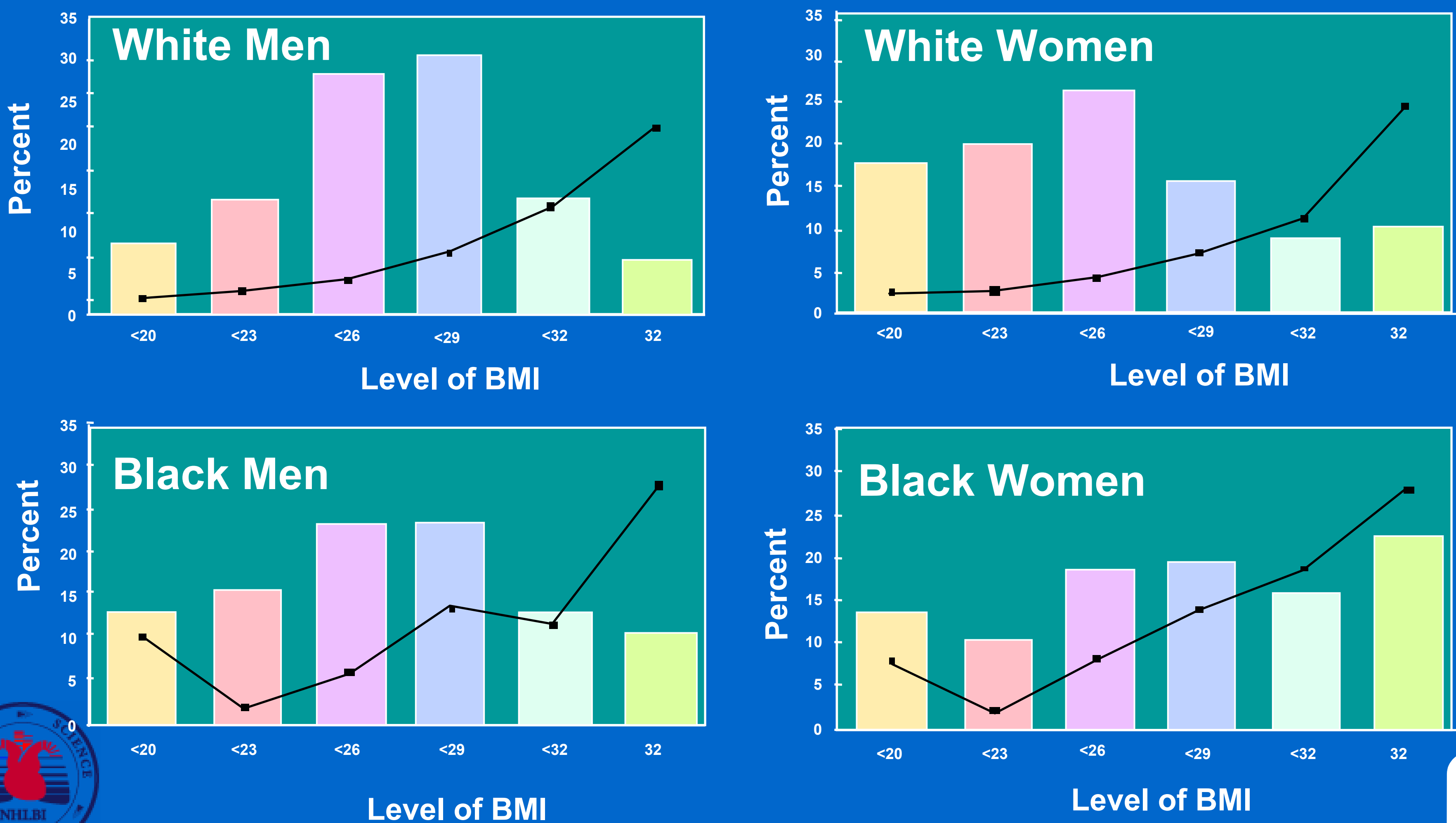
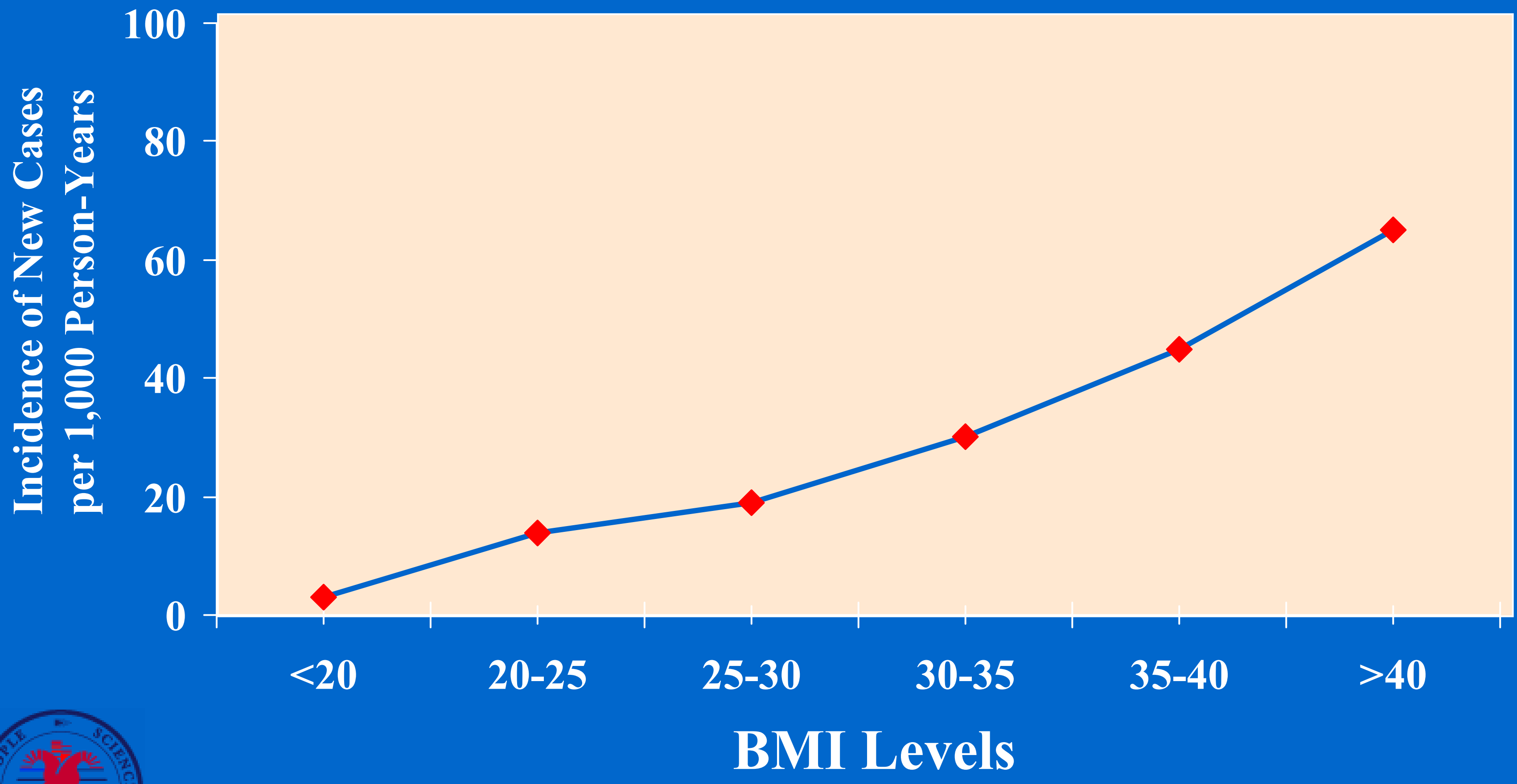
Baseline BMI and Age-Adjusted Incidence of Diabetes Mellitus



