23rd Spring Congress of Korean Diabetes Association
08.MAY. 2010

Risk factor for type 2 diabetes in Korea

: Is Korean a high risk population for type 2 diabetes?

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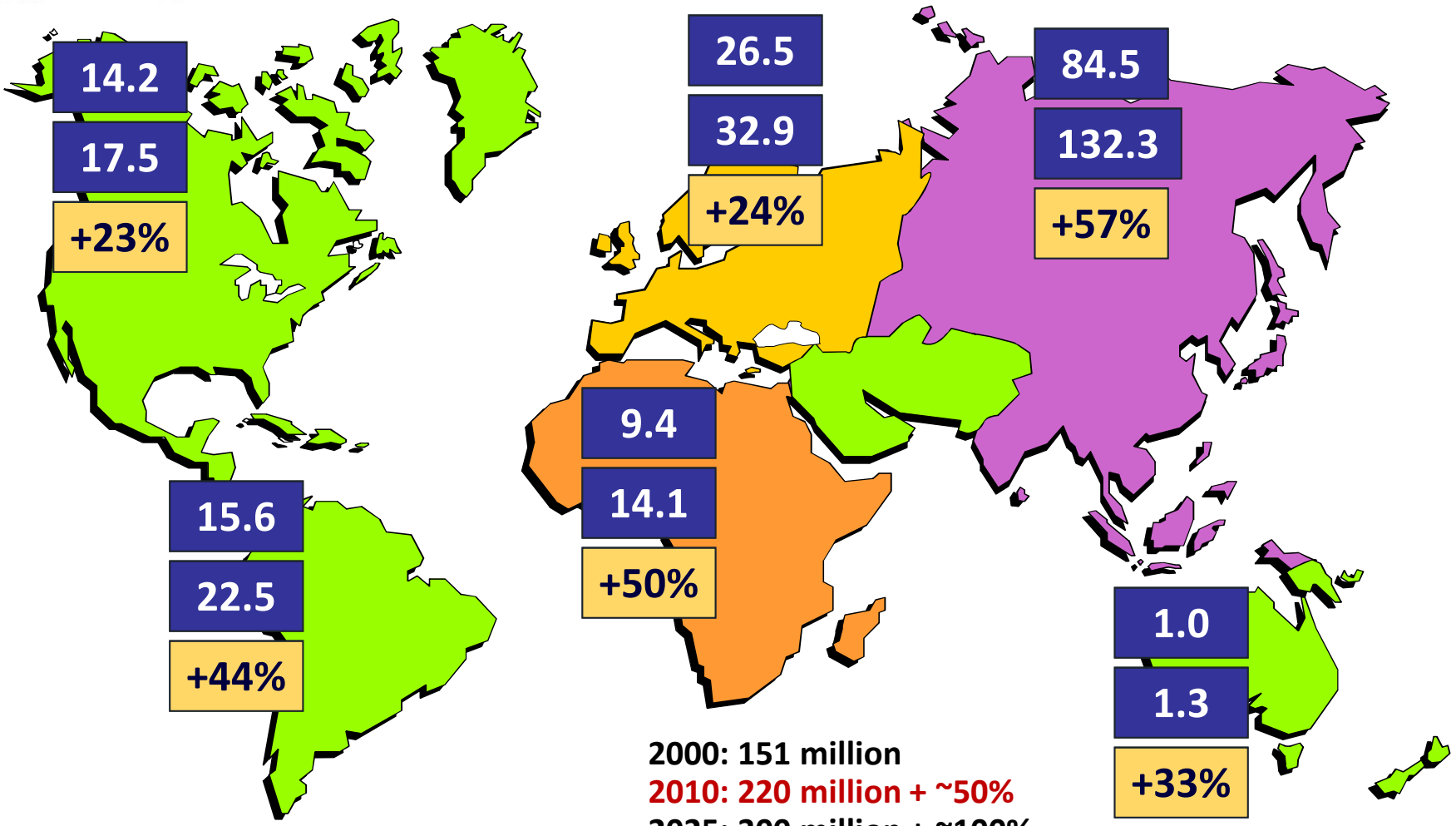
Diabetes epidemic

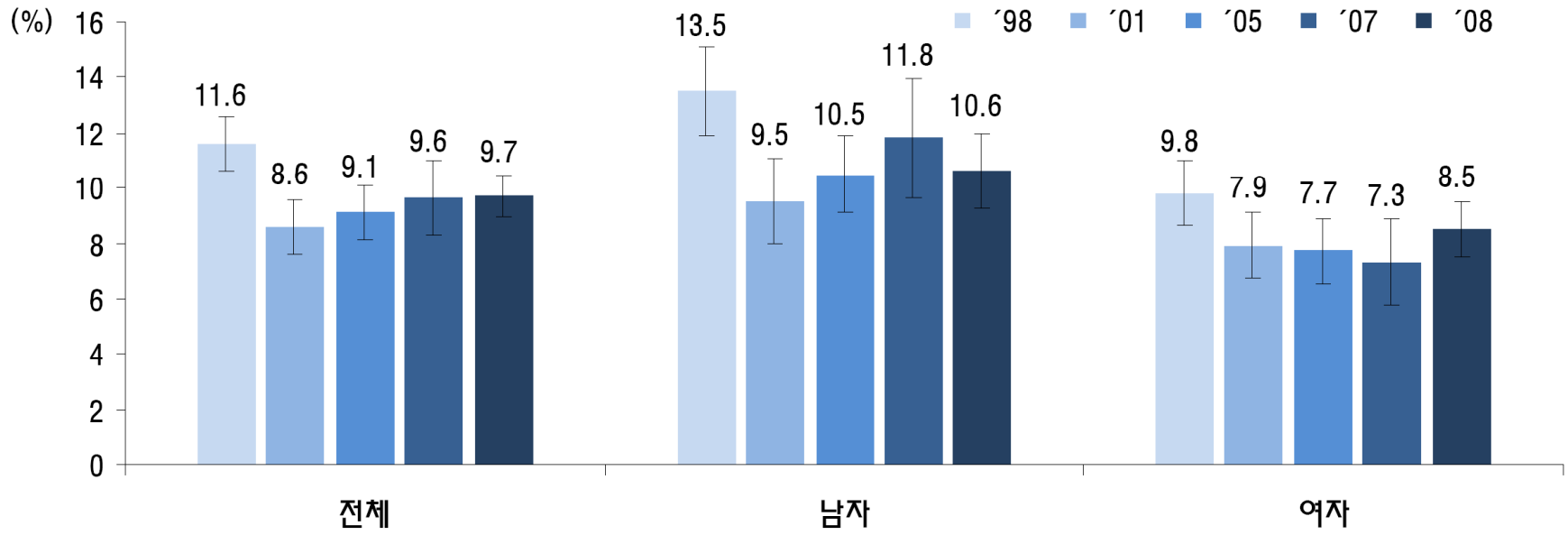


2000: 151 million
2010: 220 million + ~50%
2025: 300 million + ~100%
2030: 366 million + ~145%

Wild S, et al. Diabetes Care 2004;27:1047—53.
Zimmet P, et al. Nature 2001;414:782—7.

Diabetes
in South Korea

그림. 당뇨병 유병률 추이



※ 당뇨병 유병률 : 공복혈당이 126 mg/dL 이상이거나 의사진단을 받았거나 혈당강하제 복용 또는 인슐린 주사를 투여 받고 있는 분율, 만30세 이상

KNHANES, 2008

Trends of diabetes-related mortality
in South Korea

Rapidly increasing diabetes-related mortality with socio-environmental changes in South Korea during the last two decades

- Re-analyzed the annual reports on mortality in S. Korea by KNSO from 1983 to 2001

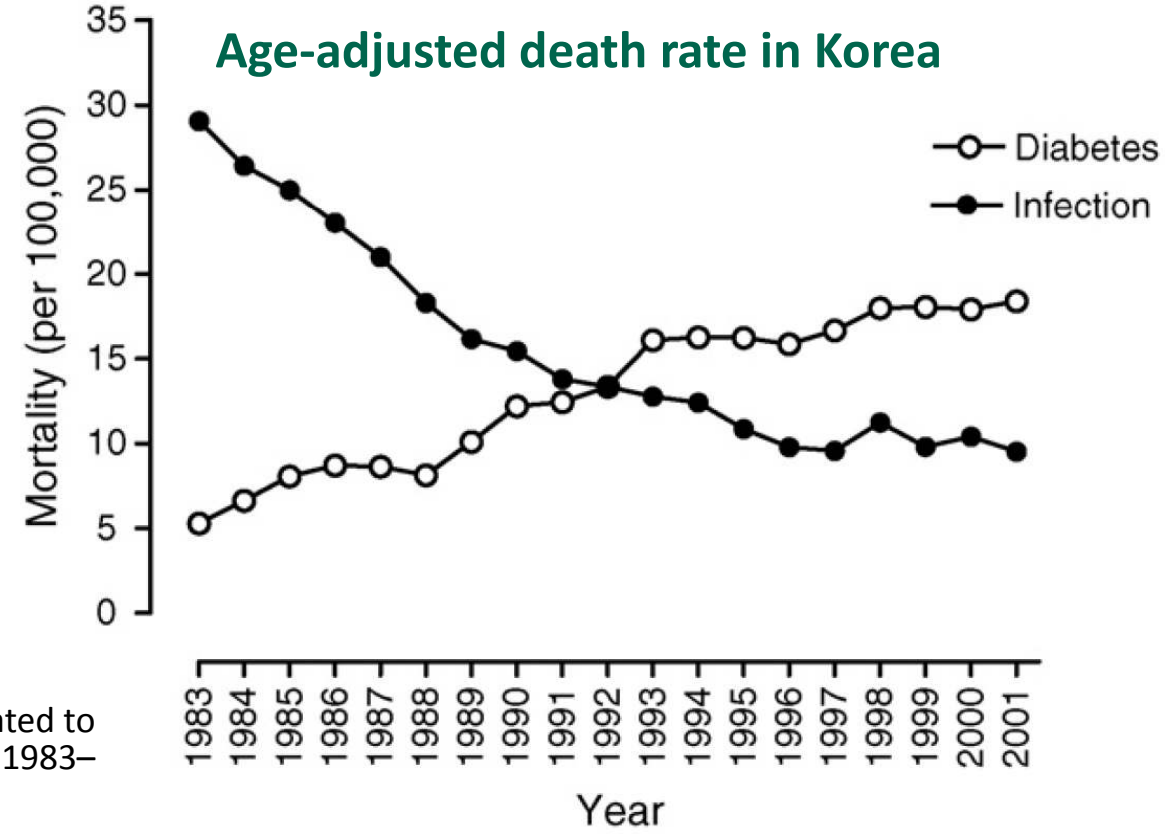


Fig. Age-adjusted death rate related to diabetes and infection in Korea (1983–2001).

Choi YJ, et al. Diabetes Res Clin Pract. 74(3):295-300, 2006

Trends of diabetes-related mortality
in South Korea

Rapidly increasing diabetes-related mortality with socio-environmental changes in South Korea during the last two decades

- Re-analyzed the annual reports on mortality in S. Korea by KNSO from 1983 to 2001

Table. Age-adjusted diabetes-related mortality rates of South Korea, Japan, the United Kingdom and the United States (1985–2000)

Age-adjusted diabetes-related mortality rates of South Korea, Japan, UK & USA

Year	South Korea	Japan	UK	USA
1985	10.8 (1.00)	7.9 (1.00)	10.3 (1.00)	14.3 (1.00)
1986	11.1 (1.02)	7.5 (0.94)	10.8 (1.04)	14.1 (0.98)
1987	11.2 (1.03)	7.3 (0.92)	10.3 (1.00)	14.4 (1.01)
1988	10.8 (1.00)	7.4 (0.93)	10.3 (1.00)	14.8 (1.03)
1989	13.7 (1.26)	6.8 (0.86)	10.3 (1.00)	16.9 (1.18)
1990	16.6 (1.53)	6.7 (0.84)	10.1 (0.98)	17.1 (1.19)
1991	17.8 (1.64)	6.6 (0.83)	10.1 (0.98)	17.2 (1.20)
1992	21.2 (1.96)	6.5 (0.82)	10.0 (0.97)	17.3 (1.21)
1993	27.3 (2.52)	6.5 (0.82)	8.0 (0.77)	18.2 (1.27)
1994	28.9 (2.67)	6.7 (0.84)	7.6 (0.73)	18.9 (1.32)
1995	28.8 (2.66)	8.4 (1.06)	7.8 (0.75)	19.5 (1.36)
1996	28.3 (2.62)	7.3 (0.92)	7.5 (0.72)	20.0 (1.39)
1997	29.7 (2.75)	6.8 (0.86)	7.3 (0.70)	19.9 (1.39)
1998	32.8 (3.03)	6.7 (0.84)	7.3 (0.70)	20.1 (1.40)
1999	33.4 (3.09)	6.6 (0.83)	7.5 (0.72)	–
2000	33.7 (3.12)	6.1 (0.77)	7.5 (0.72)	–

Data shown as death rate per 100,000 persons of each year (fold increase from 1985).

Choi YJ, et al. Diabetes Res Clin Pract. 74(3):295-300, 2006

Risk factors for type 2 diabetes

Table. Risk factors for type 2 diabetes
Age ≥45 years
Overweight (BMI ≥25 kg/m^2)
Family history of diabetes (i.e., parents or siblings with diabetes)
Habitual physical inactivity
Race/ethnicity (e.g., African-Americans, Hispanic-Americans, Native Americans, Asian-Americans, and Pacific Islanders)
Previously identified IFG or IGT (A1C ≥5.7%)
History of GDM or delivery of a baby weighing >9 lbs
Hypertension (≥140/90 mmHg in adults)
HDL cholesterol ≤35 mg/dL and/or a triglyceride level ≥250 mg/dL
Polycystic ovary syndrome
History of vascular disease

American Diabetes Association. Diabetes Care. 27(S1):S11-4, 2004

Risk factors
in Korean populations

인슐린비의존형 당뇨병의 위험인자 분석

- 연천지역사회 2개읍, 8개면 전지역을 대상으로 무작위 집단표본조사 실시
- 표본의 크기는 표본조사 대상인 26,927예 중 약 13%에 해당하는 3,804예

Table. Risk factors of Diabetes Mellitus.

단변량 분석	성별(남>여)	남: 8.7%, 여: 7.2%	X^2=14.6, p<0.001
	비만도	체질량지수 증가	X^2=9.6, p<0.01
	도시화 정도	도시화	X^2=6.3, p<0.05
	활동도	직업상 활동도 증가	X^2=11.4, p<0.01
	가족력	당뇨병 가족력 1인 이상	X^2=14.1, p<0.001
다변량 분석	WHR		3.82 (1.38-10.62)
	혈청 중성지방 농도		2.02 (1.41-2.89)
	연령		3.27 (1.65-6.48)
	당뇨병의 가족력		2.1 (1.34-3.34)
	수축기 혈압		1.69 (1.01-2.83)
	도시화 정도		1.56 (1.15-2.12)

박용수 등. 당뇨병 20(1): 14-24, 1996

Risk factors

the InterASIA Study in the Chinese adult population

Risk factors for type 2 diabetes mellitus in the Chinese adult population

- A nationally representative sample of 15,236 Chinese adults aged 35-74 years

Risk factors	Men		Women	
	OR	95% CI	OR	95% CI
Family history of diabetes				
No	1	–	1	–
Yes	5.87	4.14–8.31	4.79	3.55–6.48
Physical activity (METS)[a]				
<28.2	1	–	1	–
28.2–52.0	0.56	0.42–0.73	0.57	0.44–0.74
≥52.1	0.58	0.41–0.81	0.47	0.33–0.68
TC (mg/dl)				
<200	1	–	1	–
200–239	1.34	1.00–1.80	2.03	1.54–2.69
≥240	2.93	2.08–4.14	4.37	3.18–6.01
LDL-C (mg/dl)				
<130	1	–	1	–
130–159	1.41	1.00–1.98	1.84	1.35–2.45
≥160	2.83	1.96–4.08	3.79	2.70–5.31
HDL-C (mg/dl)				
<40	1	–	1	–
40–59	0.53	0.40–0.70	0.47	0.35–0.62
≥60	0.42	0.28–0.62	0.43	0.30–0.62
TG (mg/dl)				
<150	1	–	1	–
150–199	1.77	1.23–2.56	2.66	1.93–3.65
≥200	2.89	2.16–3.88	3.63	2.73–4.84

Risk factors	Men		Women	
	OR	95% CI	OR	95% CI
BMI (kg/m^2)[b]				
<24	1	–	1	–
24–27	1.22	0.93–1.61	1.74	1.33–2.28
≥28	2.49	1.76–3.53	2.70	1.93–3.77
WC (cm)[b]				
Men < 85 (women < 80)	1	–	1	–
Men ≥ 85 (women ≥ 80)	1.85	1.45–2.38	2.76	2.15–3.54
WHR[c]				
Men < 0.83 (women < 0.78)	1	–	1	–
Men 0.83–0.91 (women 0.78–0.86)	1.60	1.11–2.30	1.76	1.17–2.64
Men ≥ 0.92 (women ≥ 0.87)	2.95	2.04–4.26	4.42	2.94–6.65
Hypertension				
No	1	–	1	–
Yes	1.54	1.19–1.98	3.13	2.45–4.00
Smoking				
Never	1	–	1	–
Current	0.75	0.56–0.99	0.59	0.33–1.04
Former	1.41	0.96–2.07	0.97	0.48–1.97
Drinking (only for men)				
Never	1	–	–	–
Light	1.20	0.91–1.58	–	–
Heavy	0.71	0.50–1.02	–	–

Hu D, et al. Diabetes Res Clin Pract. 84(3):288-95, 2009

Obesity
in South Korea

Obesity as a risk factor for non-insulin-dependent diabetes mellitus in Korea

- Reviewed the medical records of final cohort of 2,531 subjects.
- Follow-up revealed 117 cases with DM with an incident of 7.8 per 1,000 person-years.

Table. Adjusted relative risk and 95% confidence interval for NIDDM among a cohort of 1,551 men and 980 women.

Risk Factors	Men			Women		
	Relative Risk	95% confidence interval	*p*-value*	Relative Risk	95% confidence interval	*p*-value*
Age (5 yr increase)	1.35	1.21-1.49	0.001	1.29	1.17-1.43	0.016
Family history of diabetes						
Absent	1.0			1.0		
Present	3.02	1.93-4.73	0.001	0.84	0.35-2.05	0.703
Total smoking amount (pack-years)						
None	1.0			1.0		
< 30	1.59	0.87-2.91	0.129	3.21	1.28-8.29	0.013
≥ 30	2.09	1.08-4.63	0.029	3.91	11.24-12.35	0.020
			p for trend=0.018			*p* for trend=0.015
Body mass index (kg/m²)						
< 23.0	1.0			1.0		
23.0 - 24.9	0.85	0.47-1.50	0.569	9.14	1.99-41.8	0.004
25.0 - 26.9	1.29	0.72-2.31	0.395	7.36	1.47-36.8	0.015
≥ 27.0	3.38	1.22-4.63	0.010	14.5	3.03-69.2	0.001
			p for trend=0.005			*p* for trend=0.005
Education						
Middle school	1.0			1.0		
High school	1.45	0.71-2.94	0.304	0.65	0.26-1.60	0.347
College or postgraduate	0.93	0.48-1.81	0.839	0.35	0.11-1.10	0.073
						p for trend=0.150

*Using Cox proportional hazards model. All risk factors above are used as covariates

Sung EJ, et al. J Korean Med Sci. 16(4):391-6, 2001

Obesity
in South Korea

Cut-off point of BMI and obesity-related comorbidities and mortality in middle-aged Koreans

- Cohort study among 773,915 men and women from 30 to 59 years old with 8-10 year F/U.

Risk of Diabetes

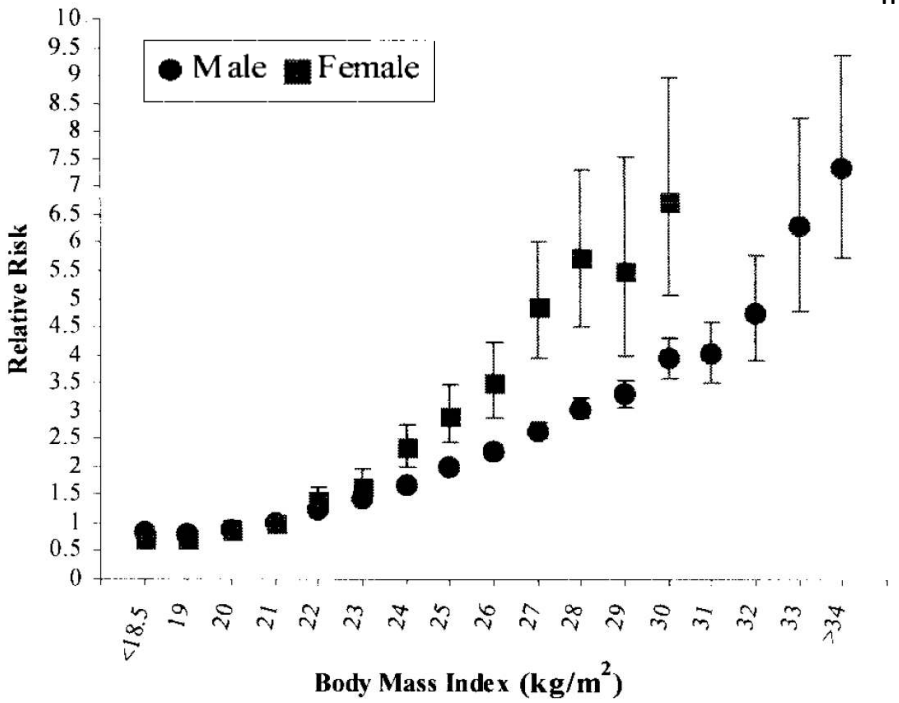


Fig. Multivariate RRs of diabetes occurrences during 8-year F/U period according to BMI.

Table. BMI in 1992 and age-adjusted diabetes incidence rates during 8-year F/U period.

	Men		Women	
	Diabetes		Diabetes	
BMI*	Cases/ person-years	IR†	Cases/ person-years	IR†
<18.5	621/111,720	5.7	133/112,386	1.3
18.5	1229/229,842	5.6	151/121,312	1.4
20	2440/421,048	6.1	237/153,740	1.6
21	3708/552,594	6.8	266/144,444	1.9
22	5282/628,874	8.4	351/130,510	2.6
23	6467/654,074	9.8	321/96,770	3.1
24	7072/603,940	11.5	341/70,036	4.7
25	6232/452,170	13.6	231/37,976	5.5
26	4397/278,228	15.6	180/23,854	6.6
27	2919/159,442	18.1	125/12,108	10.4
28	1666/79,516	20.8	90/7230	14.0
29	976/42,778	22.6	50/3768	12.0
30	495/18,518	26.5	64/3892	17.1
31	227/8302	27.3		
32	107/3400	31.5		
33	52/1342	38.5		
≥34	65/1444	45.5		

† Age-adjusted incidence rate per 1,000 person-years.

Oh SW, et al. Obes Res. 12(12):2031-40, 2004

Waist circumference
in South Korea

Waist circumference is the key risk factor for diabetes in Korean women with history of GDM

- 909 women with history of GDM were enrolled.
- During postpartum follow-up period, mean 2.13+/-1.75 years

Table. Odds ratio of diabetes by obesity parameters between the highest and the lowest quartiles[a].

	OR[a]	95% CI	*p*
Suprailiac skin fold thickness	2.10 (2.6)	1.2–3.7	<0.05
Tricep skin fold thickness	2.02 (2.6)	1.1–3.6	<0.05
Waist/hip ratio	3.11 (4.4)	1.7–5.6	<0.001
Body fat weight	3.76 (4.4)	1.8–7.6	<0.001
Body mass index	3.34 (4.4)	1.7–6.5	<0.001
Subscapular skin fold thickness	2.82 (4.5)	1.4–5.6	<0.01
Body weight	3.06 (4.6)	1.6–6.0	0.001
Waist circumference	3.86 (5.8)	1.8–8.2	<0.001

[a] Odds ratio was calculated using the logistic regression analysis. The potential confounders, such as BP, lipid profiles, age, duration of follow-up, parity, F/H of DM, and working status were included in the model as an independent variable to be controlled its effect. OR in parenthesis are the values before multiple adjustment.

Cho NH, Jang HC, Park HK, Cho YW. Diabetes Res Clin Pract. 71(2):177-83, 2006

Duration of obesity
in U.K.

