

**Master of Advanced Studies in Nutrition and Health FS 2015**

# **Cardiovascular Diseases and Blood Lipids**

**David Faeh**

Institut für Epidemiologie,  
Biostatistik und Prävention



**Universität  
Zürich**<sup>UZH</sup>

# Cardiovascular Diseases and Blood Lipids

- Epidemiology of CVD
- Blood lipids: types and functions
- Association of blood lipids with other CVD risk factors and with CVD events
- Lifestyle and blood lipids
- Recommendations

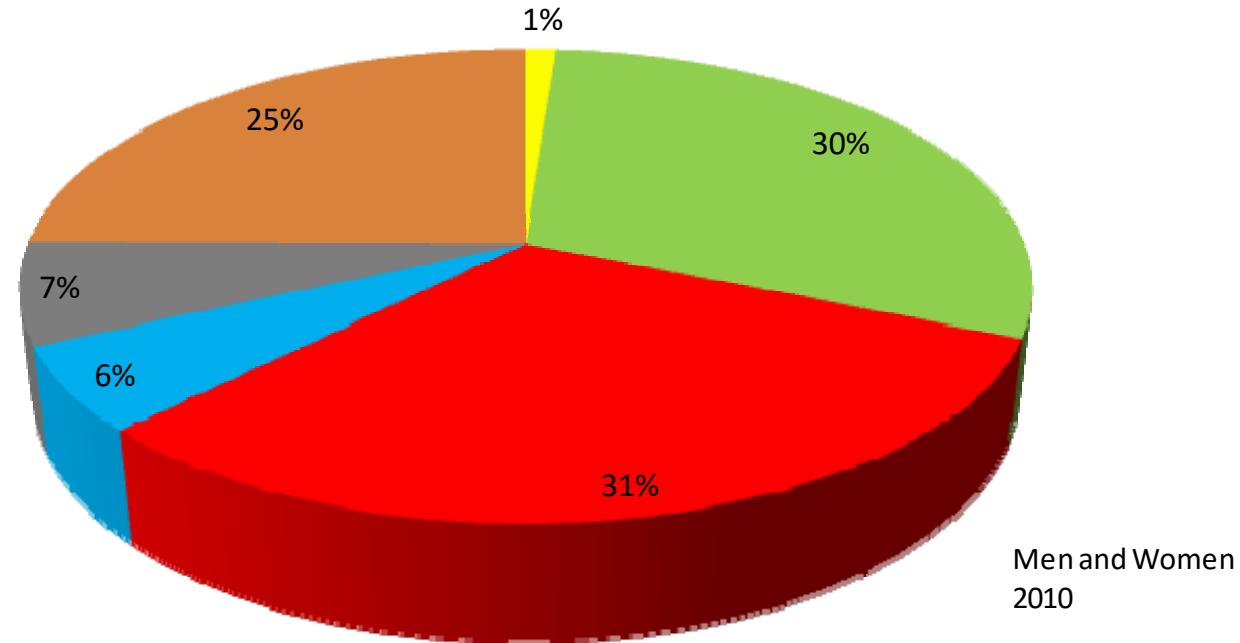


# Cardiovascular Diseases and Blood Lipids

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# Proportion of causes of death: Age standardized death rates per 100,000, Switzerland