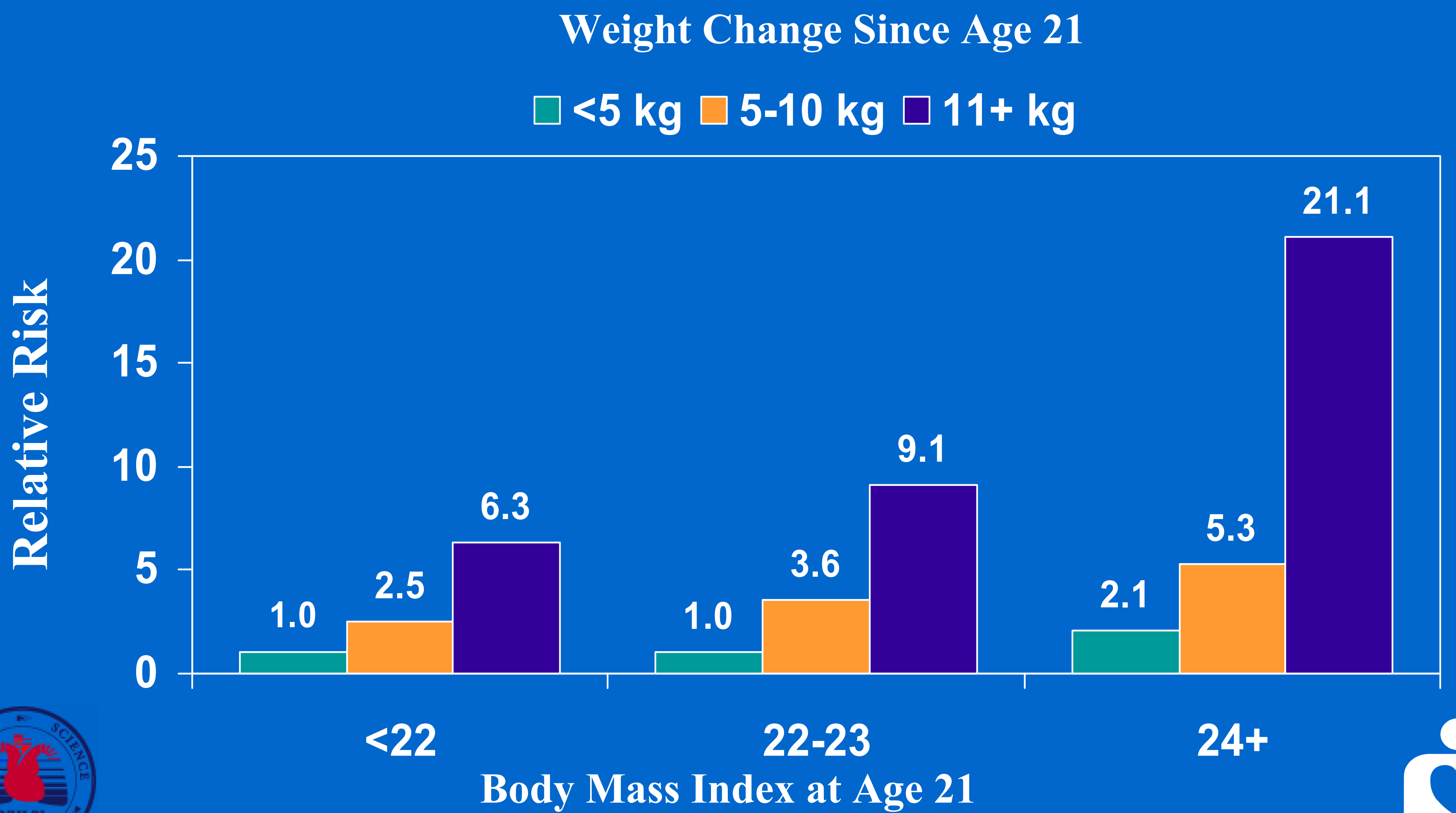
NHANES I Epidemiologic Follow-up Study. 1971-1987. Lipton R.B. et al. *Am J Epidemiol* 1993;138:826-39.
Bars: frequency distribution of body mass index (BMI). Squares and lines: incidence of diabetes (%).