Weight change and duration of overweight and obesity in the incidence of T2DM

- a prospective study of CVD in men aged 40-59 years at screening.

Table. Risk of diabetes by BMI at Q5 and duration of overweight and obesity.

BMI at Q5	*n*	Cases of diabetes	Rate per 1,000 person-years	Age-adusted RR	Adjusted RR (95% CI)
<25	2,386	34	1.3	1.00	1.00
25–27.9					
<5 years	623	17	2.5	1.80	1.74 (0.96–3.15)
≥5 years	1,541	50	3.0	2.17	2.25 (1.45–3.47)
28–29.9					
<5 years	408	18	4.0	2.91	2.68 (1.50–4.81)
≥5 years	553	39	6.7	4.87	4.74 (2.99–7.51)
≥30					
<5 years	48	3	6.5	4.92	4.36 (1.33–14.28)
≥5 years	355	42	11.8	8.66	8.04 (5.06–12.74)

*Adjusted for age, smoking status at Q5, physical activity, and recall of CHD and hypertension. Men who have lost weight (≥4%) have been excluded (*n* = 937).

Wannamethee SG, Shaper AG. Diabetes Care. 22(8):1266-72, 1999

Abdominal adiposity

Health Professionals Follow-Up Study in US

Comparison of abdominal adiposity and overall obesity in predicting risk of type 2 diabetes among men.

- A prospective cohort study of 27,270 men.
- During 13 yr of follow-up, 884 incident T2DM cases.

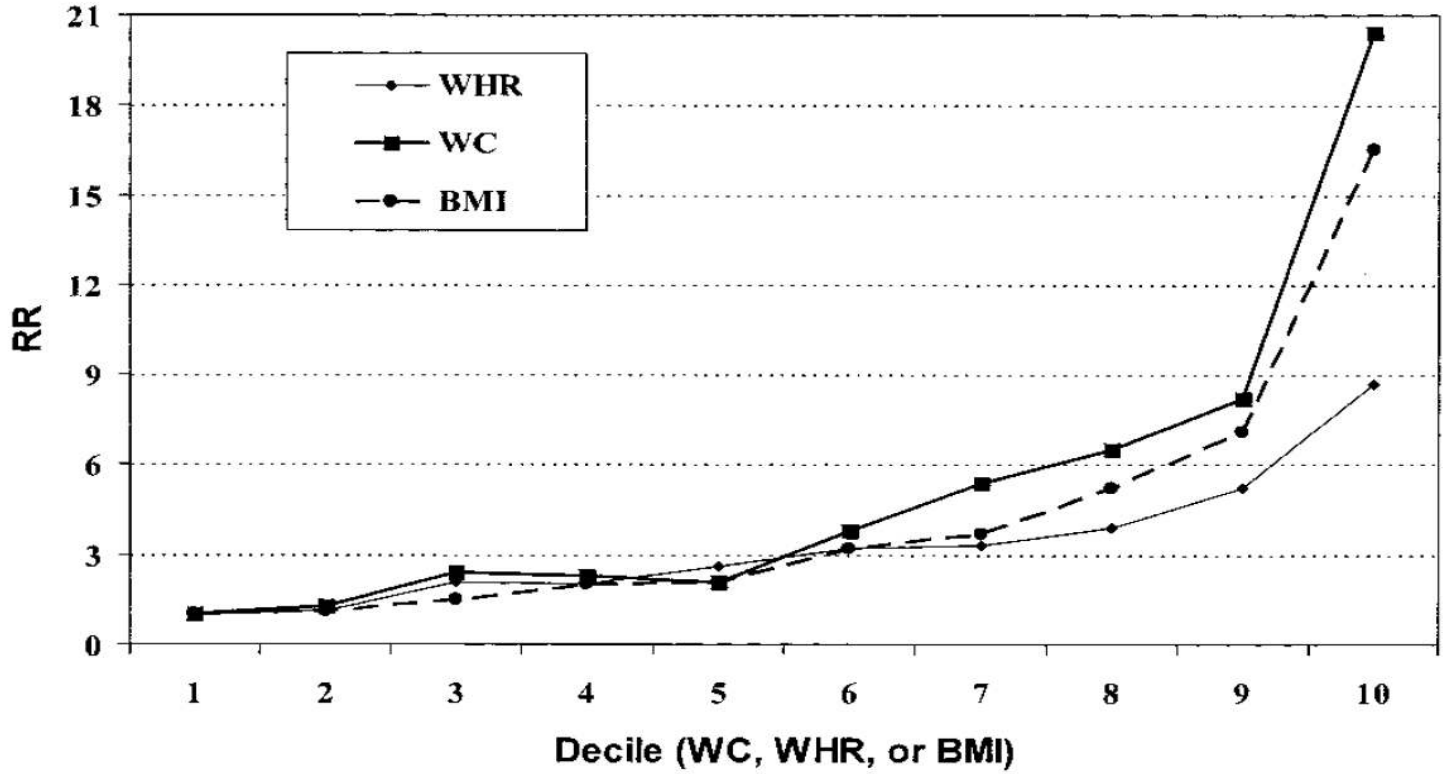


Fig. Age-adjusted RR of T2DM by baseline WC, WHR, and BMI deciles.(n=27,270).

Wang Y, et al. Am J Clin Nutr. 81(3):555-63, 2005

Obesity
a follow-up study in a Japanese population

Increases in BMI, even within non-obese levels, raise the risk for T2DM

- A follow-up study in 16,829 men and 8,370 women who were apparently healthy at baseline (age 30-59 years, BMI 14.9-43.2 kg/m^2).

Table. Incidence of DM and hazard ratio for incident DM according to deciles of BMI in Japanese men aged 30–59 years

Deciles of BMI, kg/m^2	Baseline *n*	Person years	Mean follow-up years	Mean follow-up examinations	Incident diabetes mellitus		Hazard ratio (95% confidence interval)	
					n	per 1000 person years	Crude	Multivariate adjusted†
Men								
1st, 15.0–19.7	1700	12883	7.6	6.0	27	2.1	1.00 (reference)	1.00 (reference)
2nd, 19.8–20.8	1760	13273	7.5	5.9	44	3.3	1.57 (0.97, 2.53)	1.55 (0.96, 2.50)
3rd, 20.9–21.6	1660	12519	7.5	5.8	40	3.2	1.52 (0.93, 2.47)	1.56 (0.96, 2.54)
4th, 21.7–22.3	1660	12527	7.5	5.9	50	4.0	1.89 (1.18, 3.01)**	1.85 (1.16, 2.95)*
5th, 22.4–22.9	1610	11950	7.4	5.7	62	5.2	2.47 (1.57, 3.88)***	2.46 (1.56, 3.86)***
6th, 23.0–23.6	1708	12656	7.4	5.8	77	6.1	2.91 (1.88, 4.52)***	2.91 (1.88, 4.52)***
7th, 23.7–24.3	1738	12683	7.3	5.7	108	8.5	4.10 (2.69, 6.26)***	4.07 (2.66, 6.21)***
8th, 24.4–25.1	1596	11802	7.4	5.8	99	8.4	4.01 (2.62, 6.14)***	3.98 (2.60, 6.10)***
9th, 25.2–26.3	1693	12501	7.4	5.8	145	11.6	5.56 (3.69, 8.39)***	5.55 (3.67, 8.38)***
10th, 26.4–38.5	1704	12320	7.2	5.6	217	17.6	8.55 (5.73, 12.8)***	8.68 (5.81, 13.0)***
Trend for BMI (per 1 kg/m^2)							1.26 (1.23, 1.28)***	1.26 (1.24, 1.29)***
Trend for age (per 1 year)							1.04 (1.03, 1.05)***	1.04 (1.03, 1.05)***‡

Nagaya T, et al. Diabet Med. 22(8):1107-11, 2005

Waist circumference

an 8-year follow-up of relatively lean Japanese individuals

J-shaped relationship between WC and subsequent risk for T2DM

- 3,992 employees (2,533 men & 1,459 women, aged 35-55 yrs) of a metal-products factory in Japan

Table. Age- and sex-adjusted and multivariate-adjusted hazard ratios for the incidence of T2DM according to sex-specific quintile of WC.

	Waist circumference quintile				
Parameter	Q1	Q2	Q3	Q4	Q5
Range of waist circumference, men (cm)	51.0–73.0	73.5–78.0	78.5–82.0	82.5–86.0	86.5–110.0
Range of waist circumference, women (cm)	54.0–65.0	65.5–69.0	69.5–73.5	74.0–80.0	80.5–120.0
Participants (*n*)	852	803	820	765	752
Age (years)	43.7 ± 5.7	44.3 ± 5.7	44.4 ± 5.9	44.7 ± 5.8	45.0 ± 5.9
Fasting plasma glucose (mmol/l)	4.9 ± 0.49	4.9 ± 0.46	5.0 ± 0.46	5.1 ± 0.52	5.1 ± 0.49
Family history of diabetes (%)	10.7	11.7	13.3	10.2	13.8
Prevalence of high blood pressure† (%)	21.5	24.8	28.4	35.6	38.7
Prevalence of dyslipidaemia† (%)	7.9	14.8	21.5	26.0	38.7
Total person-years	6143	5787	5689	5242	5000
Incident cases (*n*)	39	23	34	58	64
Rate per 1000 person-years	6.3	4.0	6.0	11.1	12.8
Adjusted hazard ratio (95% CI) (Model 1)	1.78 (1.06–2.98)	1.00 (reference)	1.59 (0.94–2.71)	3.11 (1.92–5.04)	3.30 (2.05–5.31)
Adjusted hazard ratio (95% CI) (Model 2)	1.81 (1.08–3.04)	1.00 (reference)	1.62 (0.95–2.76)	3.27 (2.01–5.31)	3.37 (2.09–5.43)
Adjusted hazard ratio (95% CI) (Model 3)	1.90 (1.13–3.19)	1.00 (reference)	1.50 (0.88–2.56)	2.82 (1.73–4.61)	2.72 (1.67–4.42)
Adjusted hazard ratio (95% CI) (Model 4)	1.62 (0.96–2.72)	1.00 (reference)	1.18 (0.69–2.01)	2.10 (1.28–3.46)	2.03 (1.24–3.33)

Sakurai M, et al. Diabet Med. 26(8):753-9, 2009

Abdominal adiposity

International Day for the Evaluation of Abdominal Obesity (IDEA) in 63 countries

A study of WC, CVD, and DM in 168,000 primary care patients in 63 countries

- Randomly chosen primary care physicians in 63 countries recruited consecutive patients aged 18 to 80 years (69,409 men and 98,750 women).

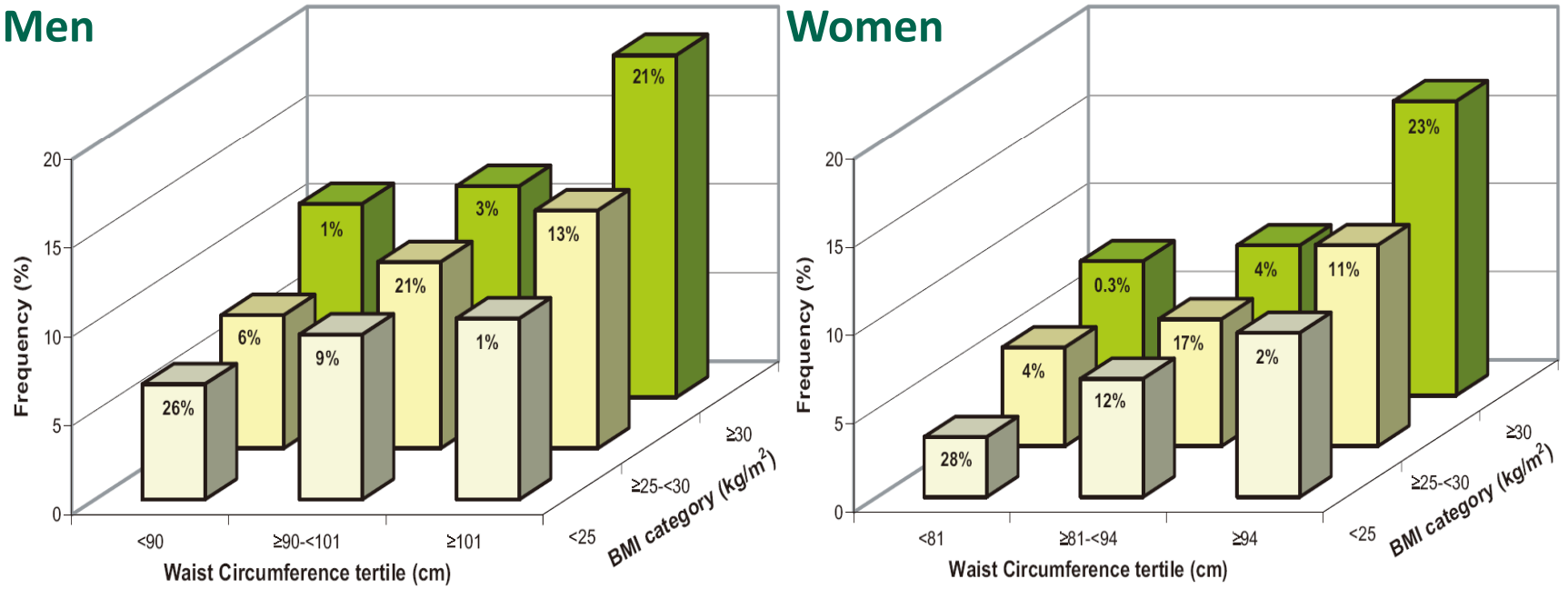


Fig. **Frequency of known diabetes mellitus** for men and women, adjusted for age, region, and smoking status, by gender-specific WC tertiles and BMI categories. The percentage of patients in each of the 9 groups is shown.

Balkau B, et al. Circulation. 116(17):1942-51, 2007

Obesity

the People's Republic of China Study & the Atherosclerosis Risk in Communities Study.

Impact of BMI on DM in Chinese Asians, American Whites, and American Blacks

- Compared the associations with BMI in Chinese Asians (n=5,980), American Whites (n=10,776), and American Blacks (n=3,582)
- Using prospective data from the People's Republic of China Study (1983-1994) and the Atherosclerosis Risk in Communities Study (1987-1998).

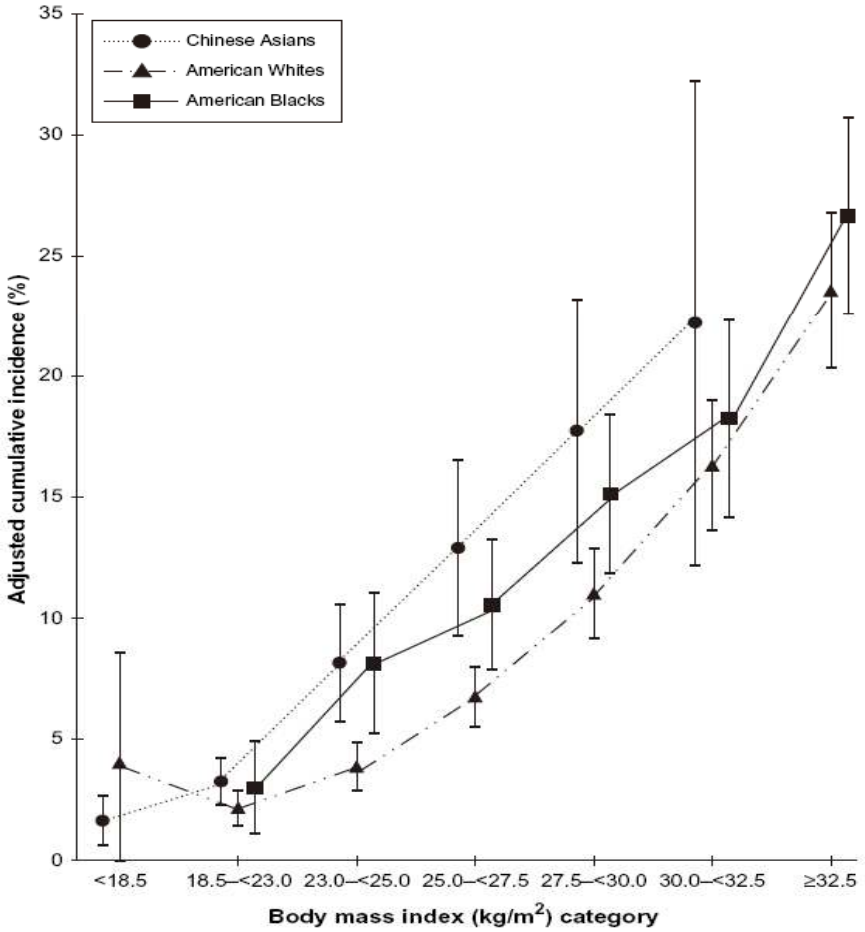


Fig. Adjusted cumulative incidence (and 95% CI) for DM by BMI categories and ethnicity, the ARIC Study (1987–1998) and the PRC Study (1983–1994). Point estimates for the same BMI categories are shifted slightly in the horizontal plane so that CIs are clearly visible.

Stevens J, et al. Am J Epidemiol. 167(11):1365-74, 2008

Abdominal adiposity

International Day for the Evaluation of Abdominal Obesity (IDEA) in 63 countries

A study of WC, CVD, and DM in 168,000 primary care patients in 63 countries

- Randomly chosen primary care physicians in 63 countries recruited consecutive patients aged 18 to 80 years (69,409 men and 98,750 women).

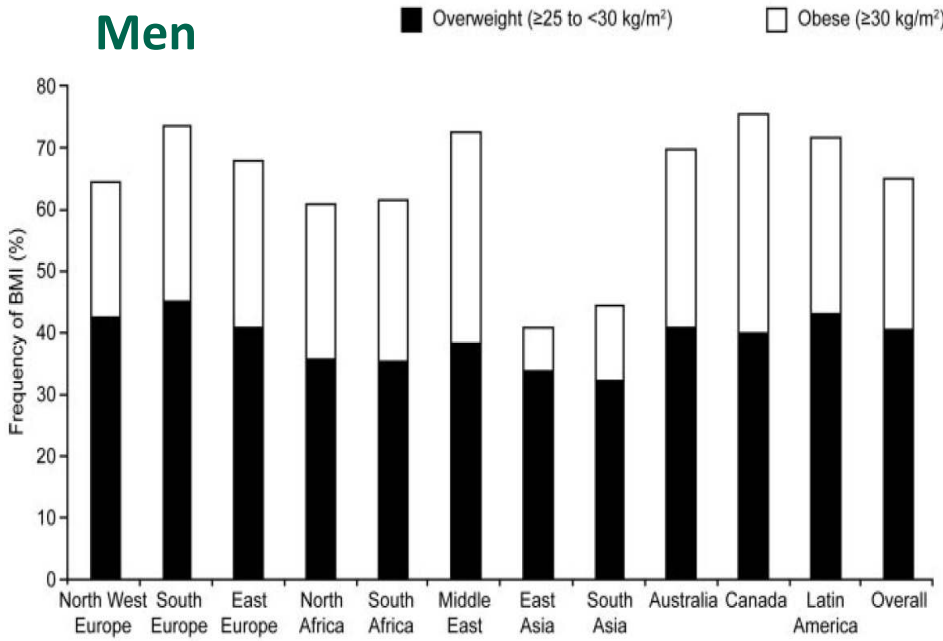


Fig. Age-standardized frequency of overweight (BMI 25-30 kg/m^2) and obese (BMI ≥30 kg/m^2) subjects by region in men.

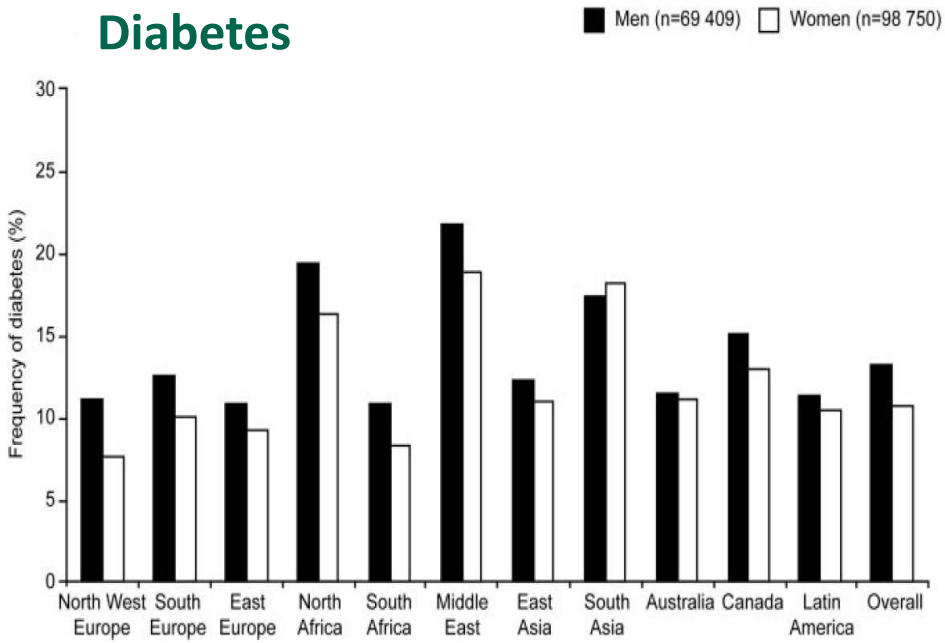


Fig. Age-standardized frequencies of DM by region in men and women.

Balkau B, et al. Circulation. 116(17):1942-51, 2007

Epidemic type 2 diabetes in Korea

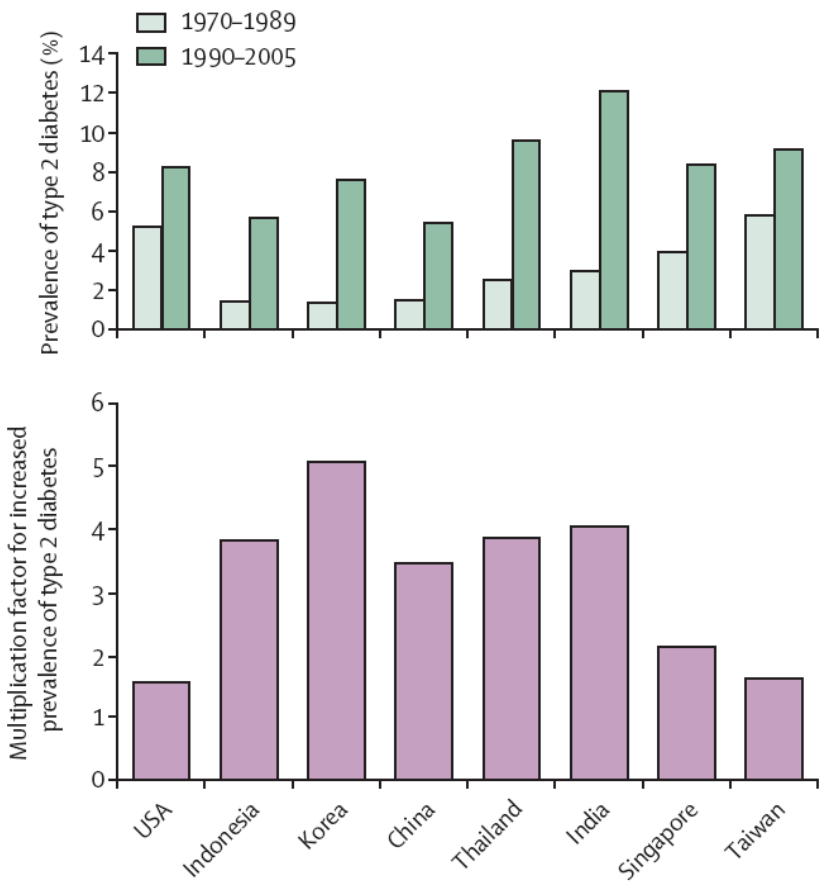


Table. Comparison of prevalence rates of diabetes in selected countries between 1970–1989 and 1990–2005.