■ Infectious

■ Cancer

■ Cardiovascular

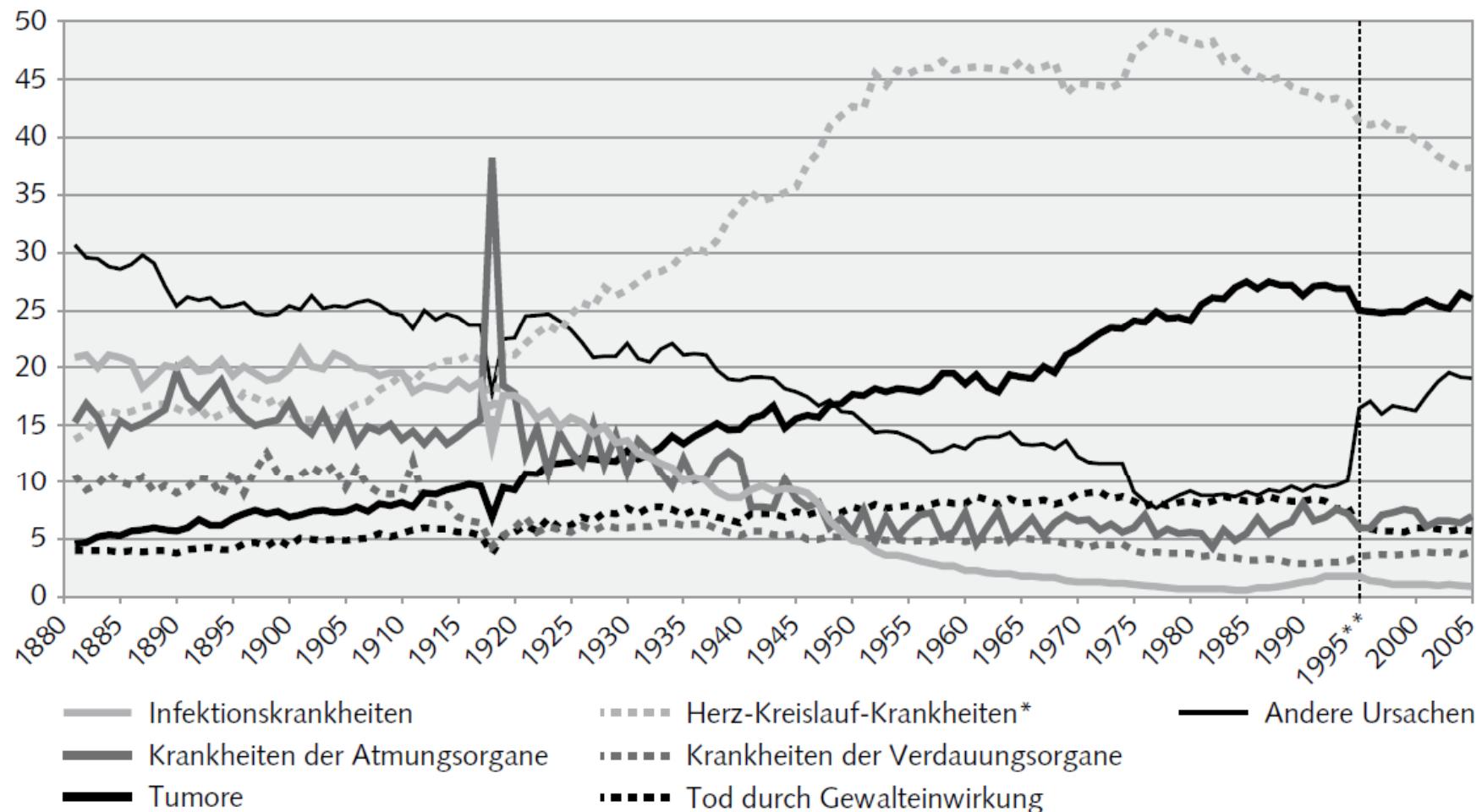
■ Respiratory

■ Injury

■ Andere

# Anteil der Todesfälle nach Haupttodesursachengruppen, 1881–2005

G 1



\* mit Krankheiten des Nervensystems bis 1900

\*\* Änderung der Klassifikation der Todesursachen (Übergang von CIM-8 zu CIM-10)

© Bundesamt für Statistik (BFS)

Raymond Kohli, Sterblichkeit nach Todesursachen, 1998/2003

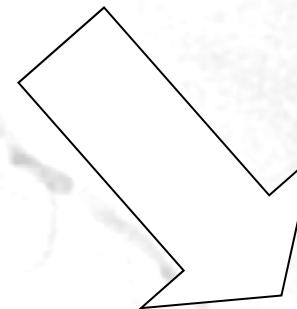
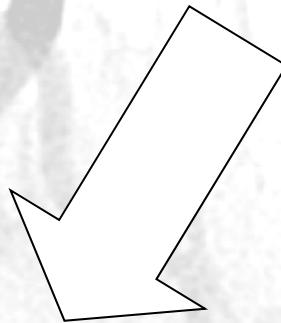
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# Cardiovascular disease (CVD)



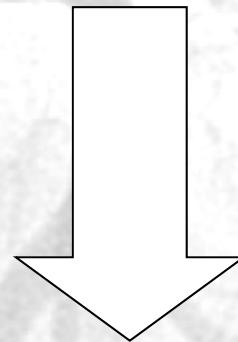
## Mortality

*Death:*  
Can be assessed  
only once „Tip of  
the iceberg“

## Morbidity

*Disease:*  
Is always higher  
than mortality.  
Can occur  
numerous times  
in one individual

# Mortality



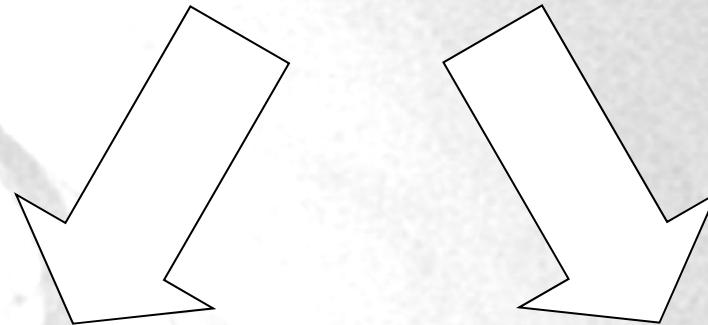
## „Incidence“

*„Film“:*

Number of...