Obesity and Diabetes Risk



Knowler WC et al. *Am J Epidemiol* 1981;113:144-156.

Weight Gain and Diabetes Risk



Adapted from Chan JM et al. *Diabetes Care* 1994;17:960-969.

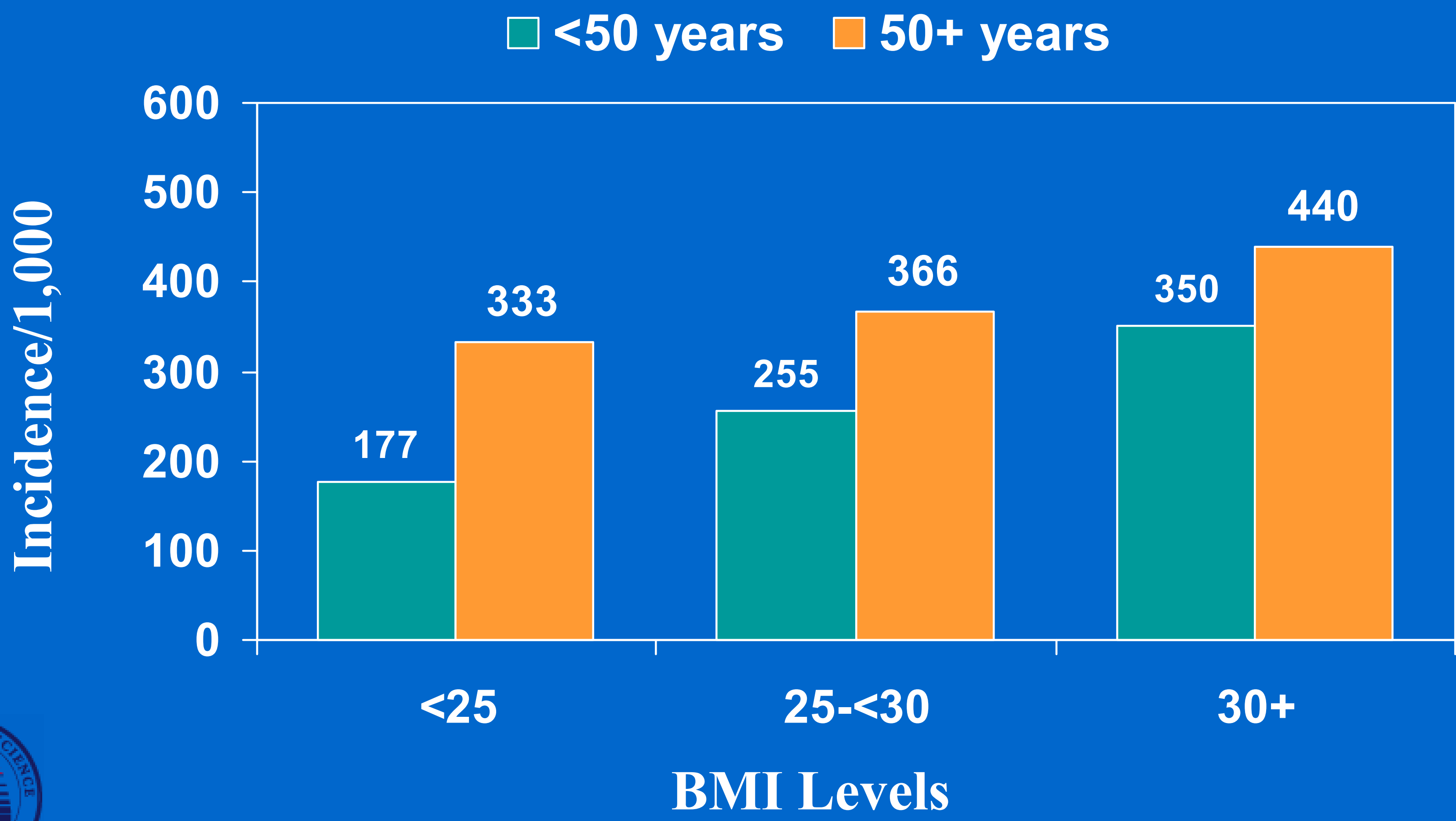
Metabolic Characteristics of Non-Obese and Obese Women With Low and High Levels of Deep Abdominal Fat

