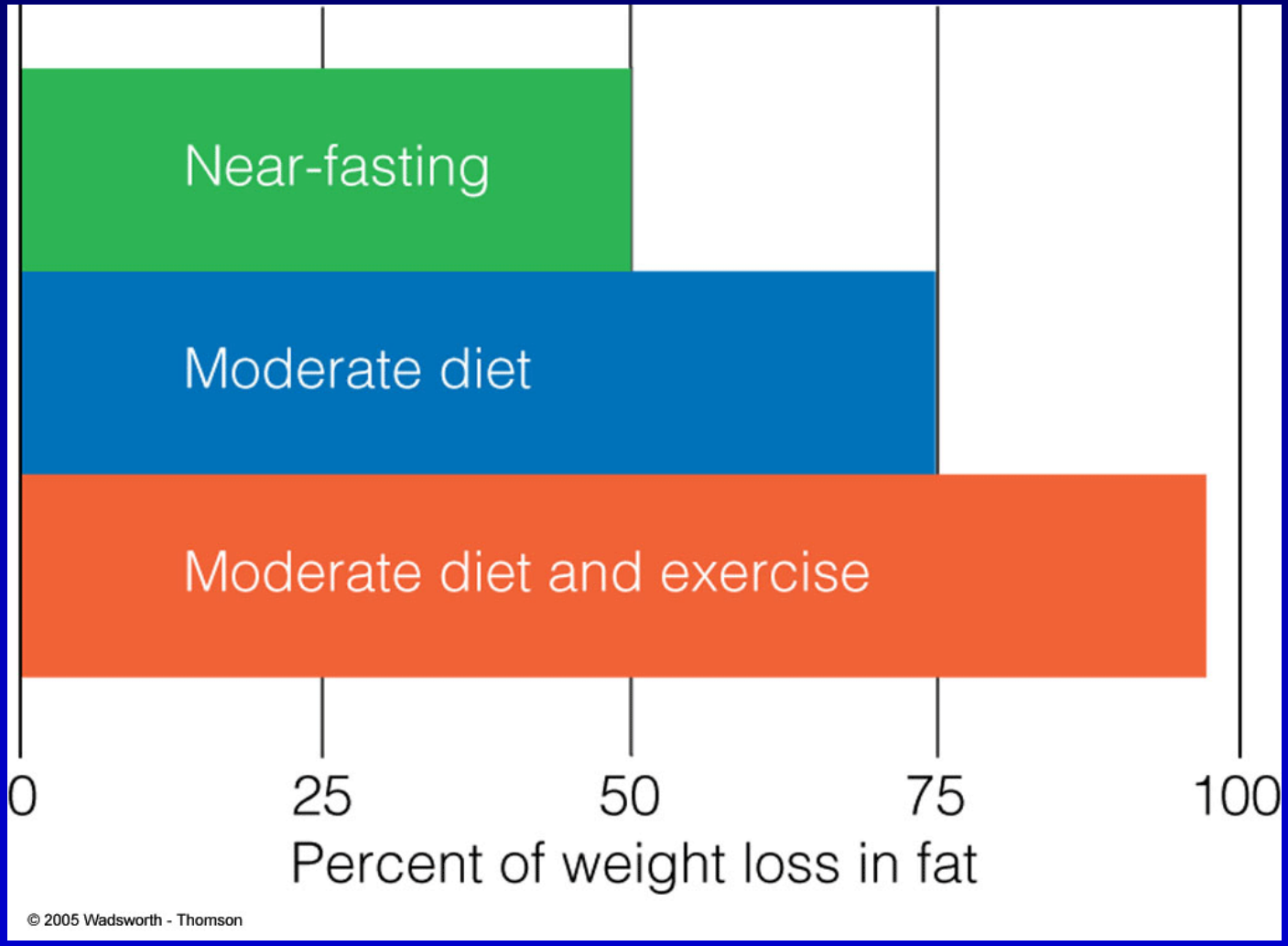
- Exercise may be most critical to help maintain weight loss

- Exercise helps to maintain muscle mass and metabolic rate

Caloric Intake and Resting Metabolic Rate



Effects of Types of Diet and Exercise on Weight Loss



Physical activity recommended for MOST days of week

- **Adult recommendations vary by goal:**
  - **Reduce risk of chronic disease: 30 minutes of moderate intensity**
  - **Manage weight and prevent weight gain: 60 minutes of moderate to vigorous activity**
  - **Sustain a weight loss: 60 to 90 minutes of moderate to vigorous activity**
- **Children and teens: 60 minutes**