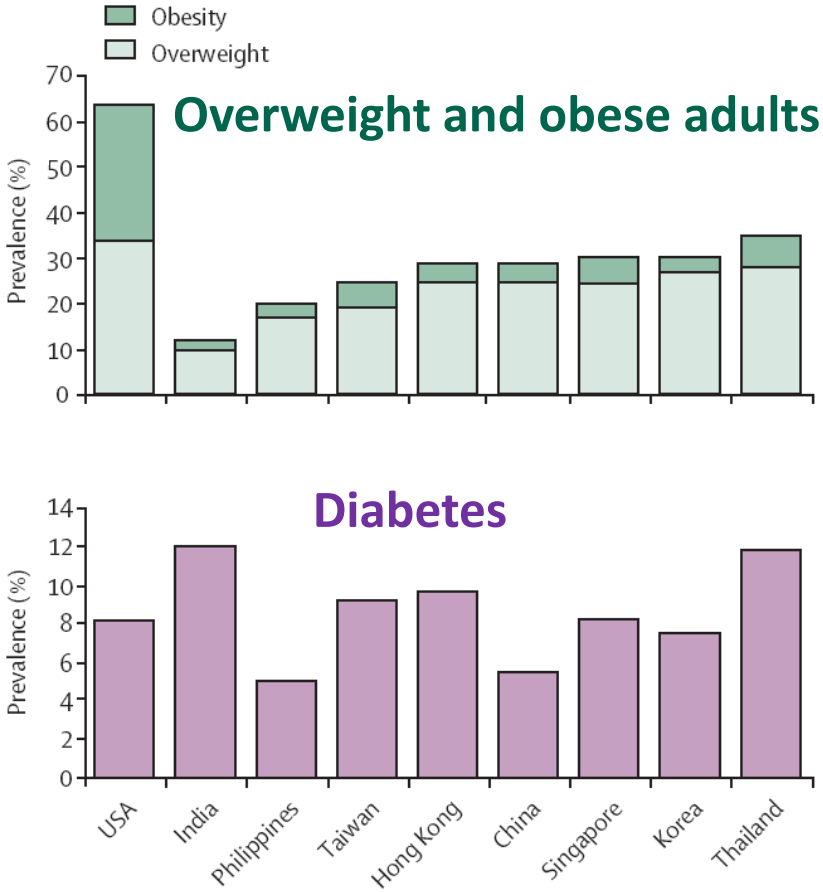
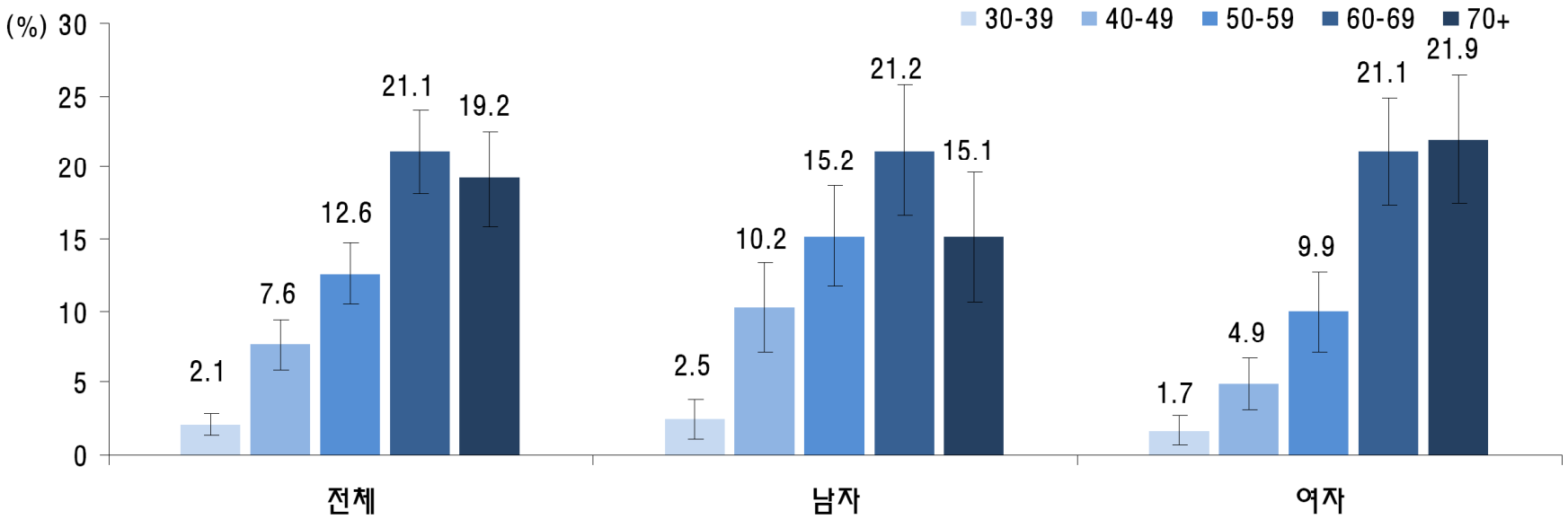


Table International comparison of prevalence of adult obesity and diabetes.

Yoon KH, et al. Lancet. 368(9548):1681-8, 2006

Diabetes
in South Korea

그림. 연령별 당뇨병 유병률



※ 당뇨병 유병률 : 공복혈당이 126 mg/dL 이상이거나 의사진단을 받았거나 혈당강하제 복용 또는 인슐린 주사를 투여 받고 있는 분율, 만30세 이상

KNHANES, 2008

Age & Family history

The 2001 Korean national health and nutrition examination survey

Risk factors of type 2 diabetes among Korean adults

- Data of 5,132 adults aged 20-85 were used from the 2001 Korean Health and Nutrition Examination Survey

Table. Multivariate Logistic Regression Determinants of T2DM Status

Predictor Variables		Odds Ratio (95% Confidence Interval)		
		Model 1	Model 2	Model 3
Age	20-39 yrs	1.00		1.00
	40-59 yrs	3.12 (1.95, 5.00)		2.19 (1.56, 3.08)
	60 yrs +	4.67 (2.80, 7.78)		4.05 (2.76, 5.95)
Education	high school or more	1.00		1.00
	less than high school	1.45 (1.11, 1.90)		1.41 (1.08, 1.84)
Gender	male	1.00		
	female	0.89 (0.52, 1.52)		
WC	normal		1.00	1.00
	high		3.44 (2.57, 4.62)	2.24 (1.79, 2.82)
MAR	low		1.00	
	high		1.31 (1.05, 1.63)	
Ever Smoking	no		1.00	1.00
	yes		1.69 (1.26, 2.26)	1.34 (1.06, 1.67)
Family History of Diabetes	no		1.00	1.00
	yes		1.60 (1.17, 2.19)	1.99 (1.44, 2.74)

Chung HR, Pérez-Escamilla R. Nutr Res Pract. 3(4):286-94, 2009

Family history
in US Caucasian families

Risk of DM in siblings of index cases with T2DM: implications for genetic studies

- Patients diagnosed at ages 35-59 years (n=563) to obtain information on the occurrence of diabetes in their relatives, particularly siblings (n=1,675).

Table. Estimates of the diabetes recurrence-risk ratio in siblings (λ_S) or offspring (λ_O) of index cases with diabetes in four US studies according to parental history of diabetes.

Authors	Number of siblings or offspring	Mean age*	Reference risk from NHANES III	Parental history of diabetes			
				No diabetic parent, λ (%)	One diabetic parent, λ (%)	Two diabetic parents, λ (%)	Standardized† estimate, λ_S
Estimates based on prevalence							
Klein *et al.* [11]	3 965	68	11.3	0.9 (10.4)	1.6 (17.8)	2.2 (25.2)	1.2
Karter *et al.* [12]	25 659	59	9.5	0.8 (7.8)	1.8 (17.2)	2.8 (26.5)	1.2
Meigs *et al.* (13)‡	2 527	54	7.6	—	2.2 (16.5)	3.4 (26.2)	—
Current study	1 348	60	9.5	1.2 (11.2)	2.5 (21.4)	4.0 (34.5)	1.6
Estimates based on cumulative risk							
Current study	1 657	65	11.3	1.2 (14.0)	2.6 (29.2)	3.7 (41.9)	1.8

*For the studies by Klein *et al.* and Karter *et al.* the average age of siblings was assumed to be the same as index cases.
†Standardized by the direct method to the distribution of parental history of diabetes in the study by Klein *et al.*
‡Estimates of λ_O are shown for the offspring of affected parents. The prevalence of diabetes in offspring with no diabetic parent was 6.1% (ratio to reference risk = 0.8).

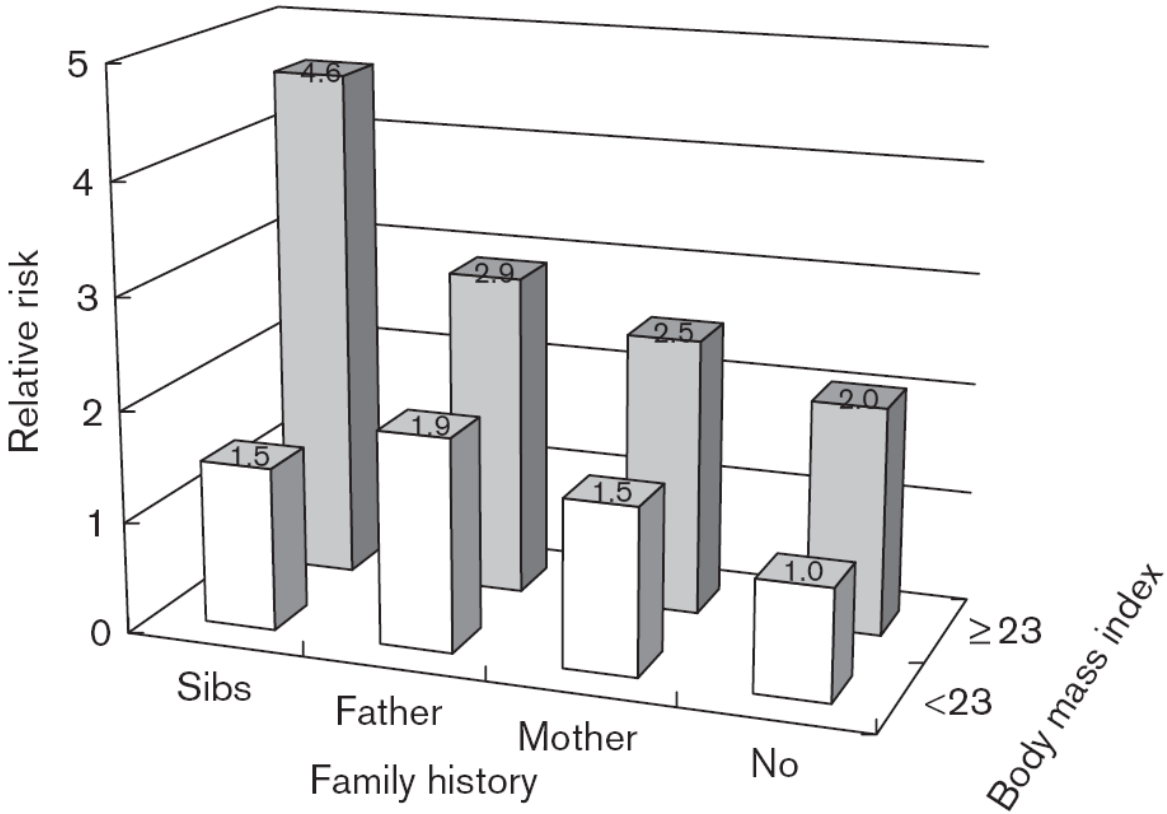
Weijnen CF, et al. Diabet Med. 19(1):41-50, 2002

Family history
the Chin-Shan Community Cardiovascular Cohort Study in Chinese

Sibling and parental history in type 2 diabetes risk among ethnic Chinese

- Among 2,960 participants free from baseline DM through the Chin-Shan Community Cardiovascular Cohort Study, there were 548 cases that developed DM after a median 9 yrs F/U

Fig. Relative risk of diabetes during the 9-year follow-up period according to various family history status and BMI value (cutoff by median level, 23 kg/m^2), with adjustment for sex, alcohol intake, smoking, marital status, education, job status, and physical activity.



Chien KL, et al. Eur J Cardiovasc Prev Rehabil. 15(6):657-62, 2008

Changes in occupation distributions
in South Korea

The nutrition transition in South Korea

- Secondary data on economics, dietary intake, anthropometry, and causes of death, including a series of comparable nationally representative dietary surveys (the National Nutrition Survey).

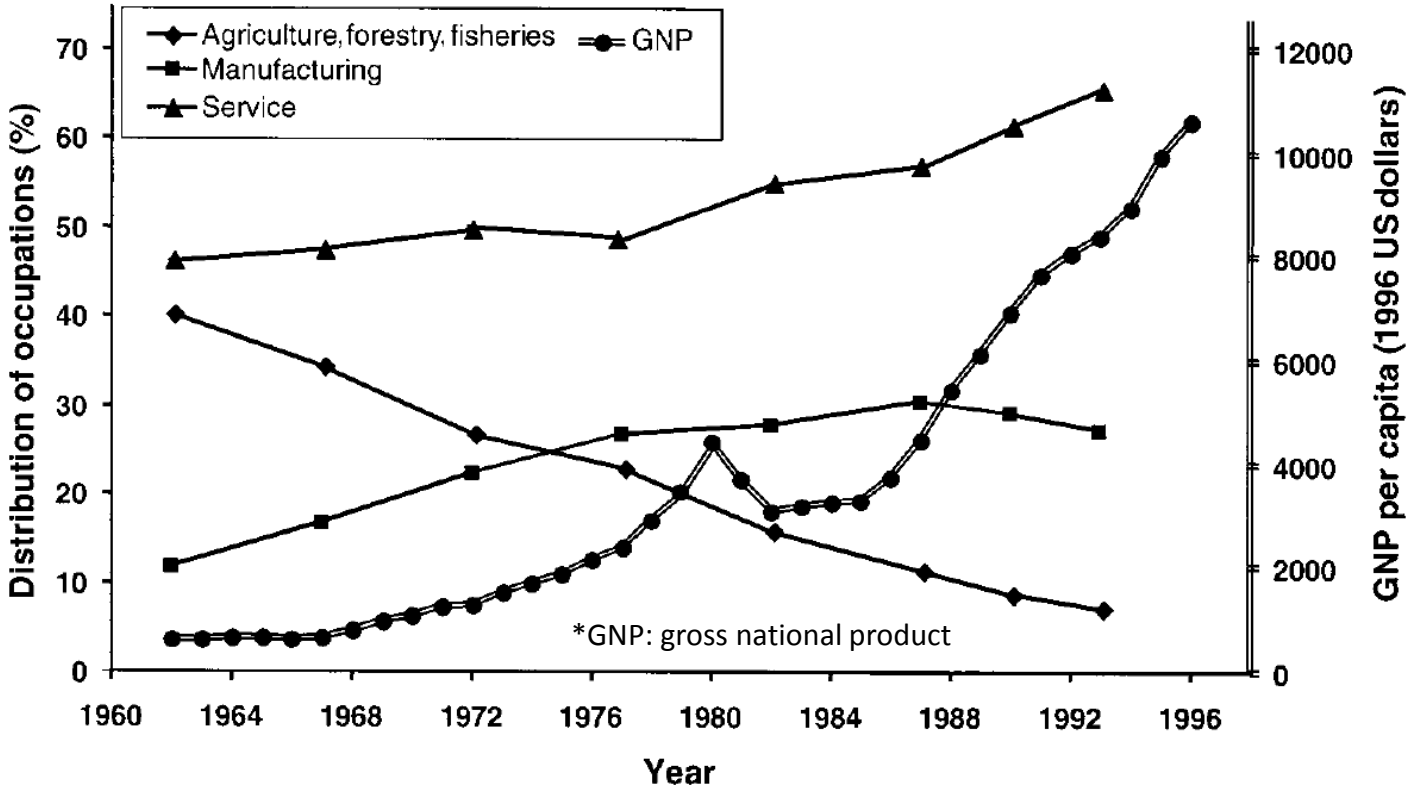


Fig. Trends in GNP and the distribution of occupations, South Korea, 1962–1996

Kim S, et al. Am J Clin Nutr. 71(1):44-53, 2000

Changes of physical activity
in South Korea

Rapidly increasing diabetes-related mortality with socio-environmental changes in South Korea during the last two decades

- Re-analyzed the annual reports on mortality in S. Korea by KNSO from 1983 to 2001

Changes of indirect measures of physical activity

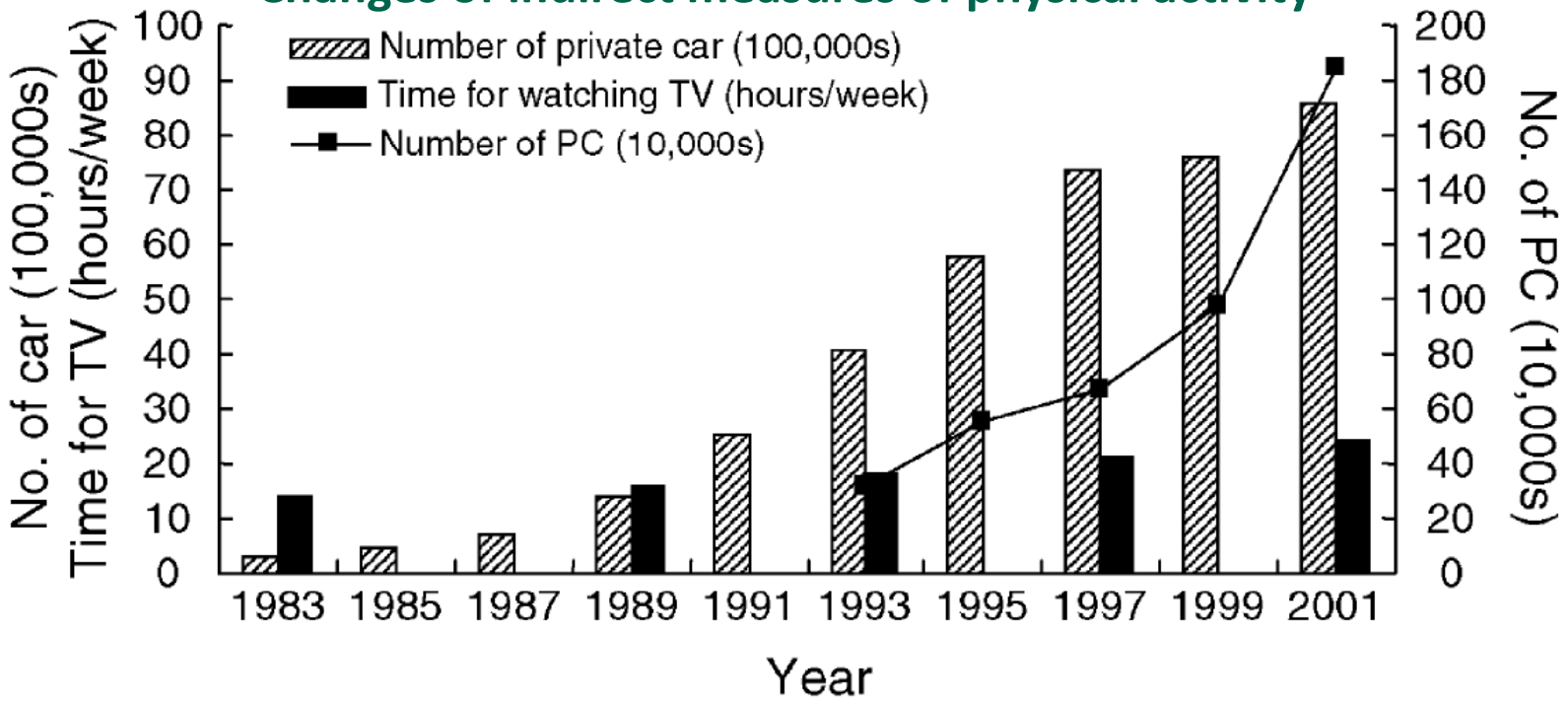
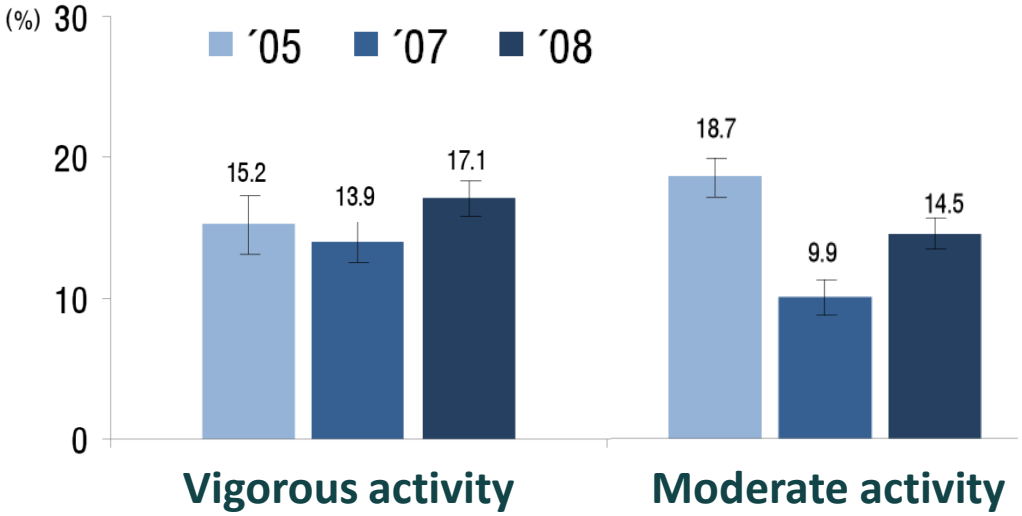
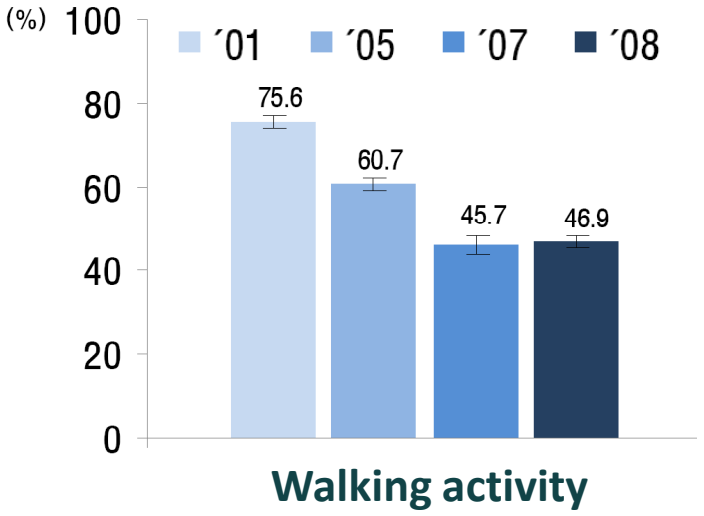


Fig. Trends of changes in proxies for physical activities among South Koreans.