- ...death cases (mortality) or
- ...new diseases (morbidity) per number of persons under risk (100'000) and during a certain time span (1 year)

# Morbidity

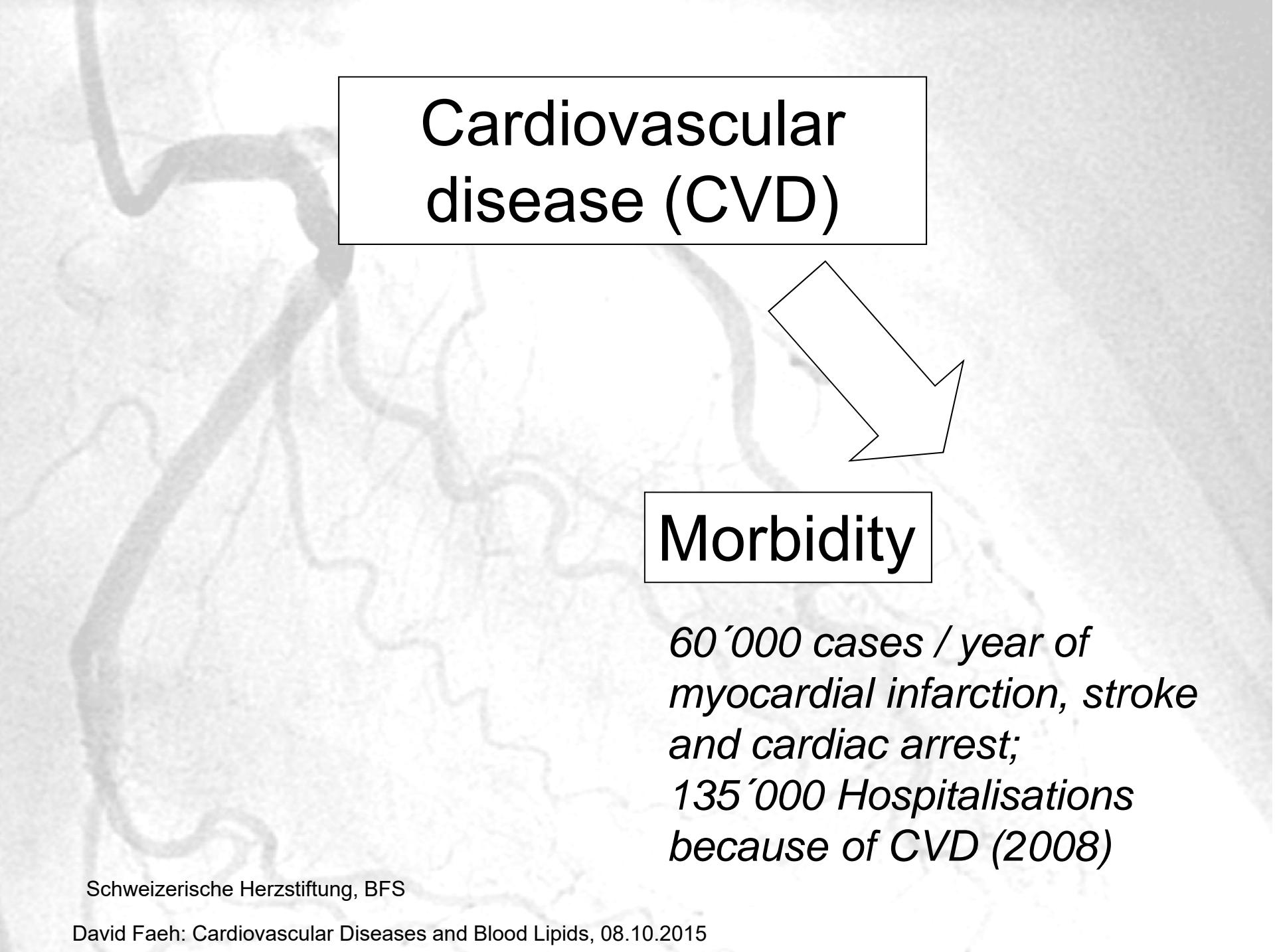


## Incidence

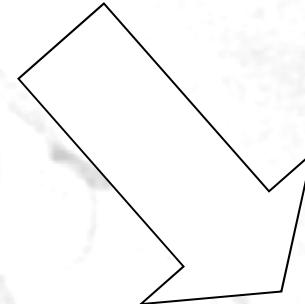
## Prevalence

*„Photo“:*

Number of persons that have a disease at a specific point of time (in %)



# Cardiovascular disease (CVD)



## Morbidity

*60'000 cases / year of  
myocardial infarction, stroke  
and cardiac arrest;  
135'000 Hospitalisations  
because of CVD (2008)*

# Cardiovascular disease (CVD)

Mortality

2010: 20'000 † (32% of all †);