Ways to increase physical activity

Take stairs instead of the escalator

Park your car at a distance

Sedentary Behavior and Mortality

Sedentary Behavior and Mortality

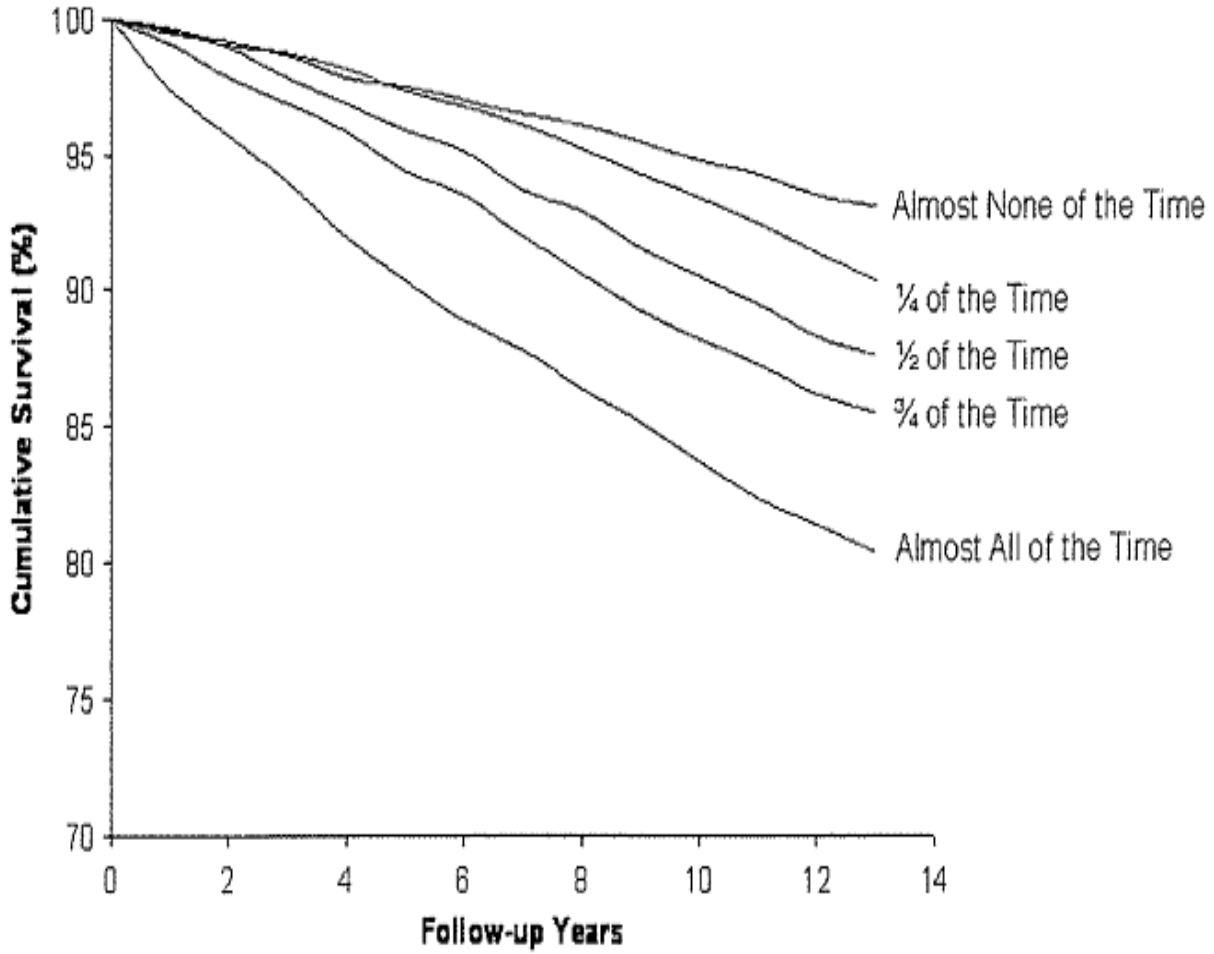
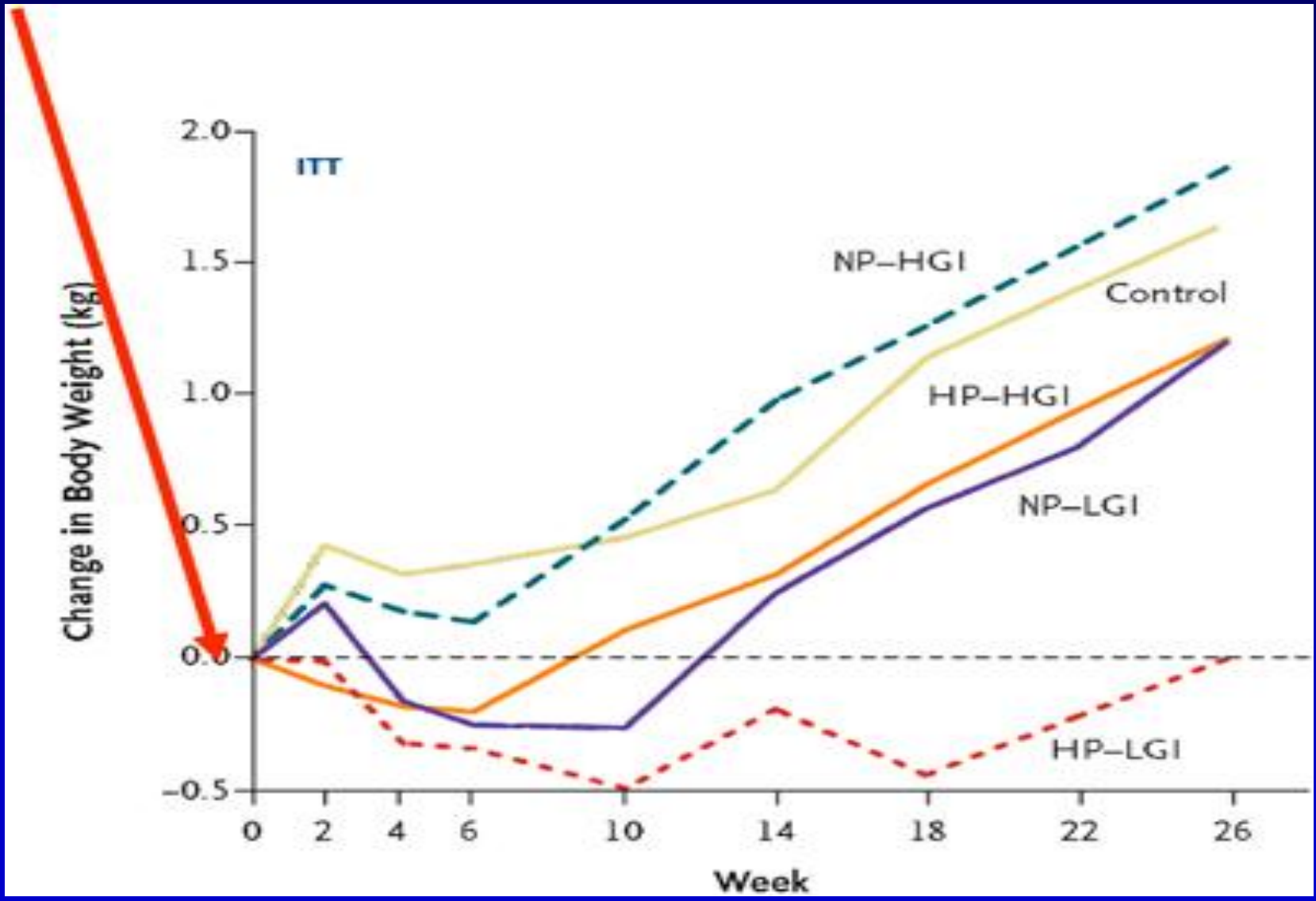