Choi YJ, et al. Diabetes Res Clin Pract. 74(3):295-300, 2006

Physical activity
in South Korea





※ 격렬한신체활동실천율 : 최근 1주일 동안 평소보다 몸이 매우 힘들거나 숨이 많이 가쁜 격렬한 신체활동을 1회 20분 이상, 주 3일 이상 실천한 분율, 만19세 이상

※ 중등도신체활동실천율 : 최근 1주일 동안 평소보다 몸이 조금 힘들거나 숨이 약간 가쁜 중등도 신체활동을 1회 30분 이상, 주 5일 이상 실천한 분율, 만19세 이상

※ 최근 1주일 동안 걷기를 1회 30분 이상, 주 5일 이상 실천한 분율, 만19세 이상
('01년 : 평소 하루에 총 30분 이상 걷는 분율, 만19세 이상)

KNHANES, 2008

Physical activity
in U.S.A

Physical activity and incidence of NIDDM in women

- Prospective cohort of 87,253 US women aged 34-59 years and free of DM, CVD, and cancer.
- During 8 years of F/U (confirmed 1,303 cases of NIDDM)

Table. Physical activity level and RR of NIDDM during 8 years of follow-up

Frequency of vigorous exercise (per week)	Total person-years	No. cases of NIDDM	Age-adjusted RR (95% CI)	Age and BMI adjusted (95% CI)
0	362,784	844	1.0	1.0
1	62,740	100	0.74 (0.6-0.91)	0.89 (0.72-1.11)
2	73,242	88	0.55 (0.44-0.68)	0.71 (0.56-0.89)
3	62,139	100	0.73 (0.59-0.9)	0.93 (0.75-1.16)
4+	94,290	135	0.63 (0.53-0.75)	0.86 (0.71-1.04)
Total	**655,195**	**1,267**	—	—

Manson JE, et al. Lancet. 338(8770):774-8, 1991

Physical activity

The Physicians' Health Study in U.S.A

A prospective study of exercise and incidence of diabetes among US male physicians

- Prospective cohort study (5 years of follow-up)
- 21,271 US male physicians, aged 40-84 years and free of diagnosed DM, MI, CVA, and cancer

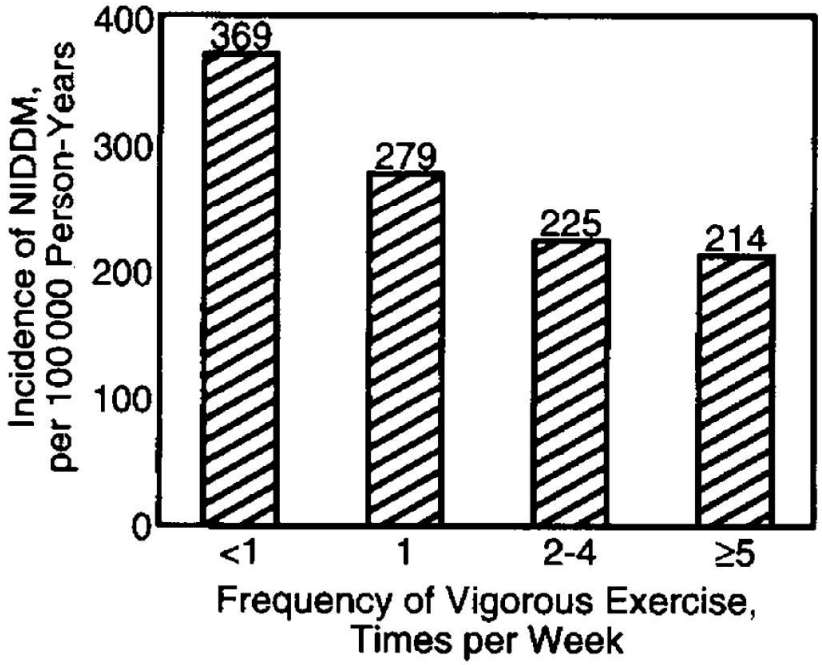


Fig. Age-adjusted incidence rates of NIDDM according to frequency of vigorous exercise

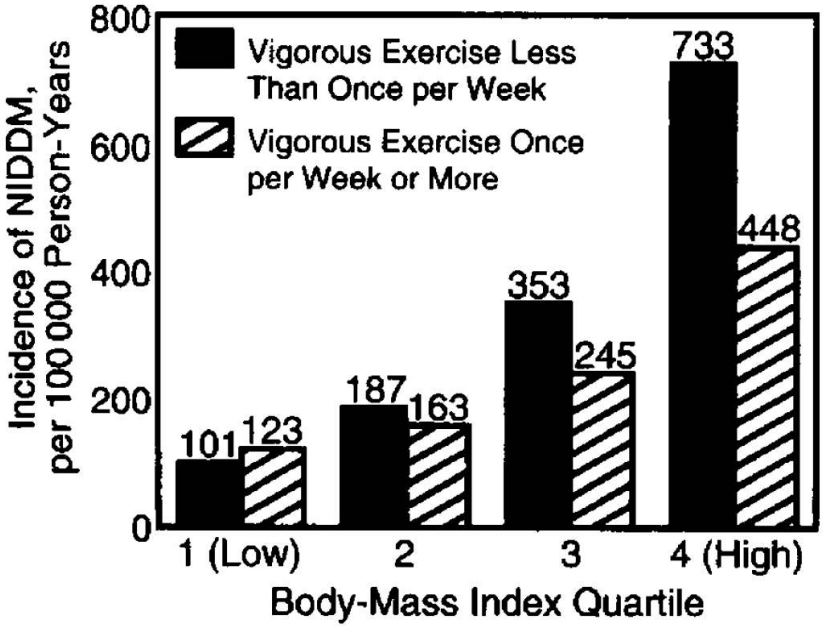


Fig. Age-adjusted incidence rates of NIDDM according to frequency of vigorous exercise, presented separately by quartile of BMI.
(Cutpoints for the BMI quartiles are <23, 23-24.4, 24.5-26.4, and >26.4 kg/m^2.) *Manson JE, et al. JAMA. 268(1):63-7, 1992*

Physical activity, BMI, and HTN

The Physicians' Health Study in U.S.A

A prospective study of exercise and incidence of diabetes among US male physicians

- Prospective cohort study (5 years of follow-up)
- 21,271 US male physicians, aged 40-84 years and free of diagnosed DM, MI, CVA, and cancer

Table. Physical activity, BMI, and History of HTN as independent predictors of NIDDM

Variable	Multivariate* Relative Risk (95% Confidence Interval)	P
Vigorous exercise†		
Less than weekly	1.00 (Referent)	. . .
At least weekly	0.70 (0.53 to 0.92)	.01
Body-mass index quartile, kg/m²		
<23	1.00 (Referent)	. . .
23-24.4	1.07 (0.64 to 1.79)	.79
24.5-26.4	1.73 (1.10 to 2.74)	.02
>26.4	3.09 (2.02 to 4.72)	<.001
History of hypertension‡		
No	1.00 (Referent)	. . .
Yes	2.03 (1.47 to 2.80)	<.001

*The multivariate model included simultaneous control for the variables listed above as well as age (years), cigarette smoking (current, former, never), history of high serum cholesterol level (yes, no), parental infarction before age 60 years (yes, no), alcohol consumption (daily or more often, weekly, monthly, less than monthly), and randomized treatment assignment to aspirin and β-carotene (active agent or placebo).

†Physical activity long enough to work up a sweat.

Manson JE, et al. JAMA. 268(1):63-7, 1992

Physical activity
the Osaka Health Survey in Japanese men

Leisure-time physical activity at weekends and the risk of T2DM in Japanese men

- Prospective examination of 6,013 Japanese men aged 35-60 years who were free of DM, IFG, or HTN at study entry

Table. RR of T2DM according to overall leisure-time physical activity on both weekdays and at weekends

Regular physical activity		Age-adjusted RR (95% CI)	Multiple-adjusted RR* (95% CI)
At least once a week			
Study entry (1981–90)†			
	No	1.00	1.00
	Yes	0.73 (0.59–0.89)	0.75 (0.61–0.93)
Study entry – the third examination‡			
(1981–1990)	(1985–1994)		
No →	No	1.00	1.00
Yes →	No	0.77 (0.54–1.08)	0.78 (0.56–1.10)
No →	Yes	0.70 (0.50–0.98)	0.66 (0.47–0.93)
Yes →	Yes	0.61 (0.45–0.82)	0.63 (0.47–0.86)
Frequency (times per week)			
0		1.00	1.00
1–2		0.78 (0.63–0.97)	0.80 (0.64–0.99)
⩾3		0.54 (0.34–0.86)	0.55 (0.34–0.87)

Okada K, et al. Diabet Med. 17(1):53-8, 2000

Physical activity
in Japanese male office workers

Hours of work and the risk of developing T2DM in Japanese male office workers

- A cohort of 1,266 Japanese male office workers aged 35-59 years and free of IFG, T2DM, history of DM, or medication for HTN were re-examined over 5 successive years

Table. Hours of work a day and the risks of T2DM among 1266 Japanese male office workers during 5 years of follow up.

	Hours of work a day					*Test for trend p value*
	< 8.0	*8.0–8.9*	*9.0–9.9*	*10.0–10.9*	*≥ 11.0*	
Type 2 diabetes:						
Cases	20	19	6	5	4	
Person-years	1651	1577	1048	838	824	
Rate/1000 person-years	12.1	12.0	5.7	6.0	4.9	
Age adjusted relative risk	1.00	0.91	0.46	0.43	0.36	0.014
(95% CI)	(Reference)	(0.48 to 1.72)	(0.17 to 1.26)	(0.17 to 1.10)	(0.12 to 1.11)	
Multivariate adjusted relative risk*	1.00	0.90	0.50	0.49	0.30	0.014
(95% CI)	(Reference)	(0.46 to 1.74)	(0.18 to 1.42)	(0.19 to 1.26)	(0.09 to 0.94)	

Nakanishi N, et al. Occup Environ Med. 58(9):569-74, 2001

Physical activity
in middle-aged Japanese men

Daily life activity and risk of developing T2DM in middle-aged Japanese men

- 2,924 Japanese male office workers aged 35 to 59 years who did not have IFG, T2DM or a history of CVD, and were not receiving medication for HTN

Table. Risk of developing IFG or T2DM according to levels of selected daily life activities.

Energy expenditure in daily life ($kcal \cdot kg^{-1} \cdot day^{-1}$)	Cases/ person-years	Rate per 1000 person-years	RR (95% CI)	
			Age-adjusted values	Multivariate-adjusted values[a]
Occupational physical activity[b]				
<14.3	155/5646	27.5	1.00 (reference)	1.00 (reference)
14.3–17.9	117/5956	19.6	0.75 (0.59–0.95)	0.88 (0.68–1.12)
≥18.0	97/6086	15.9	0.62 (0.48–0.80)	0.85 (0.65–1.13)
p value for trend			<0.001	0.242
Walking or cycling[c]				
<2.9	137/5948	23.0	1.00 (reference)	1.00 (reference)
2.9–4.8	110/5943	18.5	0.79 (0.61–1.01)	0.87 (0.67–1.12)
≥4.9	122/5796	21.0	0.88 (0.69–1.12)	1.03 (0.80–1.31)
p value for trend			0.277	0.881
Brisk walking				
<1.3	145/5573	26.0	1.00 (reference)	1.00 (reference)
1.3–2.4	139/6623	21.0	0.81 (0.64–1.02)	0.97 (0.76–1.23)
≥2.5	85/5491	15.5	0.59 (0.45–0.77)	0.78 (0.59–1.03)
p value for trend			<0.001	0.099
Other physical activities[d]				
<5.2	154/5662	27.2	1.00 (reference)	1.00 (reference)
5.2–7.6	120/5994	20.0	0.76 (0.60–0.97)	0.80 (0.63–1.02)
≥7.7	95/6031	15.8	0.58 (0.45–0.75)	0.68 (0.52–0.88)
p value for trend			<0.001	0.003

Nakanishi N, et al. Diabetologia. 47(10):1768-75, 2004

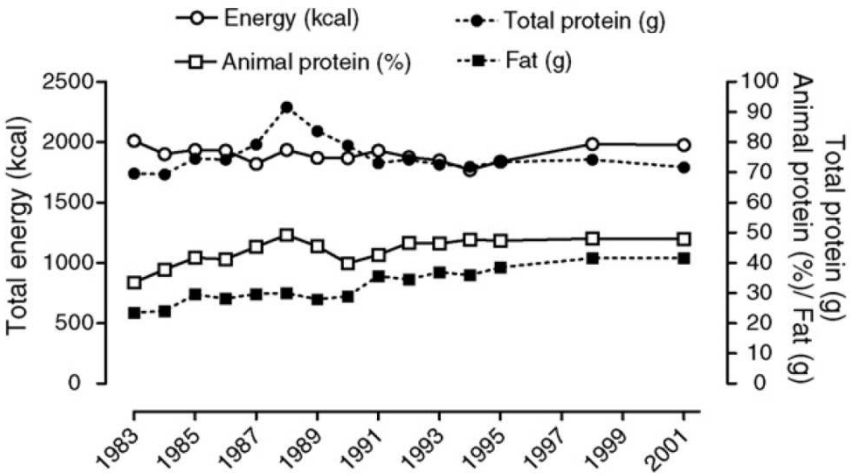
Nutritional changes
in South Korea

Rapidly increasing diabetes-related mortality with socio-environmental changes in South Korea during the last two decades

- Re-analyzed the annual reports on mortality in S. Korea by KNSO from 1983 to 2001

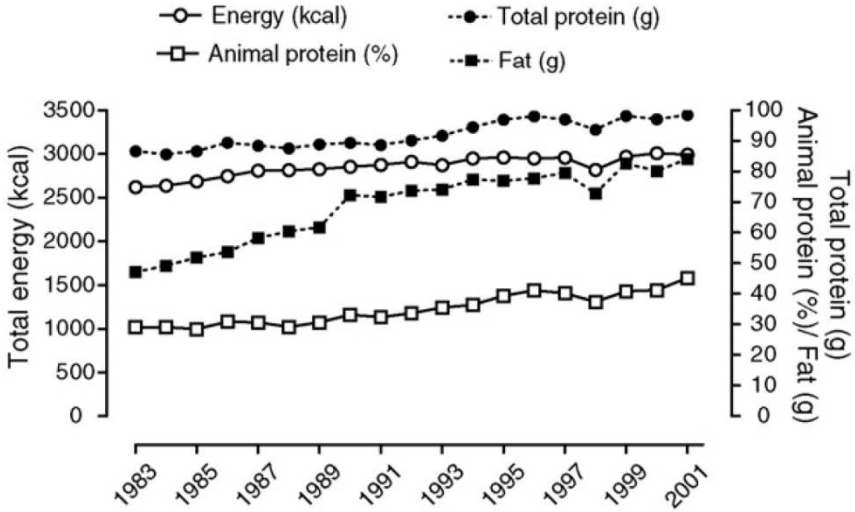
Trends of changes in diet factors in South Korea

Energy intake



- Overall total energy: 2012 kcal → 1976 kcal
- Plant–food intake: 75.0% → 56.0%
- Animal protein intake: 33.5% → 47.9%
- Fat intake: 23.5 g/day → 41.6 g/day

Energy supply



- Total energy supply: 2,622 kcal → 2,994 kcal
- Total protein & animal protein ↑
- Fat supply: 47.1 g/day → 84.0 g/day

Choi YJ, et al. Diabetes Res Clin Pract. 74(3):295-300, 2006

Total energy intake
in South Korea

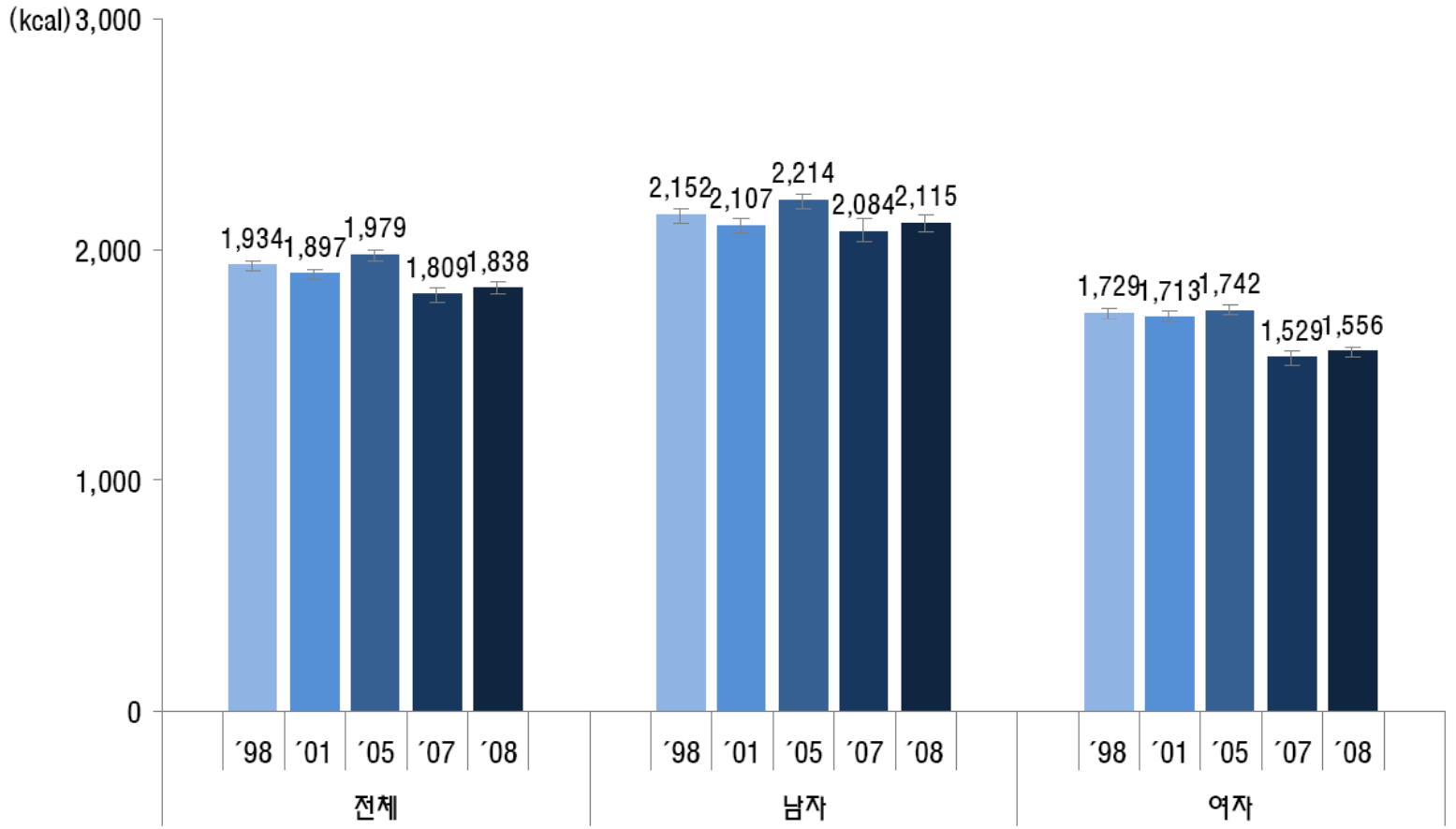


Fig. Trends in total energy intake in South Korea.

KNHANES, 2008

Sources of energy
in South Korea

The nutrition transition in South Korea

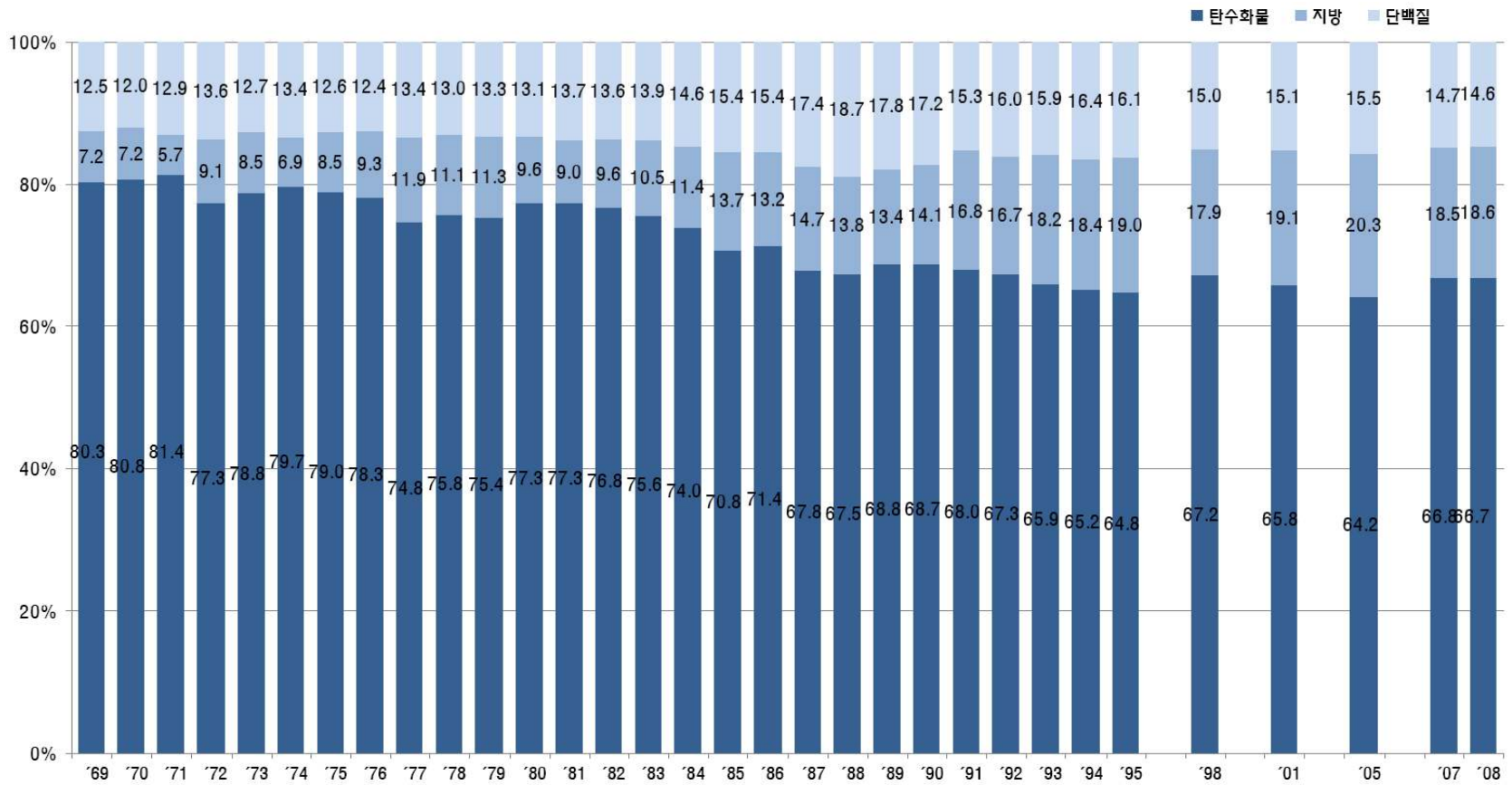


Fig. Trends in sources of energy in South Korea.

KNHANES, 2008

Intake trends for major food groups
in South Korea

The nutrition transition in South Korea

- Secondary data on economics, dietary intake, anthropometry, and causes of death, including a series of comparable nationally representative dietary surveys (the National Nutrition Survey).

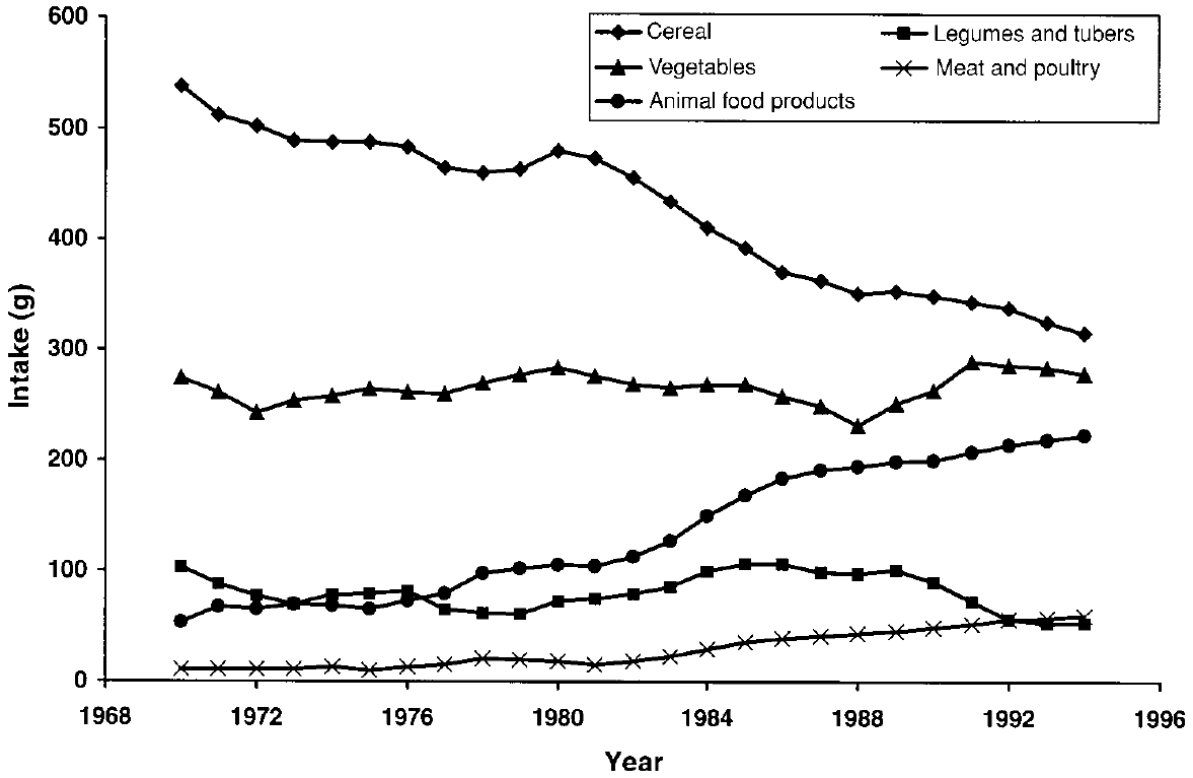


Fig. Trends in daily intake per capita by food group in South Korea.

Kim S, et al. Am J Clin Nutr. 71(1):44-53, 2000

Intake trends
in South Korea

The nutrition transition in South Korea

- Secondary data on economics, dietary intake, anthropometry, and causes of death, including a series of comparable nationally representative dietary surveys (the National Nutrition Survey).