Variable	Non-obese (n = 25)	Obese: level of deep abdominal fat	
		Low (n = 10)	High (N = 10)
% Body fat	28.0	47.0*	49.8*
Deep abdominal fat area (cm^2)	50.3	107.0*	186.7*+
TG (mmol/L)	0.79	1.47*	2.57*+
CHOL (mmol/L)	4.59	5.18	5.65*
LDL-CHOL (mmol/L)	3.00	3.56	3.81*
HDL-CHOL (mmol/L)	1.36	1.25	0.96*+
Fasting insulin (pmol/L)	39.0	91.5	150.3*+
Glucose area ([mmol/L/180 min] x 10^{-3})	1.07	1.14	1.40*+
Insulin area ([pmol/L/180 min] x 10^{-3})	46.6	82.1	121.0*+

*Significantly different from non-obese women.
+Significantly different from obese women with low levels of deep abdominal fat, $p<0.05$.
The values represent means ± SD. The number of subjects is shown in parentheses. Triglyceride data were log 10 transformed for statistical analysis.

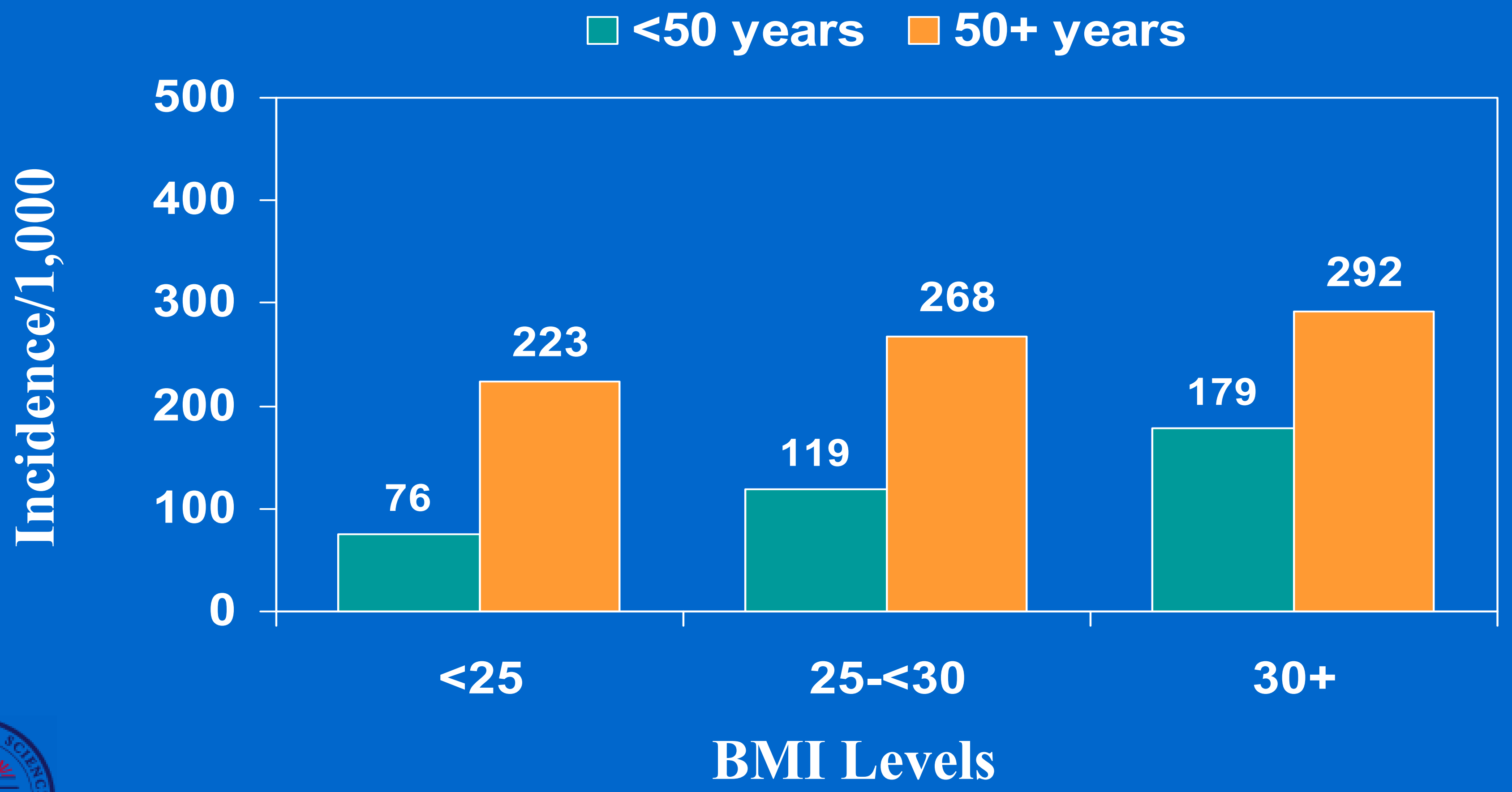
Despres JP et al. *Arteriosclerosis* 1990;10:497-511.