FIGURE 1—Kaplan–Meier survival curve for all-cause mortality across categories of daily sitting time in 17 ,013 men and women 18–90 yr of age, in the Canada Fitness Survey, 1981–1993. Log-rank $\chi^2 = 174.4$, $df = 4$, $P < 0.0001$. The sample sizes across the categories were 3022 (17.8%), 6652 (39.1%), 4379 (25.7%), 2138 (12.6%), and 822 (4.8%), for the categories of almost none of the time, one fourth of the time, half of the time, three fourths of the time, and almost all of the time, respectively.

Outline

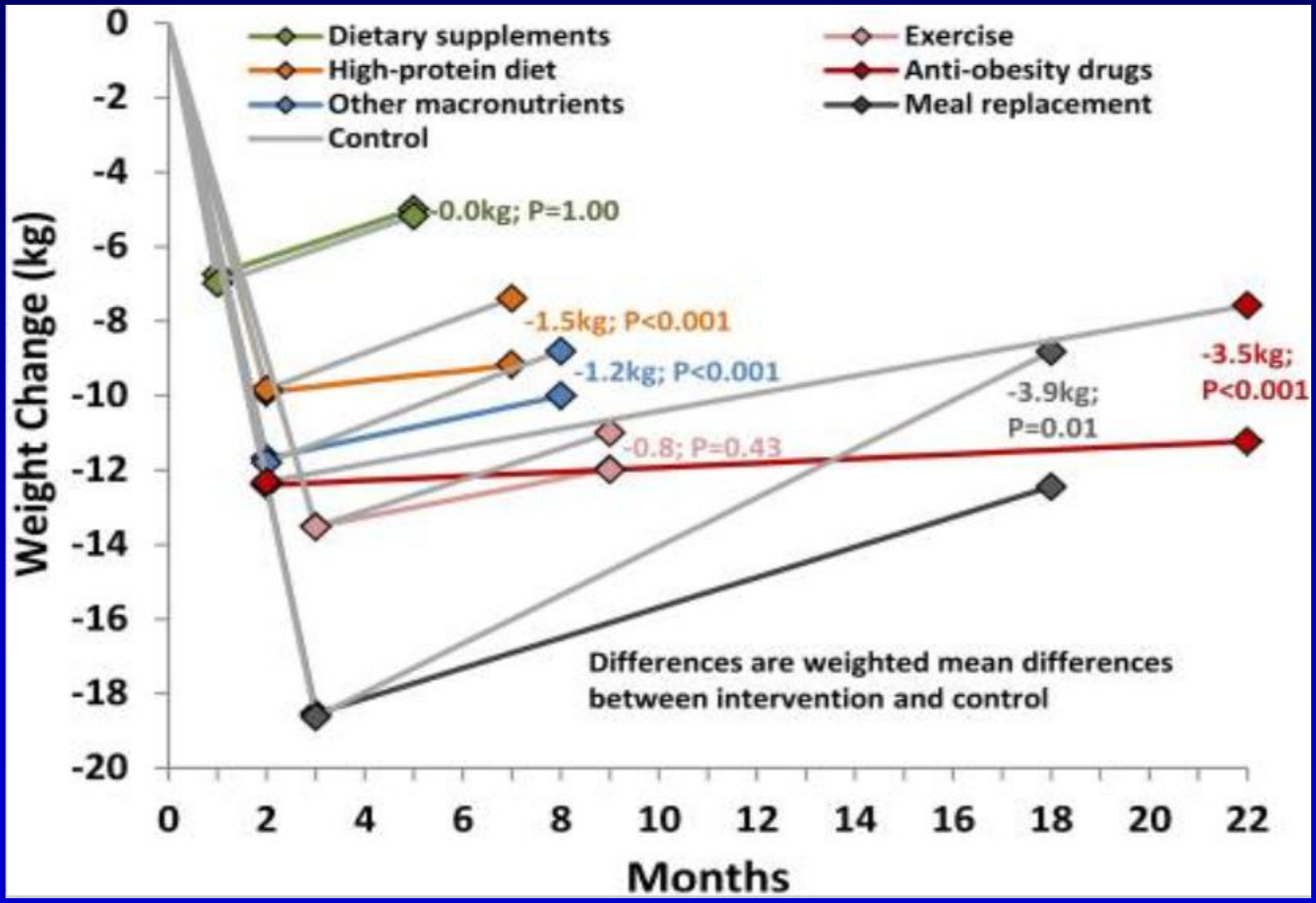
1. Diagnostic criteria for obesity and metabolic syndrome
2. Pathophysiology of obesity, insulin resistance and metabolic syndrome
3. Benefits of weight loss - evidence
4. Management strategies of obesity and metabolic syndrome
5. Dietary management of metabolic syndrome
6. Weight loss maintenance

High-protein Diets are More Effective in Weight Loss Maintenance – Diogenes Study



Larsen et al, *New England Journal of Medicine*, 2010

Meal replacements, anti-obesity drugs and high-protein diets for weight loss maintenance



Johansson et al., *American Journal of Clinical Nutrition*, 2014

Weight loss maintenance

Predictors of long-term weight loss success:

- Engaging in high levels of physical activity
- Eating a diet that is low in fat and calories
- Eating breakfast
- Self-monitoring
- Maintaining a consistent eating pattern
- Catching "slips" before they turn into larger regains

Wing R and Phelan S, Am J Clin Nutr, 2005

Prevention of Childhood Obesity

- Calculate, chart and classify BMI for all children 2-18 yrs at least yearly
- Promote breastfeeding
- Diet and physical activity:

  – **5** Five or more servings of fruits and vegetables per day
  – **2** Two or fewer hours of screen time per day, and no television in the room where the child sleeps
  – **1** One hour or more of daily physical activity
  – **0** No sugar-sweetened beverages

Summary

- Obesity and metabolic syndrome are global public health problems of epidemic proportions

- Adipose tissue dysfunction is a link between obesity and its metabolic co-morbidities

- There is strong evidence for benefits of weight loss in improving metabolic comorbidities in obese individuals

- Intensive lifestyle modification is the mainstay in weight management

- Meal replacements are an effective way of achieving energy restriction and weight loss

Thank You !