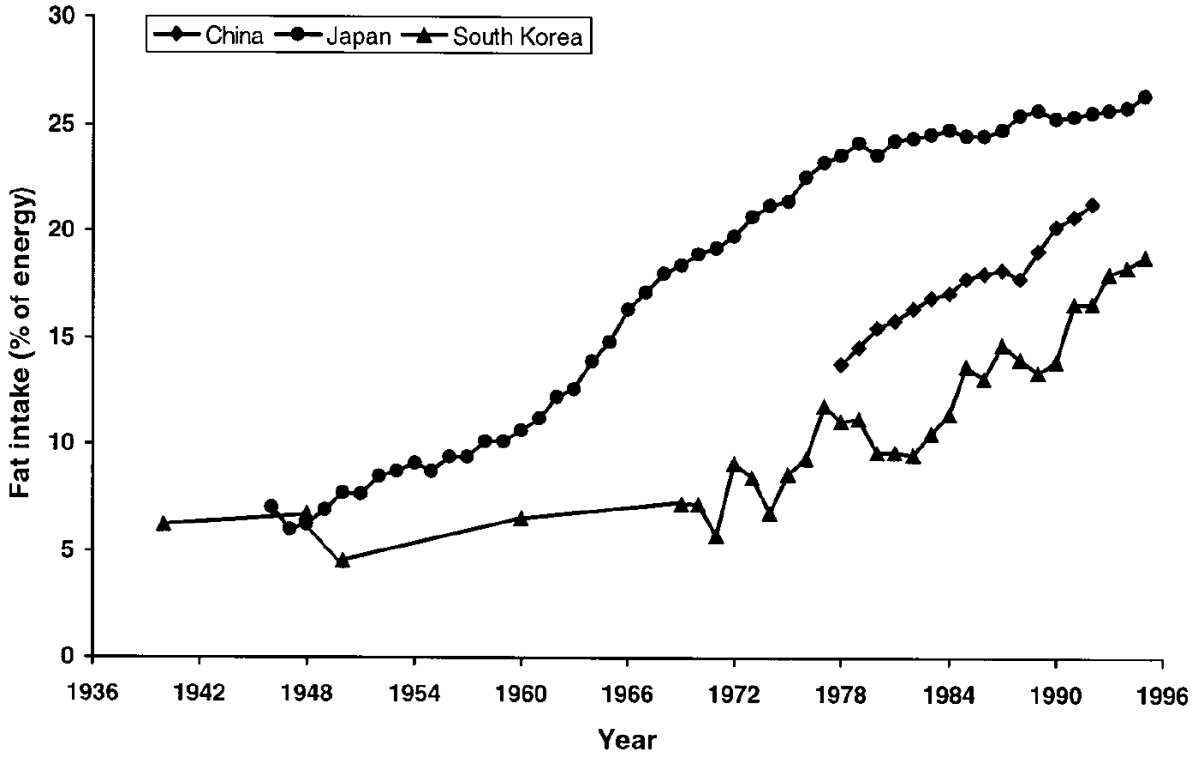


Fig. Trends in percentage of energy from fat (per capita per day) in China, Japan, and South Korea.

Kim S, et al. Am J Clin Nutr. 71(1):44-53, 2000

Diets

The Nurses' Health Study in U.S

Diet, lifestyle, and the risk of type 2 diabetes mellitus in women

- 84,941 female nurses from 1980 to 1996 (free of diagnosed CVD, DM, and cancer at baseline).
- Information about their diet and lifestyle was updated periodically.

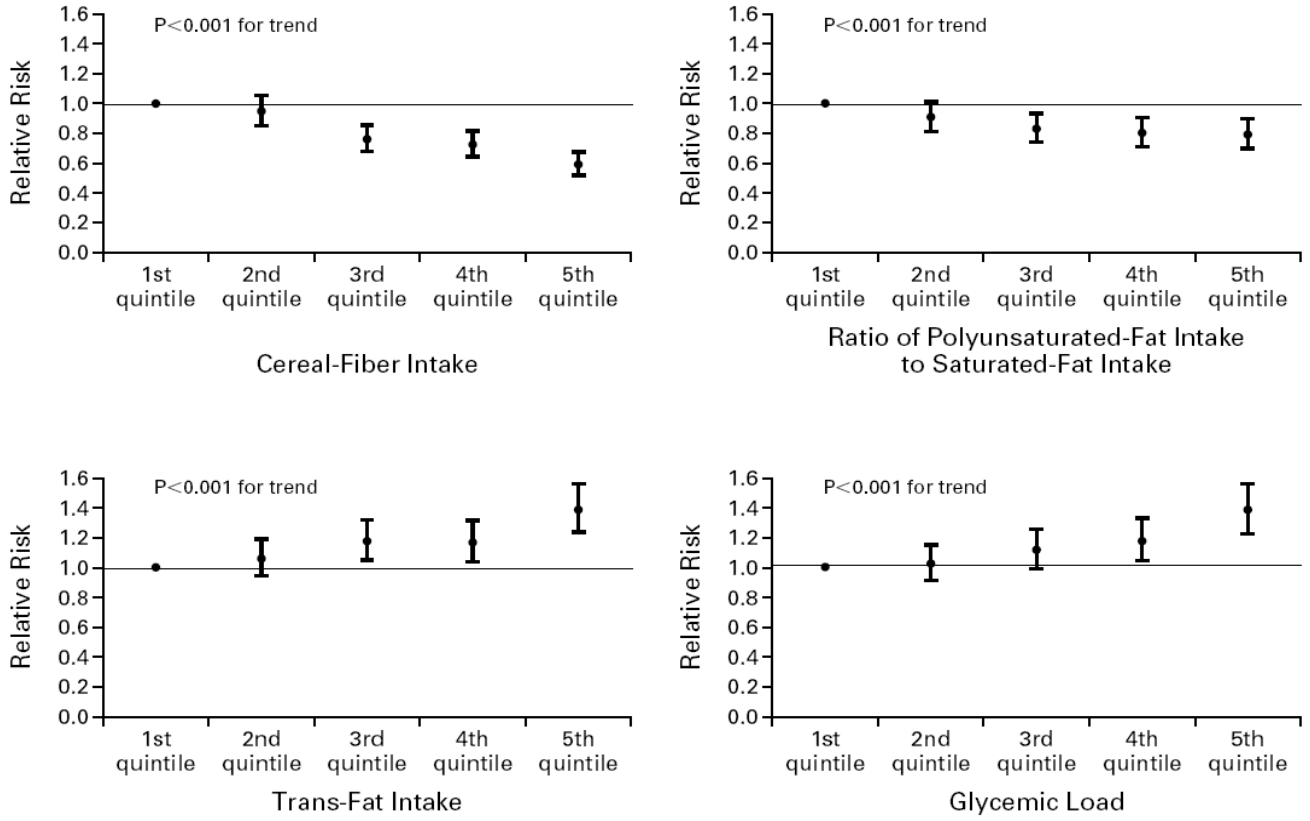


Fig. Multivariate RRs of T2DM according to ascending quintiles of diet intake

Hu FB, et al. N Engl J Med. 345(11):790-7, 2001

Lifestyles
The Nurses' Health Study in U.S

Diet, lifestyle, and the risk of type 2 diabetes mellitus in women

- 84,941 female nurses from 1980 to 1996 (free of diagnosed CVD, DM, and cancer at baseline).
- Information about their diet and lifestyle was updated periodically.

Factor	Body-Mass Index		
	<25.0	25.0–29.9	≥30.0
	relative risk (95% confidence interval)		
Quintile for dietary score†			
1	1.0	1.0	1.0
2	0.68 (0.49–0.94)	0.80 (0.66–0.96)	0.89 (0.77–1.03)
3	0.66 (0.46–0.95)	0.69 (0.55–0.86)	0.81 (0.69–0.96)
4	0.51 (0.36–0.72)	0.55 (0.45–0.68)	0.72 (0.62–0.84)
5	0.38 (0.25–0.58)	0.42 (0.32–0.55)	0.49 (0.40–0.61)
Weekly exercise‡			
<0.5 hr	1.0	1.0	1.0
0.5–1.9 hr	0.74 (0.48–1.16)	0.92 (0.70–1.23)	0.83 (0.69–0.99)
2.0–3.9 hr	0.70 (0.45–1.10)	0.90 (0.67–1.21)	0.82 (0.68–1.00)
4.0–6.9 hr	0.63 (0.40–1.00)	0.91 (0.68–1.21)	0.76 (0.62–0.92)
≥7.0 hr	0.50 (0.25–0.99)	1.06 (0.69–1.63)	0.74 (0.51–1.09)
Smoking status			
Never smoked	1.0	1.0	1.0
Former smoker	0.95 (0.73–1.24)	1.00 (0.86–1.17)	1.24 (1.12–1.39)
Current smoker			
1–14 cigarettes/day	0.72 (0.44–1.18)	1.14 (0.85–1.54)	1.47 (1.17–1.85)
≥15 cigarettes/day	1.39 (1.02–1.88)	1.40 (1.14–1.71)	1.31 (1.10–1.56)
Daily alcohol consumption			
0 g	1.0	1.0	1.0
0.1–5.0 g	0.85 (0.65–1.11)	0.70 (0.60–0.82)	0.81 (0.72–0.90)
5.1–10.0 g	0.64 (0.42–0.98)	0.62 (0.48–0.81)	0.60 (0.48–0.76)
>10.0 g	0.85 (0.63–1.14)	0.57 (0.46–0.71)	0.61 (0.50–0.74)

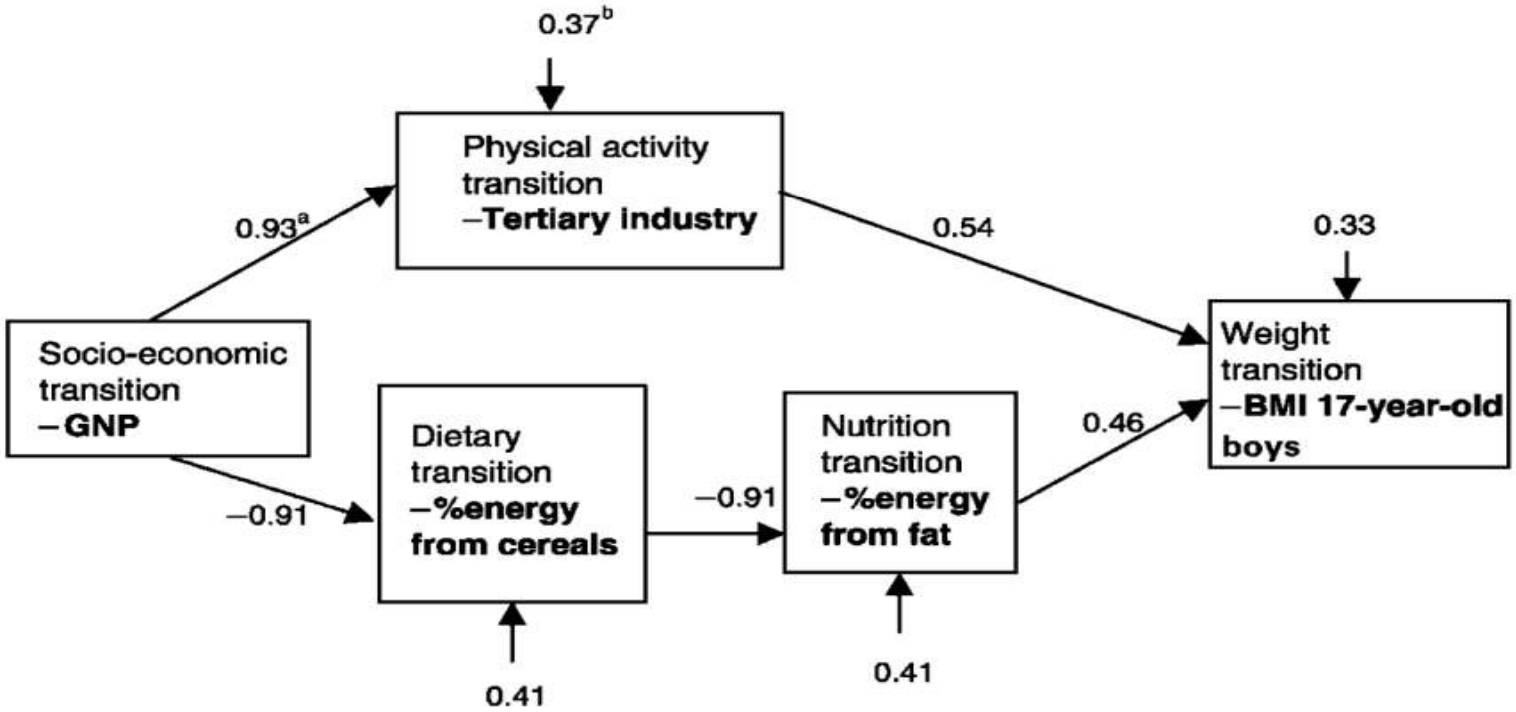
Table. Multivariate RRs of T2DM according to BMI

Hu FB, et al. N Engl J Med. 345(11):790-7, 2001

Transition
in South Korea

Socio-economic, dietary, activity, nutrition and BW transitions in South Korea

- Data were drawn from published government reports: the Korean National Nutrition Survey and annual reports at the national level for the years between 1969 and 1993.



a. Numbers on the arrows between transition boxes are path coefficients
b. Numbers on the outside arrows pointing into transition boxes are residuals

Lee SK, Sobal J. Public Health Nutr. 6(7):665-74, 2003

Genetic susceptibility

Comprehensive association study of T2DM and related quantitative traits with 222 candidate genes

- 1,161 T2DM subjects and 1,174 control Finns who are NGT
- Genotyped 3,531 tagSNPs and annotation-based SNPs and imputed an additional 7,498 SNPs

Table. Diabetes association for SNPs genotyped in FUSION stage 1 and 2 samples

SNP	Gene symbol	Chromosome	Position (bp)*	Risk/nonrisk allele	Risk allele frequency	Odds ratio (95% CI)	P_{SNP}
rs4740283	*RAPGEF1*	9	131,477,850	G/A	0.104	3.12 (1.73–5.63)	0.00013
rs2021966	*ENPP1*	6	132,192,132	A/G	0.608	1.27 (1.13–1.43)	0.00026
rs1042522	*TP53*	17	7,520,197	G/C	0.263	1.18 (1.08–1.30)	0.00086
rs1882095	*NRF1*	7	128,991,595	T/C	0.381	1.24 (1.10–1.40)	0.00096
rs10513684	*SLC2A2*	3	172,206,912	C/T	0.918	1.28 (1.11–1.49)	0.0023
rs1801282	*PPARG*	3	12,368,125	C/G	0.836	1.20 (1.07–1.33)	0.0034
rs222852	*SLC2A4*	17	7,081,330	A/G	0.610	1.14 (1.04–1.23)	0.0070
rs4843165	*FOXC2*	16	85,162,542	C/T	0.706	1.15 (1.05–1.25)	0.0078
rs5400‡	*SLC2A2*	3	172,215,002	G/A	0.871	1.19 (1.06–1.35)	0.010
rs858341	*ENPP1*	6	132,202,148	G/A	0.510	1.21 (1.06–1.39)	0.012
rs1349498	*RAPGEF4*	2	173,418,113	C/T	0.729	1.35 (1.09–1.67)	0.015
rs8069976	*SOCS3*	17	73,861,445	C/A	0.849	1.17 (1.04–1.31)	0.016
rs3769249	*RAPGEF4*	2	173,648,169	G/A	0.647	1.27 (1.06–1.51)	0.018
rs17280845	*CBLB*	3	106,927,226	T/C	0.238	1.37 (1.07–1.76)	0.027
rs5219‡	*KCNJ11*	11	17,366,148	T/C	0.476	1.11 (1.02–1.20)	0.031
rs10915239	*MECR*	1	29,344,565	C/A	0.945	1.26 (1.04–1.51)	0.033

Gaulton KJ, et al. Diabetes. 57(11):3136-44, 2008

Nuclear respiratory factor 1 (nRF1) gene

Association between polymorphisms in the NRF 1 gene and T2DM in the Korean population

- The NRF1 gene was sequenced to identify polymorphisms in 24 Korean DNA samples
- 766 patients with type 2 diabetes and 303 non-diabetic subjects

Table. Association between haplotypes and the risk of type 2 diabetes

Haplotype	Locus						Frequency		p value[a]
	−46,567	−46,350	141	33,162	54,529	59,745	Diabetes	Control	
H1	G	insA	G	C	A	A	0.499	0.533	0.138
H2	G	delA	G[b]	C	A[b]	A	0.042	0.066	0.009
H3	G	delA	G	C	A	G	0.097	0.087	0.626
H4	G	delA	T[b]	C	G[b]	A	0.277	0.226	0.004
H5	A	delA	T	T	G	A	0.062	0.061	0.880

Each haplotype with a frequency >0.05 is shown

[a] p values of haplotype associations were calculated by the Haplo.Score algorithm developed by Schaid et al. [14], while controlling for age, sex and BMI as covariates. They were not corrected for multiple comparisons (five tests)

[b] Alleles regarded as the determinants modifying susceptibility to type 2 diabetes after examining the allelic differences between the protective (*H2*) and susceptible (*H4*) haplotypes

Cho YM, Lee HK, et al. Diabetologia. 48(10):2033-8, 2005

Nuclear respiratory factor 1 (nRF1) gene

Genetic variation and association analyses of nRF1 gene in Chinese pts with T2DM

- 1,027 unrelated subjects, including T2DM pts (n=596) and non-DM control subjects (n=431)
- Using a variation screening approach, 6 novel & 10 known SNPs in NRF1 gene were identified

Table. Association between the NRF1 genetic polymorphisms and type 2 diabetic patients

No.	SNP ID	SNP type	Genotype	Type 2 diabetic patients	Nondiabetic control subjects	Additive OR (95% CI); *P/Pc* values	Dominant OR (95% CI); *P/Pc* values	Statistical power*
			TT	482 (80.9)	312 (72.4)			
			TC	110 (18.5)	114 (26.5)	0.654 (0.464–0.842); **0.001/0.018**	0.620 (0.462–0.832); **0.001/0.018**	0.999
P1	Novel	−46127 T>C	CC	4 (0.6)	5 (1.1)			
			AA	562 (94.3)	423 (98.1)			
			AG	34 (5.7)	8 (1.9)	3.314 (1.444–6.693); **0.002/0.036**	3.199 (1.466–6.981); **0.002/0.036**	0.998
P9	Novel	+98560 A>G	GG	0 (0.0)	0 (0.0)			

Table. Common haplotypes of SNPs in the NRF1 gene

	Haplotypes	Type 2 diabetic patients	Nondiabetic control subjects	OR (95% CI)	*P/Pc* values
H1	T-*A*-*G*-G-T-A-C-*G*	486 (40.8)	317 (36.8)	1.184 (0.988–1.417)	0.067/0.268
H2	*T*-**G**-**G**-*G*-*T*-*A*-*C*-**G**	174 (14.6)	167 (19.4)	0.706 (0.557–0.895)	0.004/0.016
H3	T-*G*-*T*-G-T-A-C-*G*	129 (10.8)	72 (8.4)	1.332 (0.968–1.832)	0.063/0.252
H4	T-*A*-*G*-G-T-A-C-*A*	58 (4.9)	46 (5.3)	0.908 (0.599–1.383)	0.631/—

Data are *n* (%). SNP P9 was not included in the haplotype analyses. The alleles from SNPs P1, -4, -5, -6, and -7 constructed in these four haplotypes were the same and are represented in italic letters. Four haplotypes, therefore, can be simply defined as A-G-G, G-G-G, G-T-G, and A-G-A, which were constructed from SNPs P2, P3, and P8. *P* values had no adjustment, while *Pc* values were corrected for multiple comparisons.

Liu Y, et al. Diabetes. 57(3):777-82, 2008

Gene

Table. Replicated type 2 diabetes gene nearest to the identified marker

Gene	Chromosome location	Gene function	Marker	Risk allele	OR*	Replicated/discovered marker in Asian populations	Risk allele	OR
PPARG	3	Adipocyte development; target of glitazone class of drugs	rs1801282[58]	C	1·14	Not consistently replicated[53]	..	..
KCNJ11	11	Kir6·2 potassium channel	rs5219[59]	T	1·14	Japanese (rs5219)[60,61]	T	1·25, 1·32
TCF7L2	10	Transcription factor, transactivates glucagon, regulates insulin secretion	rs7903146, rs1225537[54]	T, T	1·37	Indians (rs12255372,[62] rs7903146,[63] rs10885409[64])	T, T, C	1·50, 1·50, 1·64
TCF7L2	10	Transcription factor, transactivates glucagon, regulates insulin secretion	rs7903146[55]	T	1·46	Chinese (rs290487,[56] rs1196205,[65] rs1196218[57])	C, C, G	1·51, 2·11, 1·43
TCF7L2	10	Transcription factor, transactivates glucagon, regulates insulin secretion	..	..	..	Japanese (rs1255372,[66] rs7903146[67])	T, T	1·70, 1·69
SLC30A8	8	Zinc transporter, insulin storage and secretion	rs13266634[58]	C	1·12	Japanese (rs13266634);[60] Chinese and Koreans (rs13266634)[57]	C; C	1·23; 1·13
CDKAL1	6	Islet glucotoxicity sensor, regulates insulin secretion	rs7756992, rs13266634;[68] rs7754840[58]	G, C; C	1·20, 1·15; 1·12	Chinese (rs7756992, rs13266634);[68] Japanese (rs7756992)[60]	G, C; G	1·25, 1·19; 1·16
HHEX	10	Transcription factor in pancreatic development	rs1111875[58]	C	1·13	Japanese (rs1111875);[60] Chinese and Koreans (rs7923837)[57]	C; G	1·24; 1·25
IGF2BP2	3	Growth factor binding protein, pancreas development	rs4402960[58]	T	1·14	Chinese and Koreans (rs4402960);[57] Japanese (rs4402960);[60] Indians (rs4402960)[64]	T; T; T	1·12; 1·37; 1·37
CDKN2A/ CDKN2B	9	Cyclin-dependent kinase inhibitor, islet development	rs10811661[58]	T	1·2	Chinese and Koreans (rs10811661);[57] Chinese (rs10811661);[69] Japanese (rs10811661)[60]	T; T; T	1·27; 1·31; 1·26
FTO	16	Fat mass and obesity associated; alters body-mass index	rs8050136[58]	A	1·17	Indians (rs9939609);[64] Chinese and Koreans (rs8050136)[57]	A; A	1·46; 1·16
WFS1	4	Wolframin. Endoplasmic reticulum transmembrane protein	rs10010131[70]	G	1·15	†	..	..
JAZF1	7	Transcriptional repressor	rs864745[71]	T	1·10	†	..	..
HNF1B	17	Transcription factor, pancreas development	rs757210[72]	A	1·12	†	..	..
CDC123/ CAMK1D	10	Calcium/calmodulin-dependent protein kinase 1D; cell cycle	rs12779790[71]	G	1·11	†	..	..
ADAMTS9	3	Secreted metalloprotease	rs4607103[71]	C	1·09	†	..	..
NOTCH2	1	Transmembrane receptor; pancreatic organogenesis	rs10923931[71]	T	1·13	†	..	..
THADA	2	Thyroid adenoma associated gene; apoptosis	rs7578597[71]	T	1·15	†	..	..
TSPAN8/ LGR5	12	Tetraspanin 8; cell surface glycoprotein	rs7961581[71]	C	1·09	†	..	..
KCNQ1	11	Potassium voltage-gated channel	rs2237892,[73] rs2237895[74]	C, C	1·29, 1·24	Japanese (rs 2237892),[73] Chinese (rs2237892),[73] Korean (rs2237892)[73]	C, C, C	1·43, 1·38, 1·41

Ramachandran A, Ma RC, Snehalatha C. Lancet. 375(9712):408-18, 2010

FPG and dyslipidemia

Independent risk factors for T2DM in Korean adults

- 5,372 non-diabetic participants (3,670 men and 1,702 women; 20-79 years), 5 yrs F/U

Table. Risk factors of the incident T2DM in multiple logistic regression analysis

	Relative risk	95% CI	*P*-value
Sex (male vs. female)	1.06	0.64–1.75	0.809
Current smoking	1.75	1.23–2.47	0.002
Family history of DM	2.12	1.49–3.00	< 0.001
Age (10 years)	1.26	1.04–1.53	0.019
BMI (2.5 kg/m^2)	1.37	1.16–1.62	< 0.001
ALT (quartile)	1.30	1.08–1.57	0.006
Fasting glucose (quartile)	3.35	2.69–4.17	< 0.001
Triglycerides (quartile)	1.07	0.89–1.28	0.474
HDL cholesterol (quartile)	0.84	0.71–1.00	0.048
Fatty liver	1.51	1.04–2.20	0.034

Kim CH, et al. Diabet Med. 25(4):476-81, 2008

Fasting plasma glucose
Israeli Diabetes Research Group

Normal fasting plasma glucose levels and type 2 diabetes in young men

- 13,163 subjects who had baseline FPG levels <100 mg/dL (men, 26-45 yrs of age)
- A total of 208 incident cases of T2DM occurred (during 74,309 person-years of F/U)

Table. Hazard Ratios for Type 2 Diabetes among 13,163 Men According to Quintiles of Normal FPG Levels.