26 -Year Incidence of Coronary Heart Disease in Men



Adapted from Hubert HB et al. *Circulation* 1983;67:968-977.
Metropolitan Relative Weight of 110 is a BMI of approximately 25.

26 -Year Incidence of Coronary Heart Disease in Women



Adapted from Hubert HB et al. *Circulation* 1983;67:968-977.
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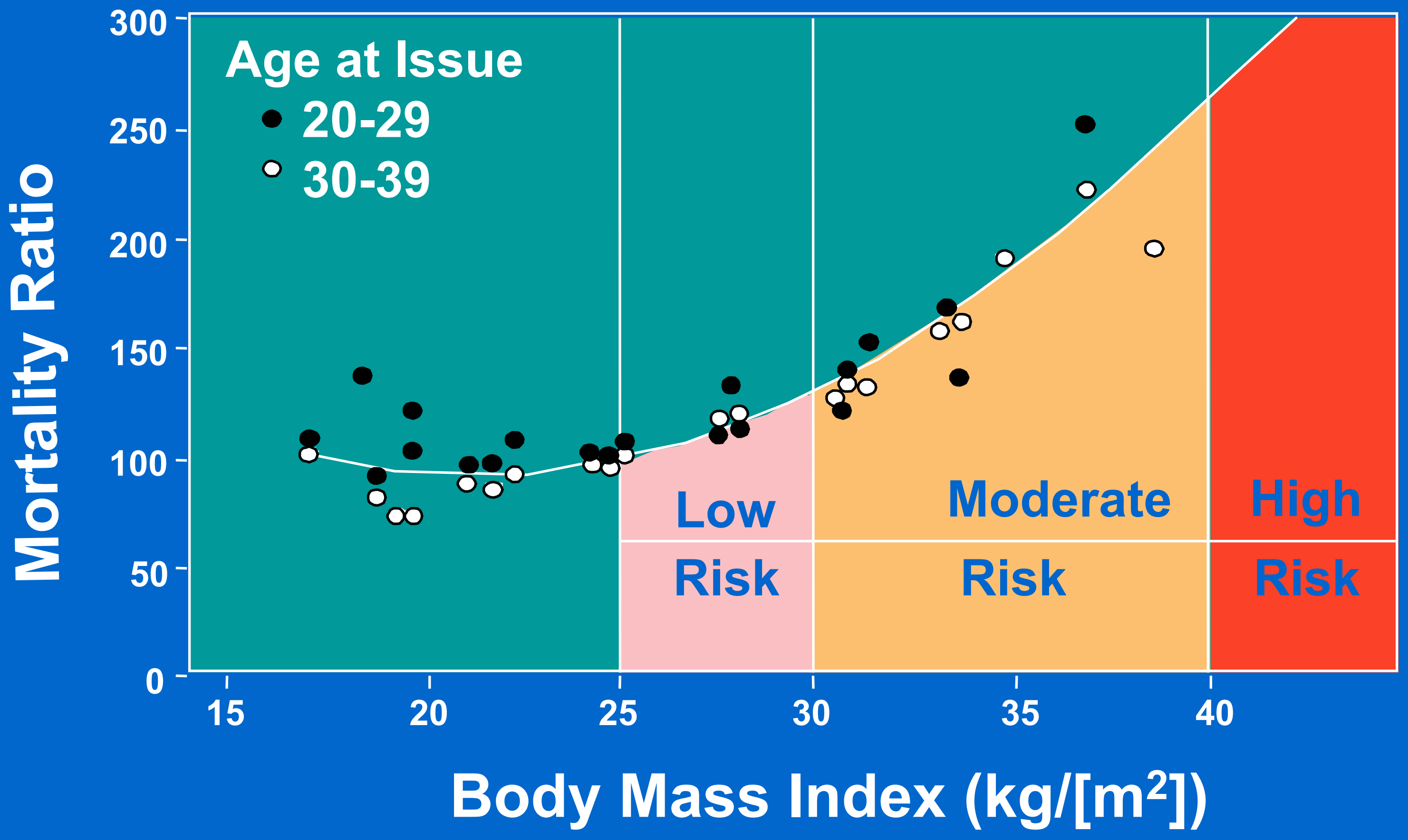
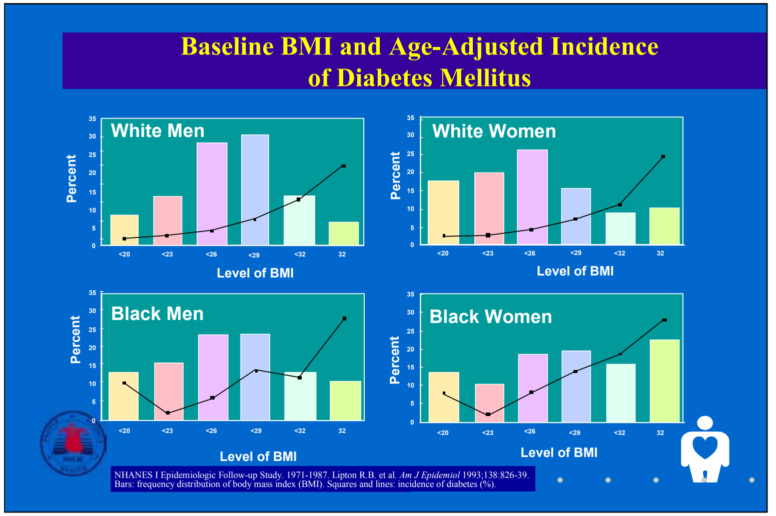
Relationship of BMI to Excess Mortality