Variable	Quintile 1 (N=2529)	Quintile 2 (N=2545)	Quintile 3 (N=2598)	Quintile 4 (N=2719)	Quintile 5 (N=2772)	P Value for Trend
Fasting plasma glucose levels (mg/dl)	50–81	82–86	87–90	91–94	95–99	—
Person-years of follow-up	13,830	13,969	14,631	15,637	16,242	—
No. of incident cases of diabetes	20	24	37	50	77	—
Adjusted risk ratio (95% CI)						
Age	1	1.47 (0.97–2.23)	1.81 (1.16–2.83)	2.33 (1.42–3.83)	3.05 (1.78–5.18)	<0.001
Age and body-mass index	1	1.35 (0.89–2.05)	1.65 (1.06–2.58)	2.17 (1.32–3.56)	2.68 (1.57–4.56)	<0.001
Age, triglyceride level, and body-mass index	1	1.30 (0.86–1.99)	1.58 (1.02–2.48)	2.05 (1.25–3.37)	2.40 (1.40–4.11)	<0.001
Multivariate†	1	1.43 (0.94–2.19)	1.82 (1.16–2.86)	2.64 (1.60–4.37)	2.84 (1.67–4.87)	<0.001

† The multivariate Cox regression model was adjusted for age, BMI, and TG levels as continuous variables; physical activity, F/H of DM, and smoking status.

Tirosh A, et al. N Engl J Med. 353(14):1454-62, 2005

IFG & IGT

the Singapore Impaired Glucose Tolerance (IGT) Follow-up Study

Lowering the criterion for IFG: impact on ds. prevalence & associated risk of DM

- the Singapore Impaired Glucose Tolerance (IGT) Follow-up Study (295 IGT & 292 NGT, 8 yrs F/U)

Table. Risk of development of diabetes according to FPG.

Glucose tolerance based on FPG criteria	*n*	Percentage who developed diabetes	Odds ratio (95% CI)
Analyses with subjects pooled within categories of FPG if FPG 5.6–6.9 mmol/l			
FPG < 5.6 mmol/l			
NGT*	200	2.4	1
IGT*	89	19.1	9.7 (3.5–26.3)
FPG 5.6–6.0 mmol/l	137	22.2	12.4 (4.7–32.8)
FPG 6.1–6.9 mmol/l	43	55.2	55.1 (20.4–148.7)
Analyses with study subjects stratified by both FPG and 2-h PG criteria			
FPG < 5.6 mmol/l			
NGT*	200	2.4	1
IGT*	89	19.1	9.7 (3.5–26.8)
FPG 5.6–6.0 mmol/l			
NGT*	66	9.6	4.4 (1.3–14.6)
IGT*	71	31.1	19.8 (7.4–53.5)
FPG 6.1–6.9 mmol/l			
NGT*	10	28.6	17.6 (4.0–77)
IGT*	33	59.8	66.2 (24.1–182.1)

Odds ratios of future diabetes were estimated using logistic regression analysis and were adjusted for age, sex, and ethnic group. Data are presented for glucose tolerance determined by FPG with and without stratification by 2-h PG following a 75-g OGTT. *Glucose tolerance based on 2-h PG criteria.

Tai ES, et al. Diabetes Care. 27(7):1728-34., 2004

IFG in Taiwan

IFG and risk of diabetes in Taiwan: follow-up over 3 years.

- A population-based cohort study was conducted among residents aged >or=40 years on the island of Penghu, Taiwan, (n=1,601)

Table. Variables independently associated with DM among 600 residents of Penghu Islets, Taiwan, 1998/1999

Variables	Age–sex adjusted odds ratio	95% CI
Triglyceride (40 mg/dl)	1.7	1.4–2.0**
Apolipoprotein B (40 mg/dl)	2.0	1.1–3.0*
IFG_0 (yes/no)	4.4	1.9–10.6**
WHR	7.1	3.4–10.8**
BMI (kg/m^2)	1.1	0.9–1.2
Family history (yes/no)	1.3	0.8–1.7

Odds ratios calculated by age-sex-adjusted multiple logistic regression analysis. Odds of diabetes were calculated vs. odds of not having diabetes. Independent variables available to the models were age, sex, family history of diabetes, BMI, triglyceride concentration, apolipoprotein B and IFG_0 (all at baseline, 1995-1996).

Chen KT, et al. Diabetes Res Clin Pract. 60(3):177-82, 2003

Insulin secretion and insulin resistance

in Korean type 2 diabetes mellitus

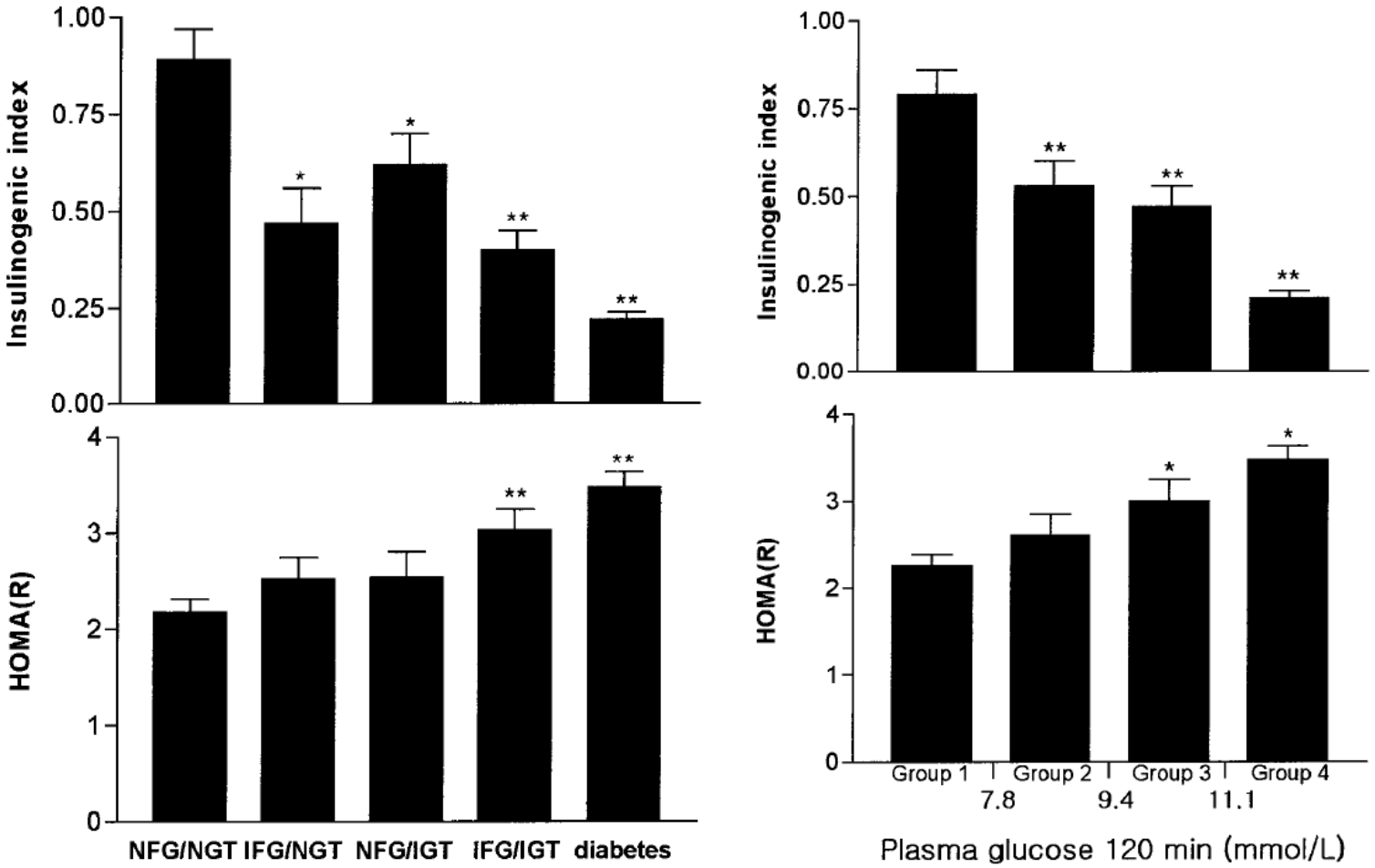
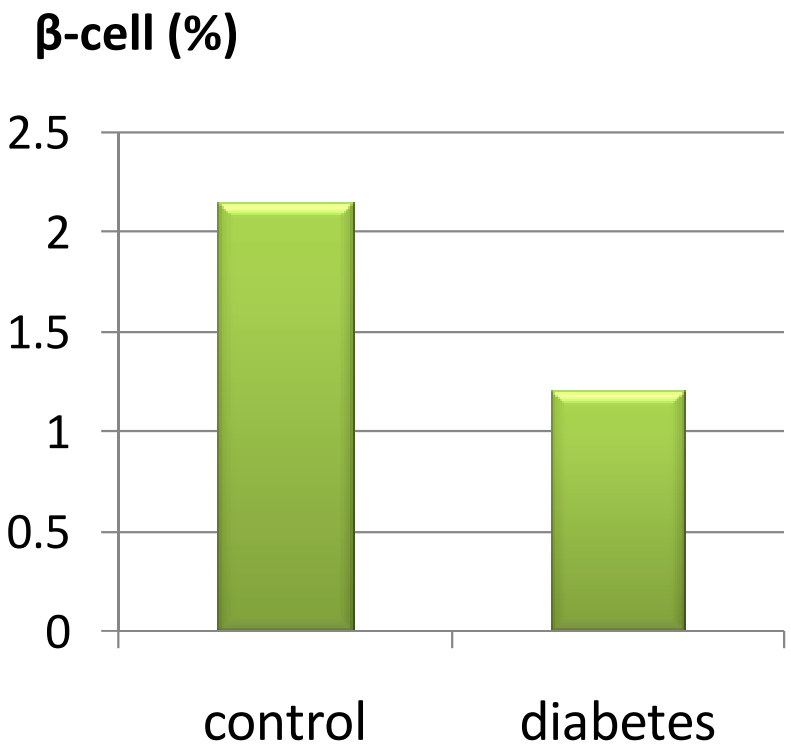
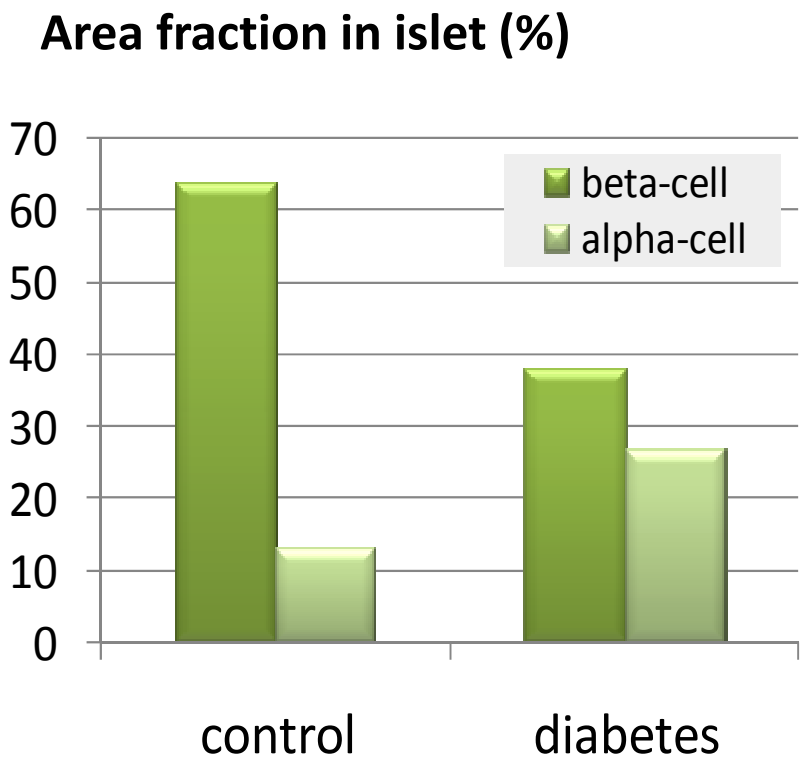


Fig. Insulinogenic index and HOMA(R) in the NFG/NGT, IFG/NGT, NFG/IGT, IFG/IGT, and diabetes groups.

Kim DJ, Lee MS, Kim KW, Lee MK. Metabolism. 50(5):590-3, 2001

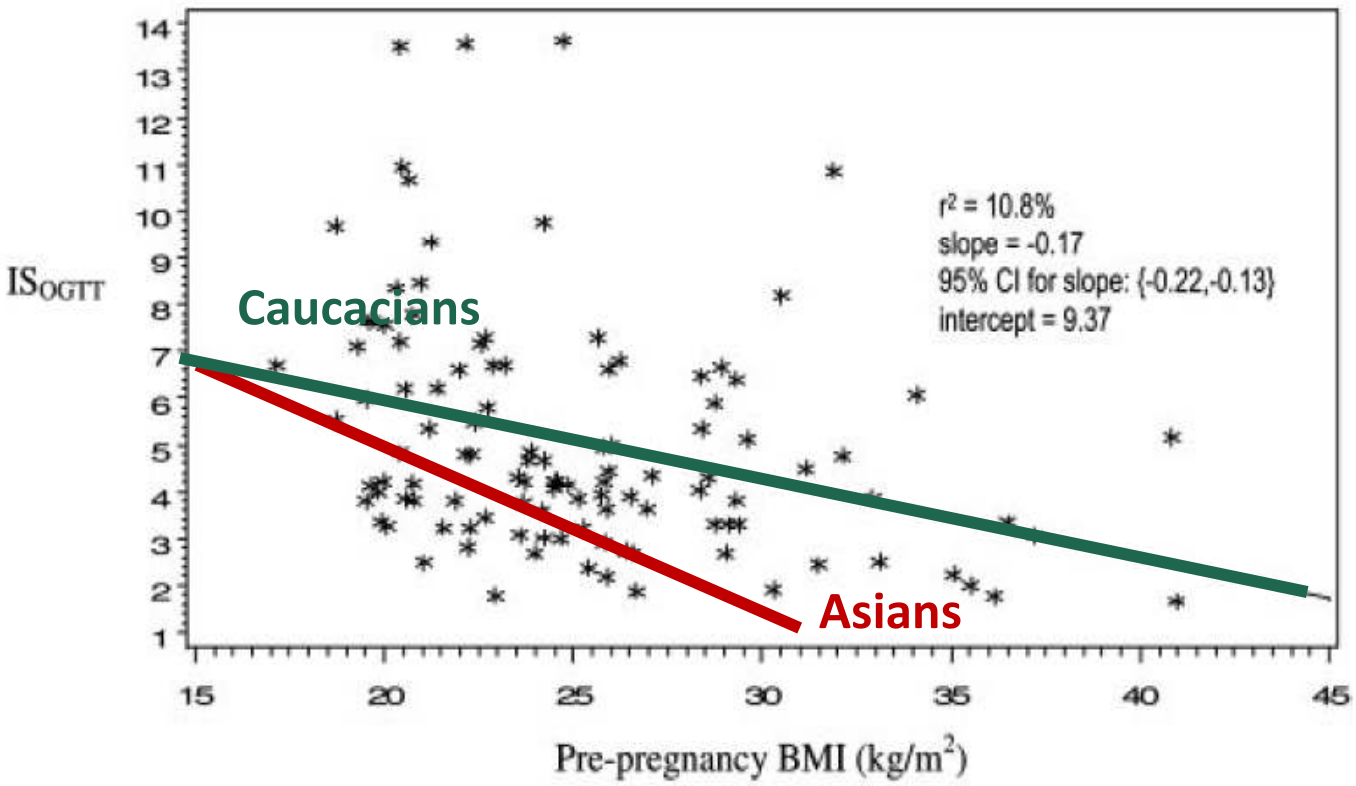
Selective β-cell loss and α-cell expansion in patients with diabetes mellitus in Korea





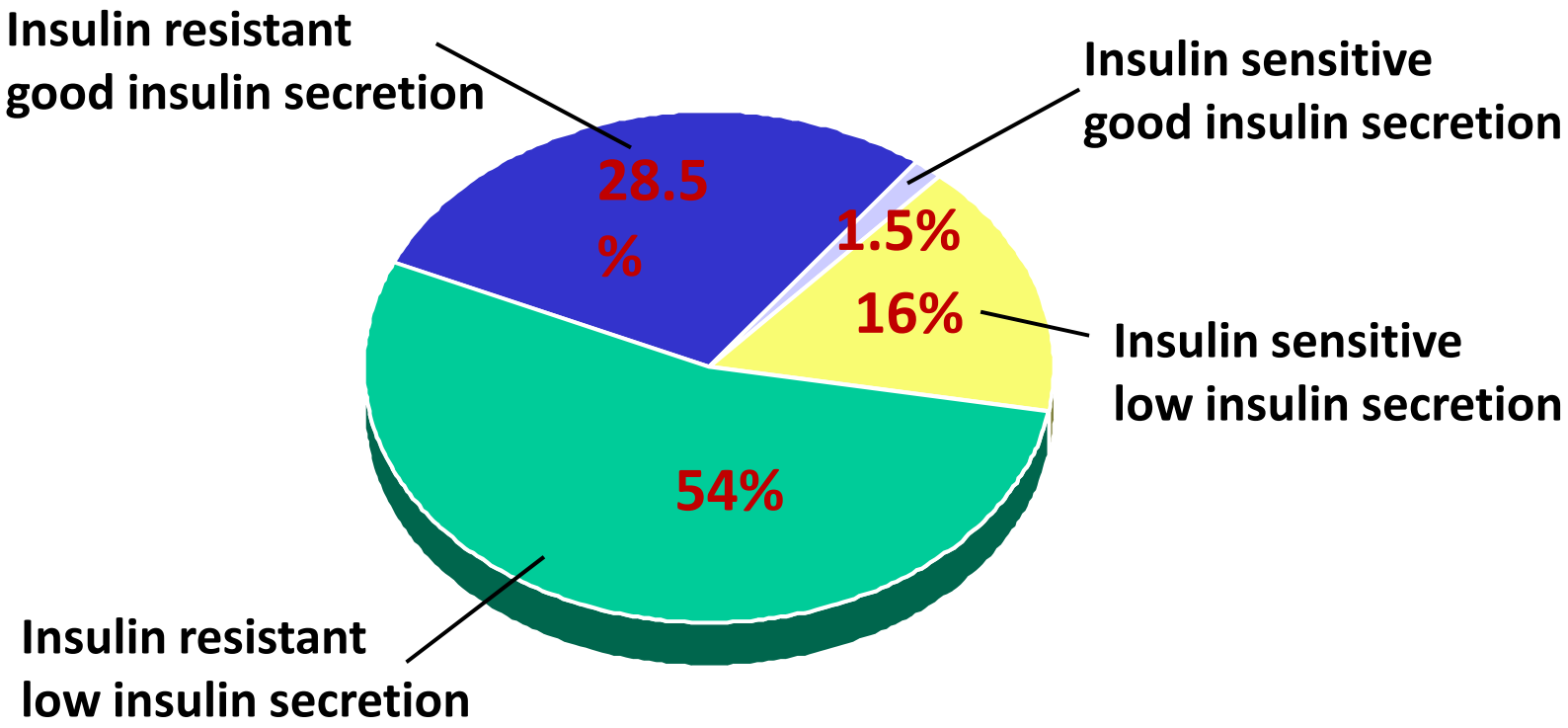
Retnakaran R et al. J Clin Endocrinol Metab 2006:91;93

Ethnic difference



Retnakaran R et al. J Clin Endocrinol Metab 2006:91;93

Insulin secretion and insulin resistance



San Antonio Heart Study: baseline status for insulin resistance and insulin secretion in those converted to type 2 diabetes during 7-year follow up; n = 195

Haffner SM, et al. Circulation 101:975–980., 2000

Insulin secretion and insulin resistance

한국인 남성에서 Homeostasis Model Assessment 표지자로 측정한 인슐린저항성 및 인슐린분비능과 당뇨병 발생위험도

- 15,781명의 남성 수진자를 대상
- 당뇨병이 있거나 공복혈당이 126 mg/dL 이상인 대상자 805명 (5.1%)은 제외

Table. RR for future DM according to different levels of HOMA-IR and HOMA β-cell.

HOMA-IR	HOMA β-cell	Case/control subjects	RR (95% CI)	*P* value
Low	High	3/85	1.00 (ref.)	< 0.001
Low	Low	33/231	4.413 (1.290~15.096)	0.018
High	High	60/230	3.379 (0.997~11.455)	0.051
High	Low	190/86	39.065 (11.736~130.035)	< 0.001

Logistic regression analyses were performed with age, body mass index and smoking included in the model. HOMA-IR, homeostasis model assessmentof insulin resistance.

최은숙 등. 당뇨병 32: 498-505, 2008

Birth weight
in Korea

Association between birth weight and insulin sensitivity in healthy young men

- 22 healthy young Korean adults

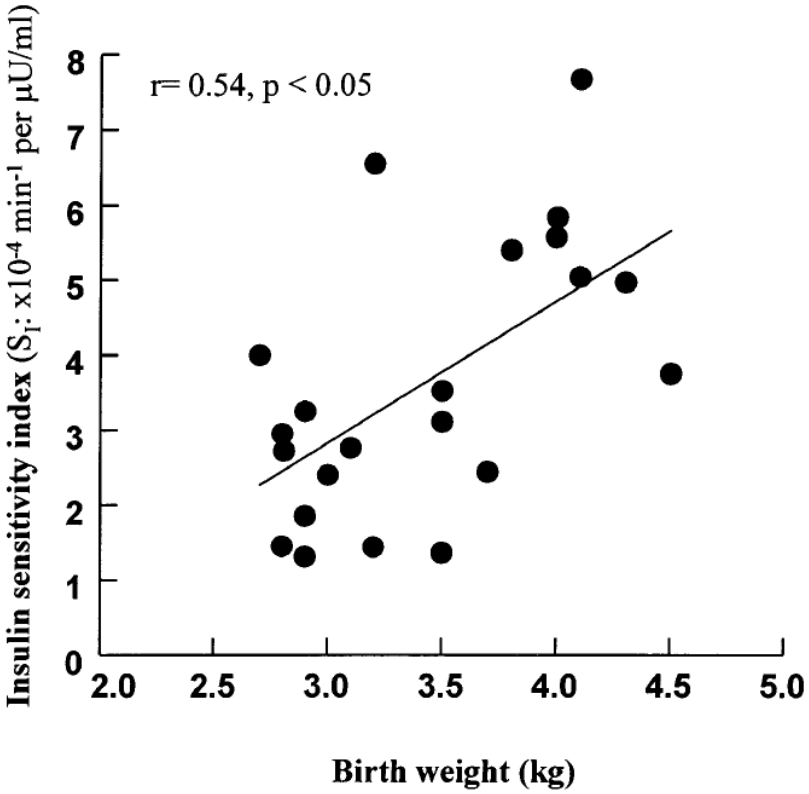


Fig. Correlation between insulin sensitivity and birth weight.