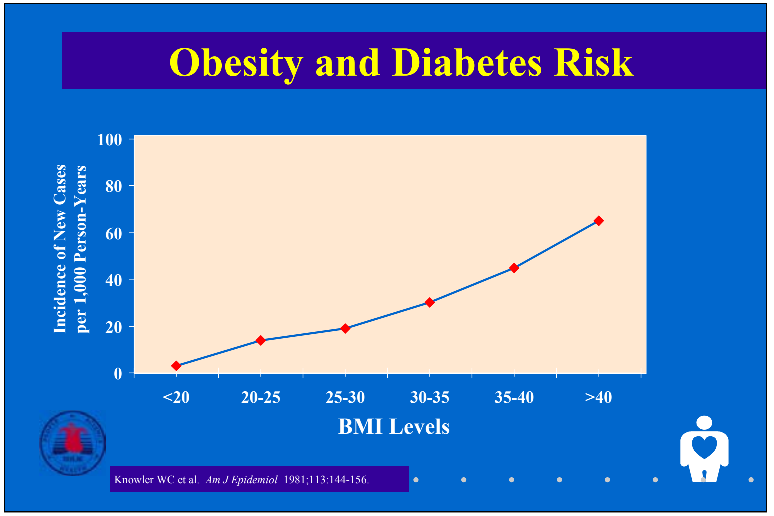


Bray GA. Overweight is risking fate. Definition, classification, prevalence and risks. *Ann NY Acad Sci* 1987;499:14-28.



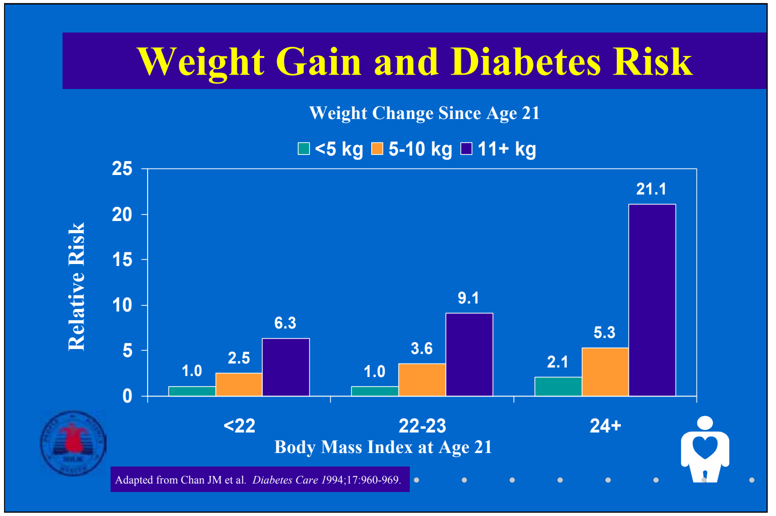
A study by Lipton and others examined the determinants of the incidence of non-insulin-dependent diabetes mellitus among blacks and whites from the NHANES I Epidemiologic Follow-up Study conducted from 1971 to 1987. A total of 880 incident cases of diabetes mellitus developed among the 11,097 white and black participants who were between the ages of 25 and 70 years at baseline.