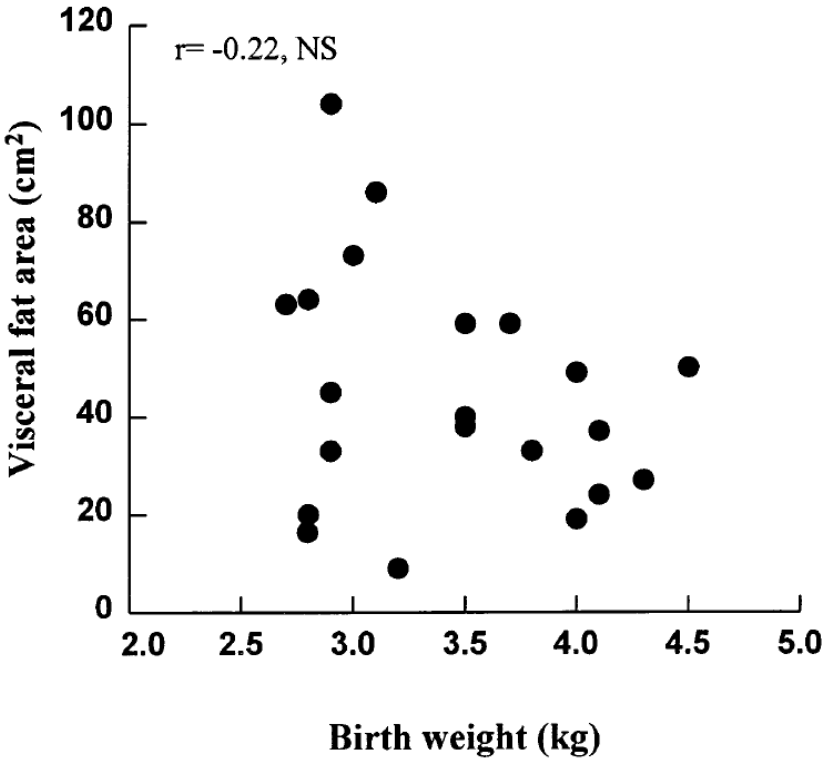


Fig. Correlation between birth weight and visceral fat area.

Choi CS, et al. Diabetes Res Clin Pract. 49(1):53-9, 2000

Fetal and infant growth

Fetal and infant growth and impaired glucose tolerance at age 64

- F/U study of men born during 1920-30 whose birth weights and weights at 1 year were known.
- 468 men born in east Hertfordshire and still living there.

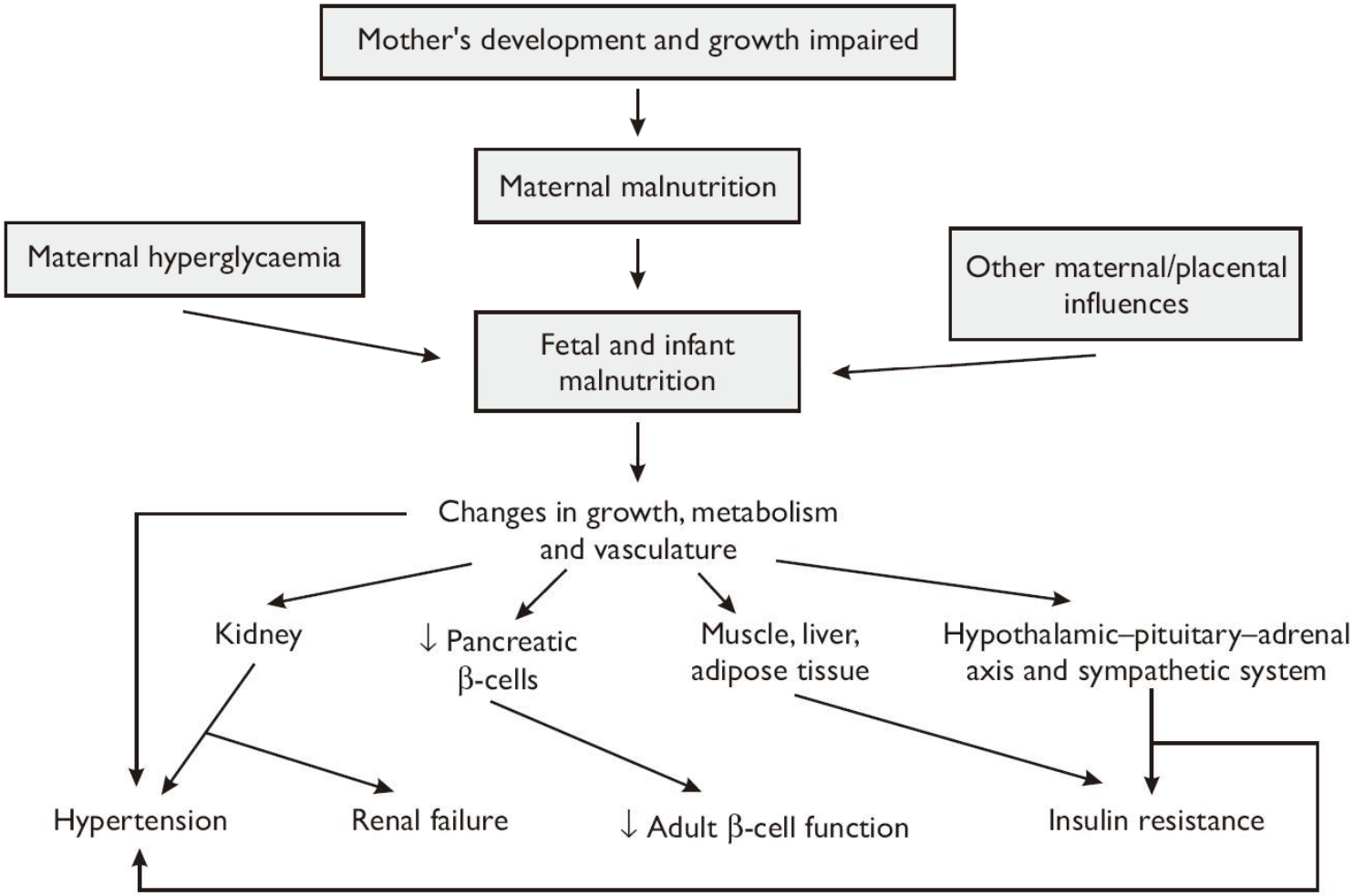
Table. Proportions of men aged 64 with IGT or DM according to birth weight.

Birth weight*		No of men	No (%) of men with two hour glucose (mmol/l) of:			Odds ratio (95% confidence interval)†
lb	g		7·8-11·0	≥11·1	≥7·8	
≤5·5	≤2495	20	6 (30)	2 (10)	8 (40)	6·6 (1·5 to 28)
-6·5	-2948	47	10 (21)	6 (13)	16 (34)	4·8 (1·3 to 17)
-7·5	-3402	104	26 (25)	6 (6)	32 (31)	4·6 (1·4 to 16)
-8·5	-3856	117	18 (15)	8 (7)	26 (22)	2·6 (0·8 to 8·9)
-9·5	-4309	54	2 (4)	5 (9)	7 (13)	1·4 (0·3 to 5·6)
>9·5	>4309	28	4 (14)	0	4 (14)	1·0 –
Total		370	66 (18)	27 (7)	93 (25)	

*Original measurements were expressed in lb and were rounded.
†Odds ratio for two hour glucose concentration of ≥7·8 mmol/l adjusted for body mass index (χ^2 for trend = 15·4; $p<0·001$).

Hales CN, et al. BMJ. 303(6809):1019-22, 1991

The thrifty phenotype hypothesis



Hales CN, Barker DJ. Br Med Bull. 60:5-20, 2001

Smoking cessation
Korea Medical Insurance Corporation Study

Smoking cessation and risk of type 2 diabetes mellitus

- 8-year prospective study
- 27,635 non-diabetic men, aged 35-44 years (5,701 nonsmokers, 7,477 ex-smokers and 14,457 sustained smokers)

Table. Relationships between smoking status and risk for developing diabetes mellitus

	Total number	Number of events (%)	Age-adjusted	Multivariate adjusted 1[b]	Multivariate adjusted 2[c]
Nonsmokers	5701	188 (3.3)	1.00	1.00	1.00
Ex-smokers	7477	272 (3.6)	1.11 (0.92–1.34)	1.14 (0.94–1.39)	1.22 (0.96–1.55)
Sustained smokers	14457	710 (4.9)	1.53 (1.04–1.08)	1.56 (1.32–1.85)	1.60 (1.29–1.97)
Smoking amount[a]					
Sustained smokers					
<10 cigarettes/day	1752	70 (4.0)	1.23 (0.93–1.63)	1.22 (0.91–1.63)	1.23 (1.86–1.77)
≥ 10 to <20 cigarettes/day	9284	435 (4.7)	1.46 (1.22–1.73)	1.49 (1.25–1.79)	1.60 (1.28–2.00)
≥ 20 cigarettes/day	3421	205 (6.0)	1.89 (1.54–2.31)	1.93 (1.57–2.38)	1.75 (1.35–2.27)
Quit smoking period[a]					
Ex-smokers					
Before 1992	4744	150 (3.2)	0.96 (0.77–1.19)	0.96 (0.77–1.20)	0.95 (0.72–1.25)
During 1992–1993	1396	49 (3.5)	1.07 (0.78–1.47)	1.18 (0.89–1.64)	1.44 (0.96–2.15)
During 1994–1995	1337	73 (5.5)	1.69 (1.28–2.23)	1.79 (1.34–2.38)	2.13 (1.51–3.00)

Data are risk ratio (95% confidence interval) unless indicated otherwise. [a]Compared with nonsmokers. [b]Adjusted for age and baseline fasting serum glucose. [c]Adjusted for age, baseline fasting serum glucose, weight change, baseline body mass index, family history of diabetes, alcohol consumption and exercise status.

Hur NW, et al. Eur J Cardiovasc Prev Rehabil. 14(2):244-9, 2007

Cigarette smoking
a four-year community-based prospective study in South Korea

Cigarette smoking is an independent risk factor for type 2 diabetes

- 10,038 subjects were recruited from rural and urban areas.
- 75 g OGTT & full biochemical assessments at baseline and during 4-year F/U period.

Table. Relationships between smoking status and risk for developing diabetes mellitus

	Total number	Number of events (%)	Unadjusted	Multivariate adjusted 3‡
Never smokers	646	51 (7·9)	1·00	1·00
Ex-smokers	983	123 (12·5)	1·59 (1·15, 2·21)	1·60 (1·07, 2·39)
Current smokers (<20 cigarettes/day)	534	57 (10·7)	1·31 (0·90, 1·92)	2·06 (1·35, 3·16)
Heavy smokers (≥20 cigarettes/day)	885	98 (11·1)	1·42 (1·01, 2·00)	2·41 (1·48, 3·93)
Total	3048	329 (108)		

Data are relative risk vs. never smokers (95% CI).
‡Adjusted of age, family history of DM, rural or urban area, waist, body fat, total pack year, exercise, alcohol drinking, income, education, WBC, HDL-C, TG, ALT, hs-CRP, systolic BP, HOMA-IR, HOMA-beta.

Cho NH, et al. Clin Endocrinol (Oxf). 71(5):679-85, 2009

Cigarette smoking
in US male physicians

A prospective study of cigarette smoking and the incidence of DM

- 21,068 US male physicians aged 40 to 84 years in the Physicians' Health Study who were initially free of diagnosed DM, CVD, and cancer
- 12 years of follow-up

Pack-Years of Smoking	Cases	Age-Adjusted*	Multivariate Adjusted†
0 (never smoker)	323	1.0 (Referent)	1.0 (Referent)
1 to 19.9	148	1.0 (0.8–1.2)	1.0 (0.8–1.3)
20 to 39.9	116	1.4 (1.1–1.7)	1.3 (1.0–1.6)
≥40	122	2.1 (1.7–2.5)	1.6 (1.3–2.1)
P for trend‡		<0.001	<0.001

* Adjusted for age (1-year categories) and treatment assignment (aspirin and beta-carotene).

† Adjusted for age (1-year categories), body mass index (quartiles), physical activity (<1, 1, 2–4, and 5 or more times per week), history of hypertension, history of high cholesterol, parental history of myocardial infarction at age <60, alcohol consumption (<monthly, monthly, weekly, daily), and treatment assignment.

Table. Association between Pack-Years of Cigarette Smoking and Risk of T2DM

Manson JE, et al. Am J Med. 109(7):538-42,2000

Smoking cessation

The ARIC (Atherosclerosis Risk in Communities) Study in US

Smoking, smoking cessation, and risk for type 2 diabetes mellitus

- 10,892 middle-aged adults who initially did not have diabetes in 1987 to 1989.

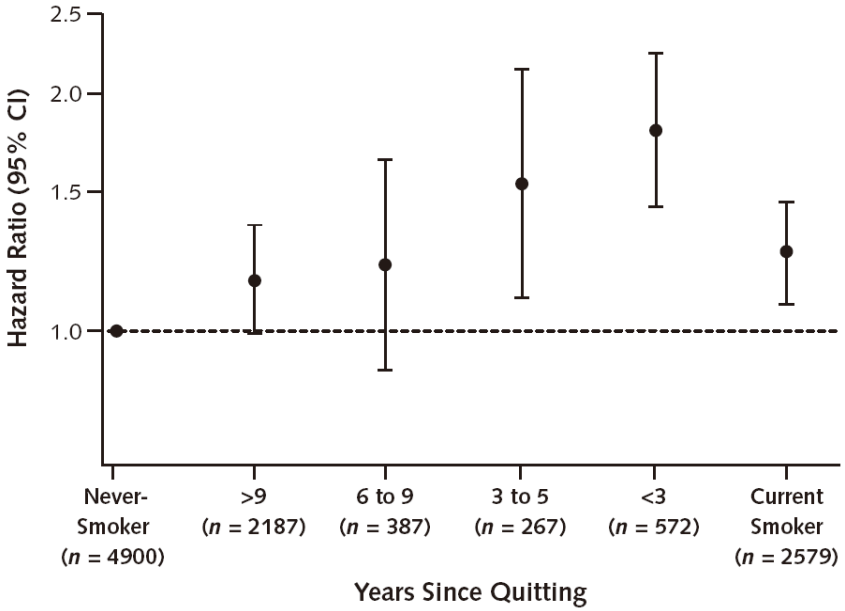
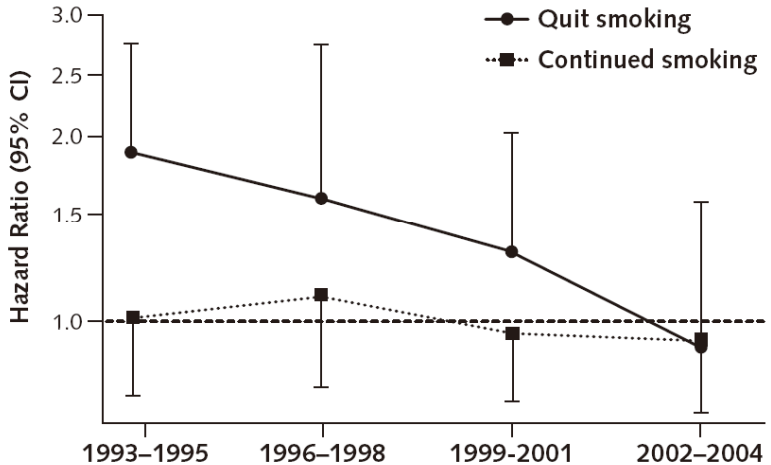


Fig. 9 year adjusted HR (1990–1998) for incident DM in 10,892 middle-aged adults, by years since quitting before baseline (1987–1989).



Patients, *n*	Clinic	Clinic	Telephone	Telephone
At risk	10 406	10 004	9744	9256
Quit	423	395	381	359
Continued	2210	2133	2079	1987

Fig. Adjusted HR for incident self-reported DM during 12 years in 10,406 middle-aged adults without diabetes at baseline and 3-year F/U.

Yeh HC, et al. Ann Intern Med. 152(1):10-7, 2010

Cigarette smoking
in middle-aged Japanese men

Cigarette smoking and risk for IFG and T2DM in middle-aged Japanese men

- 1,266 Japanese male office workers 35 to 59 years of age who did not have IFG or T2DM and were not taking medication for HTN at study entry.

Table. Smoking Status and Risk for IFG and T2DM in the Study Sample.

Condition	Never-Smokers	Former Smokers	Current Smokers			*P* Value for Trend*
			1–20 Cigarettes/d	21–30 Cigarettes/d	≥31 Cigarettes/d	
Impaired fasting glucose						
Cases, *n*	20	18	16	12	21	
Person-years	1877	979	1206	892	863	
Rate per 1000 person-years	10.7	18.4	13.3	13.4	24.3	
Age-adjusted relative risk (95% CI)	1.00 (referent)	1.61 (0.85–3.04)	1.20 (0.62–2.32)	1.21 (0.59–2.48)	2.20 (1.19–4.07)	0.019
Multivariate-adjusted relative risk (95% CI)†	1.00 (referent)	1.62 (0.85–3.10)	1.14 (0.58–2.25)	1.33 (0.63–2.80)	2.56 (1.32–4.95)	0.013
Type 2 diabetes						
Cases, *n*	7	5	11	12	19	
Person-years	1906	1014	1227	899	892	
Rate per 1000 person-years	3.7	4.9	9.0	13.3	21.3	
Age-adjusted relative risk (95% CI)	1.00 (referent)	1.29 (0.41–4.06)	2.38 (0.92–6.15)	3.54 (1.39–9.01)	5.60 (2.35–13.32)	<0.001
Multivariate-adjusted relative risk (95% CI)†	1.00 (referent)	1.08 (0.34–3.42)	1.88 (0.71–5.00)	3.02 (1.15–7.94)	4.09 (1.62–10.29)	<0.001

* Calculated across increasing categories of smoking for current smokers only.
† Controls for age, body mass index, alcohol consumption, regular physical exercise, family history of diabetes, systolic and diastolic blood pressure, fasting plasma glucose level, total cholesterol level, high-density lipoprotein cholesterol level, triglyceride level, uric acid level, and hematocrit at study entry.

Nakanishi N, et al. Ann Intern Med. 133(3):183-91, 2000

Smoking habit
a follow-up study in Japan

Heavy smoking raises risk for type 2 diabetes mellitus in obese men; but, light smoking reduces the risk in lean men

- a follow-up study in 16,829 apparently healthy men 30 to 59 years of age.

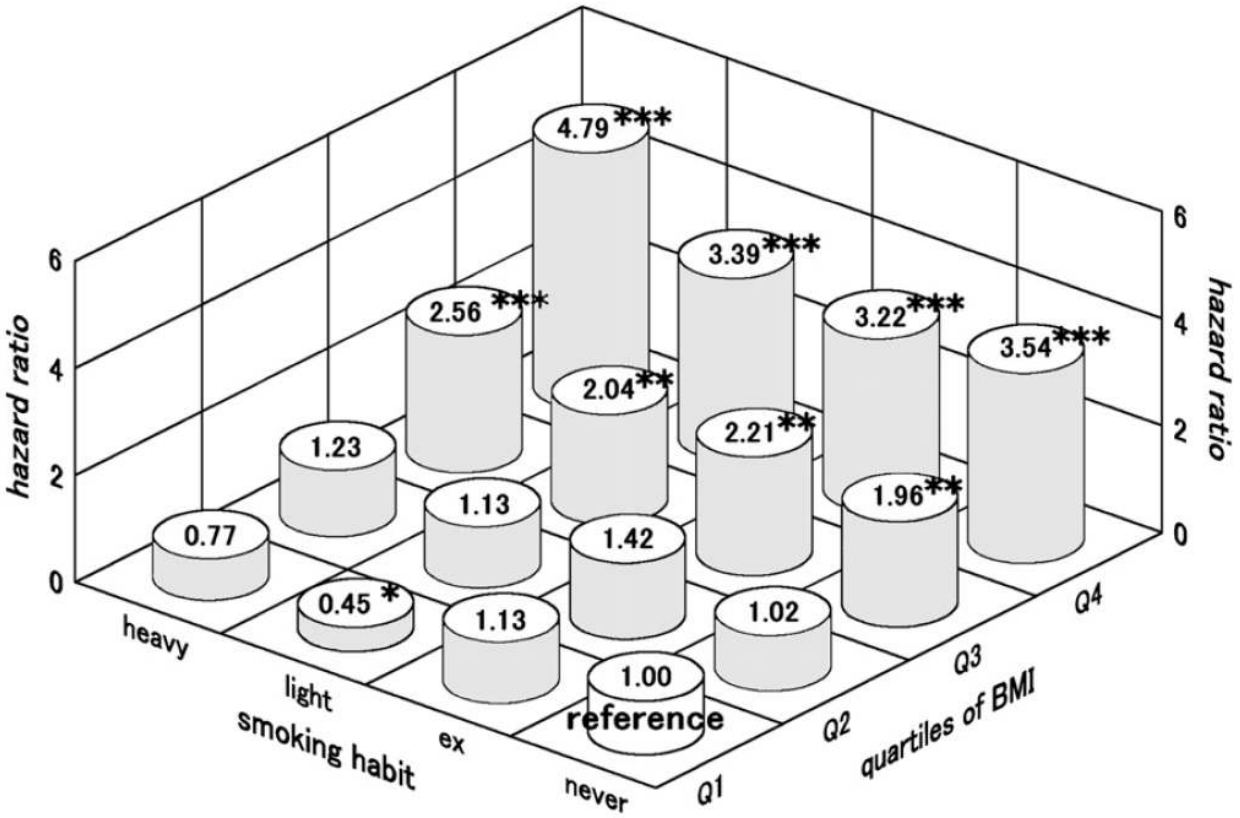


Fig. Multivariate-adjusted (for age, drinking, exercise, education) HR for incident DM in 16 groups according to smoking and quartiles of BMI (reference: never-smokers in Q1 of BMI).
*, p <0.05; **, p <0.01; ***, p <0.001.

Nagaya T, et al. Ann Epidemiol. 18(2):113-8, 2008

Alcohol
in obese Korean men

Alcohol consumption and higher incidence of IFG or T2DM in obese Korean men

- The annual health evaluation data of 2,500 male workers from 2002 to 2006, retrospectively

Table. The adjusted RR for IFG or T2DM by alcohol intake during 4 years' observation by tertile of waist, BMI, and adiponectin

	RR[a]	(95% CI)
Alcohol (g ethanol/day)		
0	1	(Reference)
1–14	1.123	(0.916–1.378)
15–29	1.332	(1.063–1.669)
≥30.0	1.346	(1.051–1.724)

Table. The adjusted RR for IFG or T2DM by amount of alcohol intake according to BMI during 4 years

	Body mass index (kg/m^2) Normal[b] (15.9–22.9)		Overweight (23.0–24.9)		Obese (25.0–38.7)	
	673		514		530	
Number of participants	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)
Alcohol intake (g ethanol/day)						
0	1	(Reference)	1	(Reference)	1	(Reference)
1–14	0.842	(0.603–1.176)	1.164	(0.795–1.705)	1.498	(1.042–2.153)
15–29	1.068	(0.736–1.551)	1.421	(0.947–2.133)	1.634	(1.091–2.447)
≥30.0	1.019	(0.662–1.568)	1.604	(1.031–2.495)	1.563	(1.019–2.396)
FPG (mg/dL)	1.040	(1.021–1.061)	1.049	(1.026–1.072)	1.047	(1.025–1.068)
GGT (mg/dL)	1.001	(0.996–1.006)	1.000	(0.995–1.005)	1.005	(1.002–1.008)

[a]Relative risk adjusted for age, family history of diabetes, smoking, exercise, FPG, aspartate aminotransferase, and GGT.
[b]Normal group include 46 underweight subjects.

Roh WG, et al. Alcohol. 43(8):643-8, 2009

Alcohol
in middle-aged Japanese men

Alcohol consumption and risk for IFG or T2DM in middle-aged Japanese men

- 2,953 Japanese male office workers aged 35-59 years who did not have IFG, T2DM, HTN, or a history of CVA

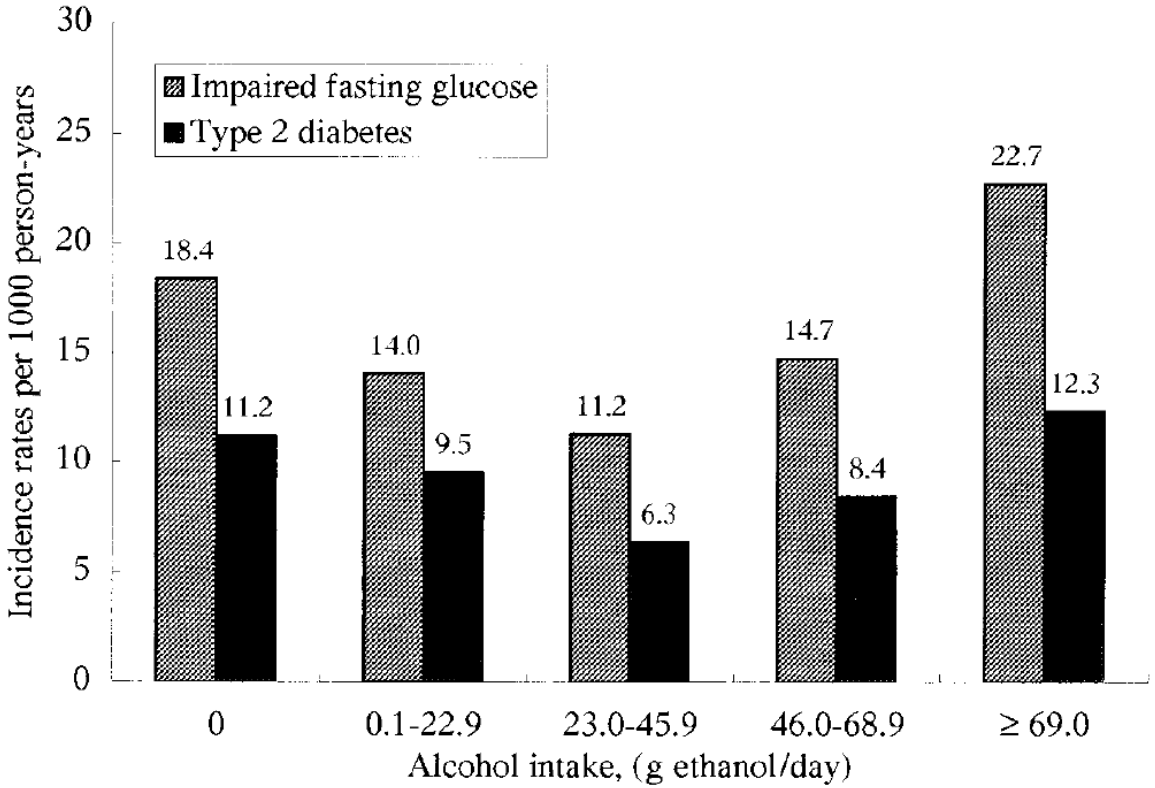


Table. Incidence rates per 1,000 person-years for IFG and T2DM according to alcohol intake among 2,953 Japanese male office workers during 7 years of follow-up.