- This slide points out the striking differences in body mass index among the four race/sex groups. The mean body mass index was higher among black women, and the age adjusted slope of the BMI-NIDDM risk relation among blacks differed from that among whites.
- At nearly every level of obesity, blacks had a higher risk of diabetes than whites, suggesting that other factors may contribute to risk. Among both the very lean (body mass index < 20) and the overweight (body mass index ≥ 26), blacks experienced a greater age-adjusted risk of diabetes than whites.
- Among white women, there was essentially no excess risk compared with white men. Black women were 50 percent more likely to develop non-insulin-dependent diabetes mellitus (NIDDM) than black men, and they had twice the risk of white women.



In a study of Pima Indians by Knowler and colleagues, the contributions of obesity to the incidence of diabetes and parental diabetes were examined.

- The incidence of diabetes mellitus was determined in 3,137 Pima Indians during periodic examinations that included measurement of weight, height, and glucose tolerance.
- Data was adjusted for age and sex. The incidence was strongly related to body mass index, increasing steadily from 0.8 ± 0.8 cases/1000 person-years in subjects with body mass index < 20 kg/m^2 to 72.2$\pm$ 14.5 cases/1000 person-years in those with body mass index $\geq$ 40 kg/m^2 (reported as rate $\pm$ standard error). Obesity was strongly related to the incidence of diabetes over the entire range of BMI.



The objective of this prospective study by Chan and colleagues was to investigate the relationship between obesity, fat distribution, and weight gain through adulthood and the risk of non-insulin-dependent diabetes mellitus (NIDDM).

- In 1986, baseline data were collected from 27,983 U.S. male health professionals, 40 to 75 years of age. Current height and weight, medical history, past and frequent smoking habits, family history of various diseases, and weight at age 21 were collected. Biennial questionnaires sent out in 1988, 1990, and 1992 were used to update exposure information and ascertain newly diagnosed cases of diabetes.
- Multivariate analysis was calculated to control for smoking, family history of diabetes, and age. There was a strong positive association between overall obesity as measured by body mass index (BMI) and risk of diabetes.
- Early obesity strongly predicts the risk of diabetes. As shown in this slide, overall absolute weight gain throughout adulthood was strongly related to risk of diabetes, regardless of BMI at age 21. Risk increased within each tertile of weight gain as well as within each category of BMI at age 21. Clearly, those who began with higher BMI ($\geq$ 24kg/m$^{2)}$ and gained substantial weight ($\geq$ 11.0 kg) had the highest RR (RR = 21.1, 95% CI 8.5–52.3).
- The steady increase in change in weight gain shows that almost any weight gain after adolescence is associated with a higher risk of diabetes. These data suggest that it may be equally important to attain a healthy weight earlier in life as well as maintain it throughout adulthood.

Metabolic Characteristics of Non-Obese and Obese Women With Low and High Levels of Deep Abdominal Fat

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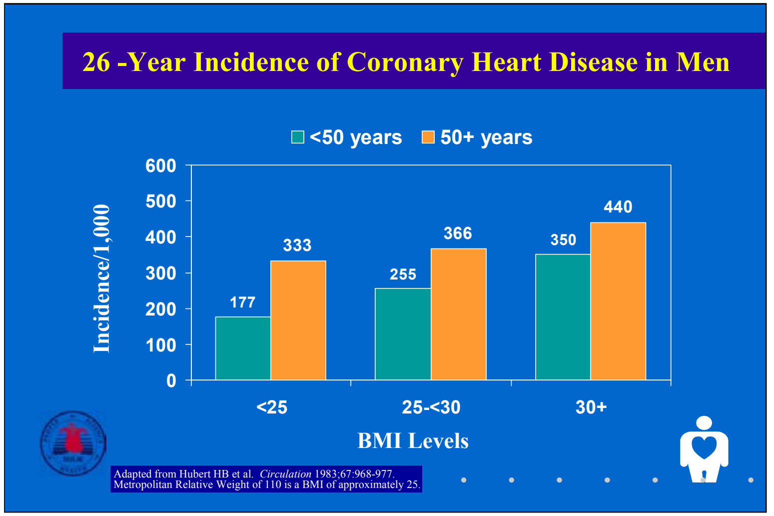
Despres JP et al. *Arteriosclerosis* 1990;10:497-511.