Multivariate-adjusted RR (95% CI)	**1.51**	**1.31**	**1.00**	**1.18**	**1.43**

(*p*=0.016)

Nakanishi N, et al. Diabetes Care. 26(1):48-54, 2003

Alcohol
the Osaka Health Survey

Daily alcohol consumption and the risk of type 2 diabetes in Japanese men

- 6,362 Japanese men aged 35-61 years who did not have DM, IFG, HTN, or LC at study entry.
- Data on alcohol consumption were obtained from questionnaires.

Table. Relative risk of type 2 diabetes according to daily alcohol consumption

Daily alcohol consumption (ml/day)			Total person-years	Cases	Age-adjusted RR (95% CI)	Multiple adjusted RR (95% CI)*
BMI ≤22.0 kg/m²						
Study entry		Third examination				
Nondrinkers		Nondrinkers				
0.1–19.0	→	0.1–19.0	11,878	29	1.00	1.00
19.1–29.0		19.1–29.0				
29.1–50.0	→	29.1–50.0	1,484	7	1.98 (0.87–4.53)	1.61 (0.68–3.76)
≥50.1	→	≥50.1	2,846	14	2.11 (1.09–4.04)	2.01 (1.01–4.01)
P for trend					0. 01	0.03
BMI ≥22.1 kg/m²						
Study entry		Third examination				
Nondrinkers		Nondrinkers				
0.1–19.0	→	0.1–19.0	13,598	116	1.00	1.00
19.1–29.0		19.1–29.0				
29.1–50.0	→	29.1–50.0	2,056	8	0.46 (0.22–0.95)	0.43 (0.21–0.89)
≥50.1	→	≥50.1	4,744	33	1.01 (0.68–1.51)	0.94 (0.62–1.41)
P for trend					0.69	0.64

Tsumura K, et al. Diabetes Care. 22(9):1432-7,1999

Alcohol

a population-based prospective study in the JPHC study cohort I

Alcohol consumption for self-reported diabetes among middle-aged Japanese

- 12,913 men & 15,980 women, aged 40-59 years, followed for up to 10 years.
- participated in the JPHC Study Cohort I.

Table. Multivariate logistic regression analysis of the 10-year incidence of T2DM in middle-aged Japanese males according to BMI.

	BMI ≤ 22 kg/m^2 (n = 3845)		25 kg/m^2 ≥ BMI > 22 kg/m^2 (n = 5671)		BMI ≥ 25 kg/m^2 (n = 3397)	
	Odds ratio (95% CI)		Odds ratio (95% CI)		Odds ratio (95% CI)	
Alcohol intake*						
ALC_0	1.00 (referent)		1.00 (referent)		1.00 (referent)	
ALC_1	1.05	(0.55–2.01)	1.12	(0.80–1.56)	1.08	(0.79–1.48)
ALC_2	1.91	(1.05–3.46)	1.16	(0.83–1.61)	1.24	(0.89–1.71)
ALC_3	2.89	(1.63–5.11)	1.17	(0.83–1.66)	1.03	(0.73–1.44)

***Alcohol intake (g/day of ethanol):**

ALC_1: 0 < ethanol ≤ 23.0

ALC_2: 23.0 < ethanol ≤ 46.0

ALC_3: ethanol > 46.0

95% CI, 95% confidence interval. Adjusted for age, BMI, cigarette smoking, exercise, family history of diabetes and prevalent hypertension.

Waki K, et al. Diabet Med. 22(3):323-31, 2005

Alcohol consumption
SUMMARY

- **Inconsistent results**
  - J or U-shaped manner

Ajani UA, et al. Arch Intern Med. 160(7):1025-30, 2000
Carlsson S, et al. Diabet Med. 17(11):776-81, 2000
Carlsson S, et al. Diabetes Care. 26(10):2785-90, 2003
Beulens JW, et al. Diabetes Care. 28(12):2933-8, 2005
Carlsson S, et al. Diabetologia. 48(6):1051-4, 2005

  - No differences in RR reductions according to BMI

Koppes LL, et al. Diabetes Care. 28(3):719-25, 2005

  - Positive linear association

Sung KC, Kim SH, Reaven GM. Diabetes Care. 30(10):2690-4, 2007

  - No association

Waki K, et al. Diabet Med. 22(3):323-31, 2005

Adiponectin
in the Korean population

The association between adiponectin and diabetes in the Korean population

- 4,459 healthy Koreans aged 24 to 87 years

Table. Multivariable-adjusted ORs for diabetes by tertile of waist, BMI, and adiponectin

Variables	Class	Diabetes case	Men		Diabetes case	Women	
			OR	95% CI		OR	95% CI
WC (cm)	<82.0	40	1.0		3	1.0	
	82.0-<88.5	71	1.0	0.6-1.6	12	2.2	0.5-9.4
	≥88.5	77	1.1	0.6-2.0	31	2.6	0.5-13.0
BMI (kg/m^2)	<23.5	43	1.0		5	1.0	
	23.5-<25.7	73	1.5	0.9-2.4	9	0.7	0.2-2.4
	≥25.7	72	1.3	0.7-2.3	32	1.2	0.3-4.4
Adiponectin	≥8.0	46	1.0		10	1.0	
($\mu g/mL$)	5.0-<8.0	60	1.3	0.8-1.9	14	1.2	0.5-2.9
	<5.0	82	1.7	1.1-2.6	22	1.9	0.8-4.3

Model: adjusted for WC, BMI, adiponectin, age, smoking, hypertension, alcohol drinking, exercise, and HDL-C.

Yoon SJ, et al. Metabolism. 57(6):853-7, 2008

Adiponectin
Meta-analysis

Adiponectin levels and risk of type 2 diabetes

- Systematic review and meta-analysis
- 13 prospective studies with a total of 14,598 participants and 2,623 incident cases of T2DM

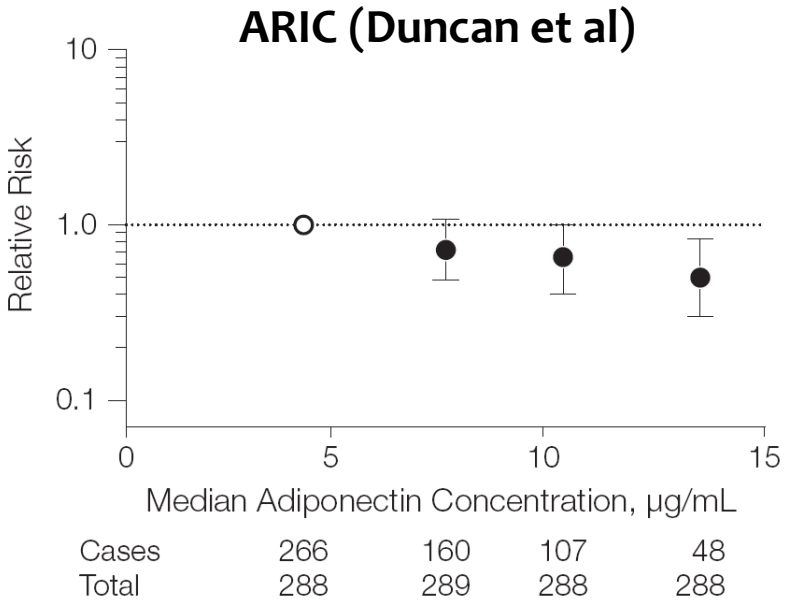


Fig. Risk of T2DM According to categories of total adiponectin levels

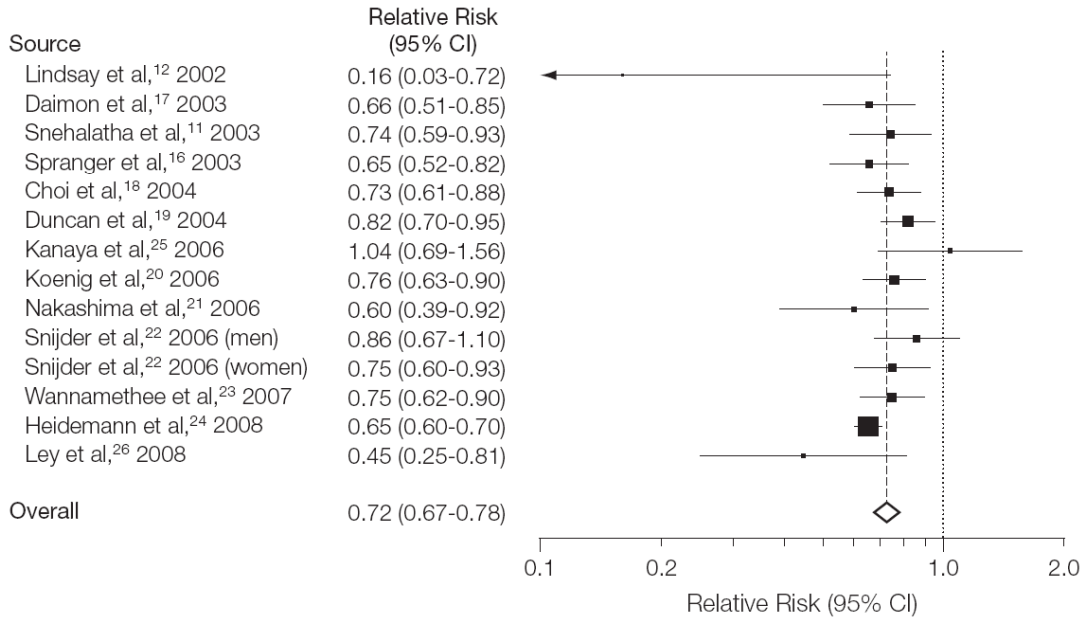


Fig. Relative risks per 1 Log µg/mL of adiponectin level and T2DM across studies

Size of squares corresponds to the weight of each study in the meta-analysis. CI indicates confidence interval.

Li S, et al. JAMA. 302(2):179-88, 2009

Fatty liver

Fatty liver is an independent risk factor for T2DM in Korean adults

- 5,372 non-diabetic participants (3,670 men and 1,702 women; 20-79 years), 5 yrs F/U

Table. Risk factors of the incident T2DM in multiple logistic regression analysis

	Relative risk	95% CI	*P*-value
Sex (male vs. female)	1.06	0.64–1.75	0.809
Current smoking	1.75	1.23–2.47	0.002
Family history of DM	2.12	1.49–3.00	< 0.001
Age (10 years)	1.26	1.04–1.53	0.019
BMI (2.5 kg/m^2)	1.37	1.16–1.62	< 0.001
ALT (quartile)	1.30	1.08–1.57	0.006
Fasting glucose (quartile)	3.35	2.69–4.17	< 0.001
Triglycerides (quartile)	1.07	0.89–1.28	0.474
HDL cholesterol (quartile)	0.84	0.71–1.00	0.048
Fatty liver	1.51	1.04–2.20	0.034

	Excluding frequent drinkers		
	Relative risk	95% CI	*P*-value
Model 1*			
Fatty liver, mild	3.21	1.88–5.45	< 0.001
Fatty liver, moderate to severe	8.47	4.93–14.58	< 0.001
Model 2†			
Fatty liver, mild	1.87	1.03–3.38	0.039
Fatty liver, moderate to severe	3.72	2.04–6.81	< 0.001
Model 3‡			
Fatty liver, mild	1.49	0.82–2.71	0.19
Fatty liver, moderate to severe	2.29	1.13–4.63	0.021

*Model 1: adjusted for sex, age.
†Model 2: adjusted for the factors in Model 1 + F/H of DM, smoking, BP, FPG.
‡Model 3: adjusted for the factors in Model 2 + BMI, serum ALT, HDL-C, TG .

Table. Relative risks according to severity of fatty infiltration in liver after excluding frequent drinkers

Kim CH, et al. Diabet Med. 25(4):476-81, 2008

Chronic hepatitis C virus infection

Association of chronic hepatitis C virus infection and DM in Korean patients

- Prospective analysis of 404 patients with chronic viral hepatitis or liver cirrhosis

Table. Prevalence of DM in patients with chronic hepatitis and liver cirrhosis

Groups	No. of patients	Age (mean±SD, yrs)	No. of diabetics	*p*
Chronic hepatitis	225	44± 14	29(12.9%)	0.002
HBV	157	40± 12	13(8.2%)	
HCV	68	52± 16	16(23.5%)	
Liver cirrhosis	179	56± 12	34(19.0%)	0.07
HBV	102	52± 11	14(13.7%)	
HCV	28	67± 9	7(25%)	
Alcohol	43	58± 12	13(30.2%)	
Total	404	49± 15	63(15.6%)	0.001
HBV	259	44± 13	27(10.4%)	
HCV	96	56± 16	23(24.0%)	

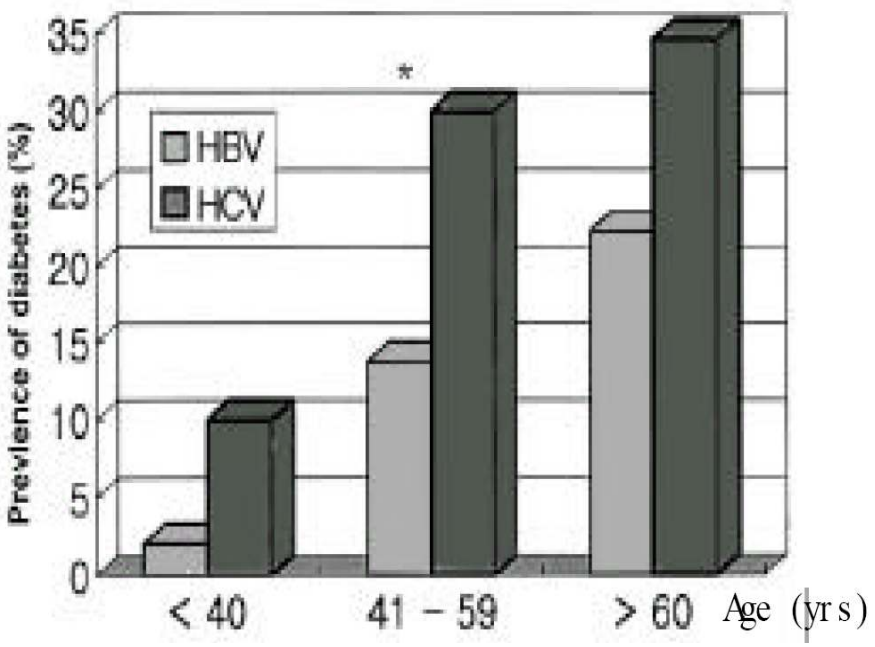


Fig. Prevalence of DM according to the etiology of chronic liver disease in 3 age group

Ryu JK, et al. Korean J Intern Med. 16(1):18-23, 2001

Algae consumption

Korean national health and nutrition examination survey in 2005

Algae consumption and risk of type 2 diabetes

- Analyzed data from the Korean National Health and Nutrition Examination Survey in 2005
- 3,405 males and females aged 20-65 yrs.

Table. Algae consumption and risk of abnormal glucose metabolism.

Algae consumption	Number of people	Number of prediabetes	Number of diabetes	Odds ratio (95% CI) for diabetes vs. prediabetes vs. normoglycemia		
				Model 1	Model 2	Model 3
Male						
Q1 (0–8.5)	274	62	15	1.000	1.000	1.00
Q2 (8.6–21.5)	383	77	10	0.76 (0.52–1.11)	0.65 (0.44–0.96)	0.64 (0.43–0.95)
Q3 (21.6–32.8)	362	67	13	0.77 (0.53–1.12)	0.69 (0.46–1.01)	0.68 (0.46–1.01)
Q4 (over 32.9)	362	71	22	0.81 (0.56–1.18)	0.67 (0.46–0.98)	0.66 (0.43–0.99)
Total	1,381	277	60	*p* for trend=0.351	*p* for trend=0.086	*p* for trend=0.088
Female						
Q1 (0–8.5)	370	42	11	1.000	1.000	1.000
Q2 (8.6–21.5)	538	54	13	0.95 (0.64–1.42)	0.94 (0.62–1.42)	0.93 (0.60–1.39)
Q3 (21.6–32.8)	477	49	6	0.89 (0.58–1.36)	0.84 (0.55–1.30)	0.77 (0.49–1.21)
Q4 (over 32.9)	606	59	11	0.91 (0.61–1.35)	0.92 (0.61–1.38)	0.80 (0.51–1.24)
Total	1,991	204	41	*p* for trend=0.596	*p* for trend=0.624	*p* for trend=0.243

Model 1: adjusted for age, family history of diabetes, education, smoking, alcohol intake, and physical activity.
Model 2: adjusted for variables in Model 1+total energy intake, body mass index, waist circumference, triglycerides.
Model 3: adjusted for variables in Model 2+intakes of food groups

Lee HJ, et al. J Nutr Sci Vitaminol (Tokyo). 56(1):13-8, 2010

Other risk factors

- GDM
- PCOS
- Persistent organic pollutants (POPs)
- Chronic arsenic poisoning
- Infections
- Oral contraceptives
- Uric acid
- WBC count
- Hematocrit
- C-reactive protein
- GGTP
- .....

The diabetes risk score
in Finland

A practical tool to predict type 2 diabetes risk

Table. Logistic regression models with drug-treated DM during F/U as the dependent variable

	Concise model: n = 4,595 (194 of whom developed diabetes)		Full model: n = 4,435 (182 of whom developed diabetes)		
	OR (95% CI)	Coefficient	OR (95% CI)	Coefficient	Score
Intercept	—	−5.514	—	−5.658	

Table 2—*Diabetes incidence by Diabetes Risk Score in 1987 and 1992 cohorts during follow-up through the year 1997*

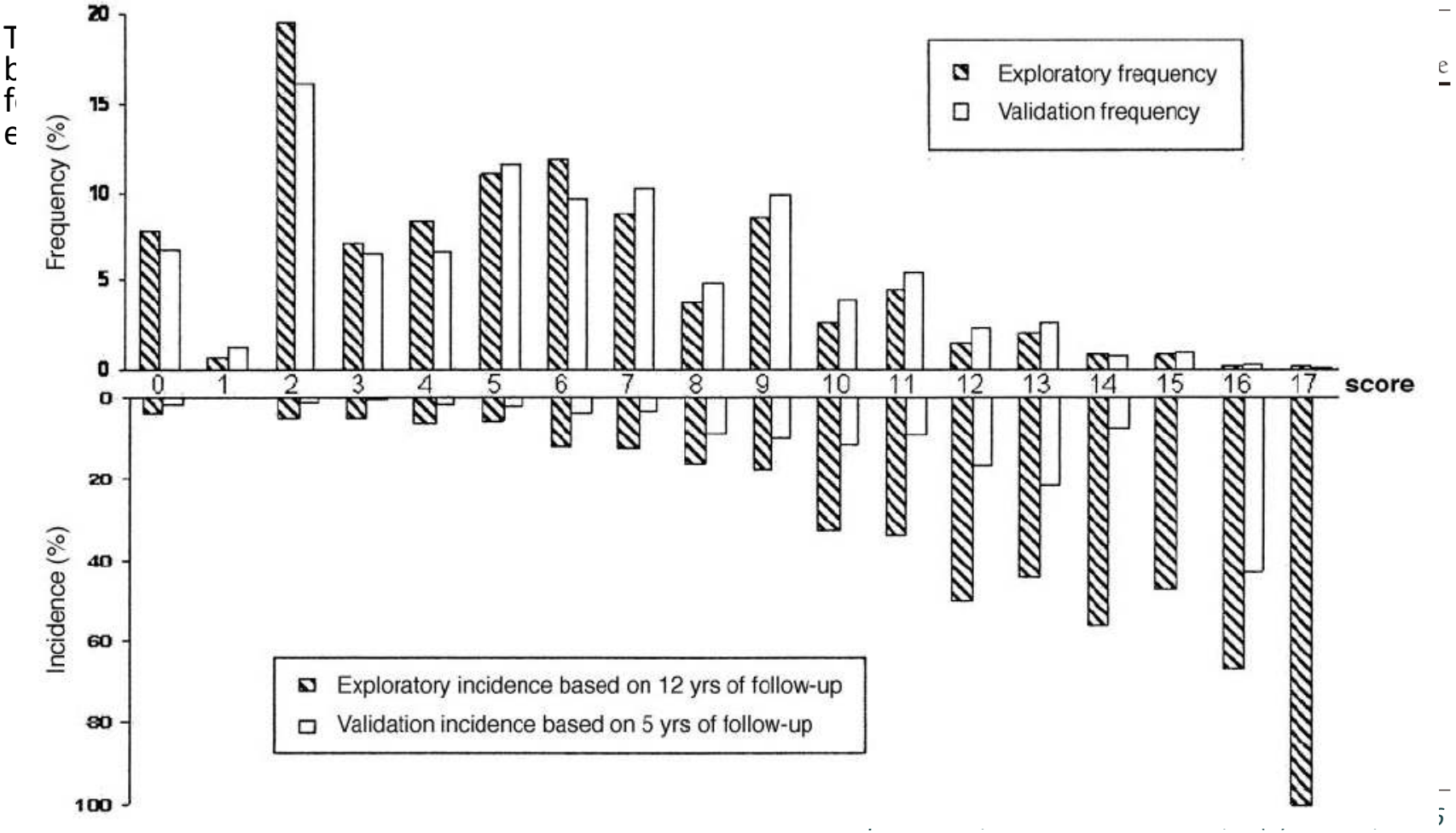
	1987 Cohort						1992 Cohort					
	Men			Women			Men			Women		
		Diabetes incidence			Diabetes incidence			Diabetes incidence			Diabetes incidence	
Score	*n*	*n*	%	*n*	*n*	%	*n*	*n*	%	*n*	*n*	%
0–3	669	2	0.3	851	5	0.6	731	2	0.3	981	1	0.1
4–8	936	22	2.4	878	11	1.3	863	7	0.8	862	3	0.4
9–12	421	44	10.5	455	30	6.6	492	13	2.6	494	11	2.2
13–20	101	33	32.7	124	35	28.2	78	18	23.1	85	12	14.1
P for trend		0.001			0.001			0.001			0.001	

logistic regression model and are presented for the full model. The concise model includes only these statistically significant variables. The full model includes also physical activity and fruit and vegetable consumption. *Question "Have you ever used drugs for high blood pressure?: No/Yes" in the questionnaire; †question "Have you ever been told by a health-care professional that you have diabetes or latent diabetes?: No/Latent diabetes/Diabetes" in the questionnaire; ‡individuals who, in their spare time, "read, watch TV, and work in the household with tasks that don't strain physically" and whose "work is mainly done sitting and does not require much walking." The next category was "physical activity at least 4 hours per week."

Lindström J, Tuomilehto J. Diabetes Care. 26(3):725-31, 2003

The diabetes risk score
in the Thai population

A risk score for predicting incident diabetes



SUMMARY

- **Diverse risk factors?**
- **Ethnic differences? :** 대동소이(大同小異, substantial identity with negligible differences)
- **Is Korean a high risk population for type 2 diabetes?**
  → YES !!!?