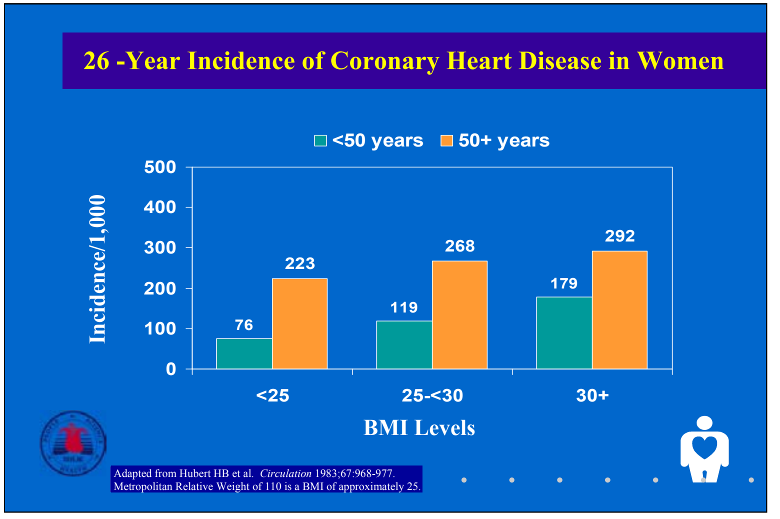
In a review article by Despres and colleagues on the regional distribution of body fat, plasma lipoproteins, and cardiovascular disease, the metabolic characteristics of non-obese women and of obese women with low or high levels of deep-abdominal fat are presented.

- The table illustrates that although obese women with low levels of deep-abdominal fat had much higher adiposity than non-obese controls, increased plasma triglycerides and insulin levels were the only two metabolic alterations observed in these women. Significant differences are represented by the asterisks (*).
- In contrast, obese women with high levels of deep-abdominal fat displayed numerous metabolic complications compared with non-obese women, including increased plasma TG, cholesterol, LDL-cholesterol, glucose, insulin and reduced HDL. Represented by *.
- Significant differences between high levels of deep-abdominal fat compared with the low levels of deep-abdominal fat obese group for triglycerides, cholesterol, fasting insulin, and HDL are represented by the plus sign (+).
- Therefore, despite comparable levels of obesity in the two obese groups, obese women with low levels of deep-abdominal fat had fewer metabolic alterations than obese women with high deep-abdominal obesity.
- This suggests that it is likely that subjects with high deep-abdominal obesity represent the subgroup of obese individuals with the highest risk for CVD.



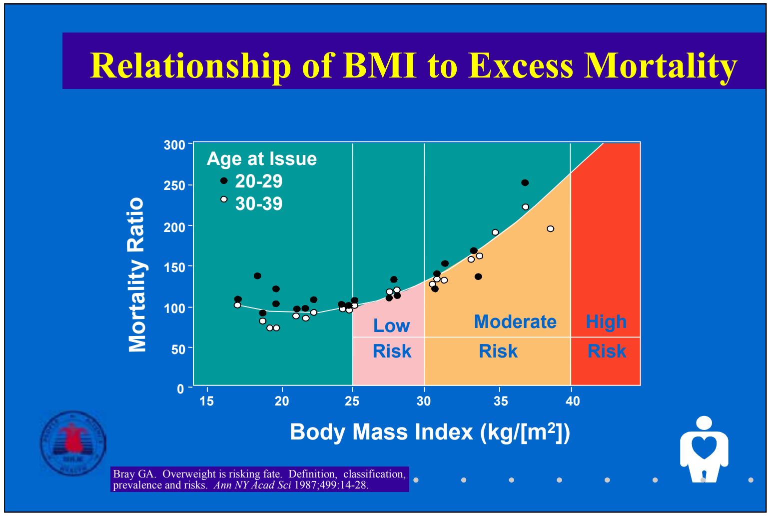
Obesity as an independent risk factor for cardiovascular disease was reexamined by Helen Hubert in the 5,209 men and women of the original Framingham cohort. Observations of disease occurrence over the 26 years indicate that obesity was an independent predictor of CVD, particularly among the younger members of the cohort and in women more than men.

- This study also showed that weight gain after the young adult years conveyed an increased risk of CVD in both sexes that could not be attributed to the initial weight or the levels of the risk factors that may have resulted from the weight gain.
- This slide shows the increasing incidence of coronary heart disease with increasing body mass index levels for both age groups of men. However, the gradient of risk was steeper among the younger men and women (< 50 years) . Among men younger than 50 years, the heaviest group experienced twice the risk of coronary disease compared with the leanest group.



In women, the incidence of coronary heart disease increased with increasing body mass index levels for both age groups.

- Among women older than 50 years, the heaviest group experienced 292 incidents of coronary heart disease compared with 223 in the BMI group < 25.
- In women younger than 50 years of age, the group of 30+ BMI experienced 179 incidents compared with only 76 in the < 25 BMI category.



A paper by George Bray examined the relationship of BMI to excess mortality.

Data was pooled from 5 prospective studies (3 industrial and 2 community) and included a total sample of 8,422 white males with a mean length of followup of 8.6 years.

This slide points out the relationship of BMI to excess mortality. There is a curvilinear increase in excess mortality with rising BMI. The risk is low with a BMI of 25 to30 and increases as BMI increases. The greatest risk is seen with BMIs above 40.