IHD: 8'300 †;

Stroke: 3'800 †

*M>F*

*90% of deaths after age 65*

Morbidity

60'000 cases / year of myocardial infarction, stroke and cardiac arrest;

135'000 Hospitalisationen wegen HKK (2008)

Schweizerische Herzstiftung, BFS

# Morbidity of CVD: UK, CDN

Myocardial infarction (GB, 60 Mio inhabitants in 2003)

- 260'000 new cases per year (incidence)
- 1.4 Mio live with the consequences (prevalence)

Cerebrovascular disease (Canada, 32 Mio, 2003)

- 50'000 new cases per year (incidence)
- 300'000 live with the consequences (prevalence)

British Heart Foundation & Heart and Stroke Foundation of Canada

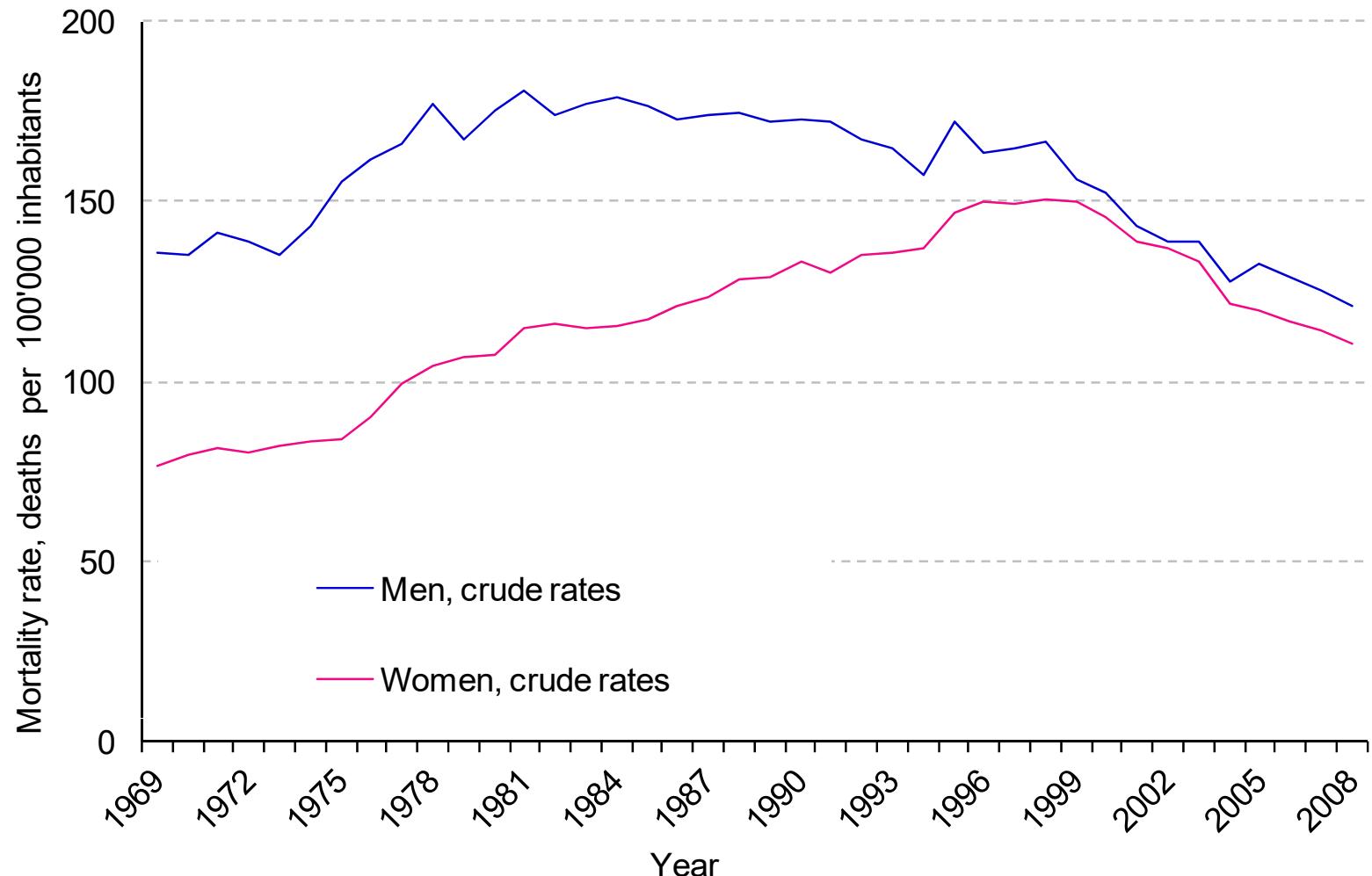
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# CHD: Crude rates



Data BFS: Todesursachenstatistik, Schweiz

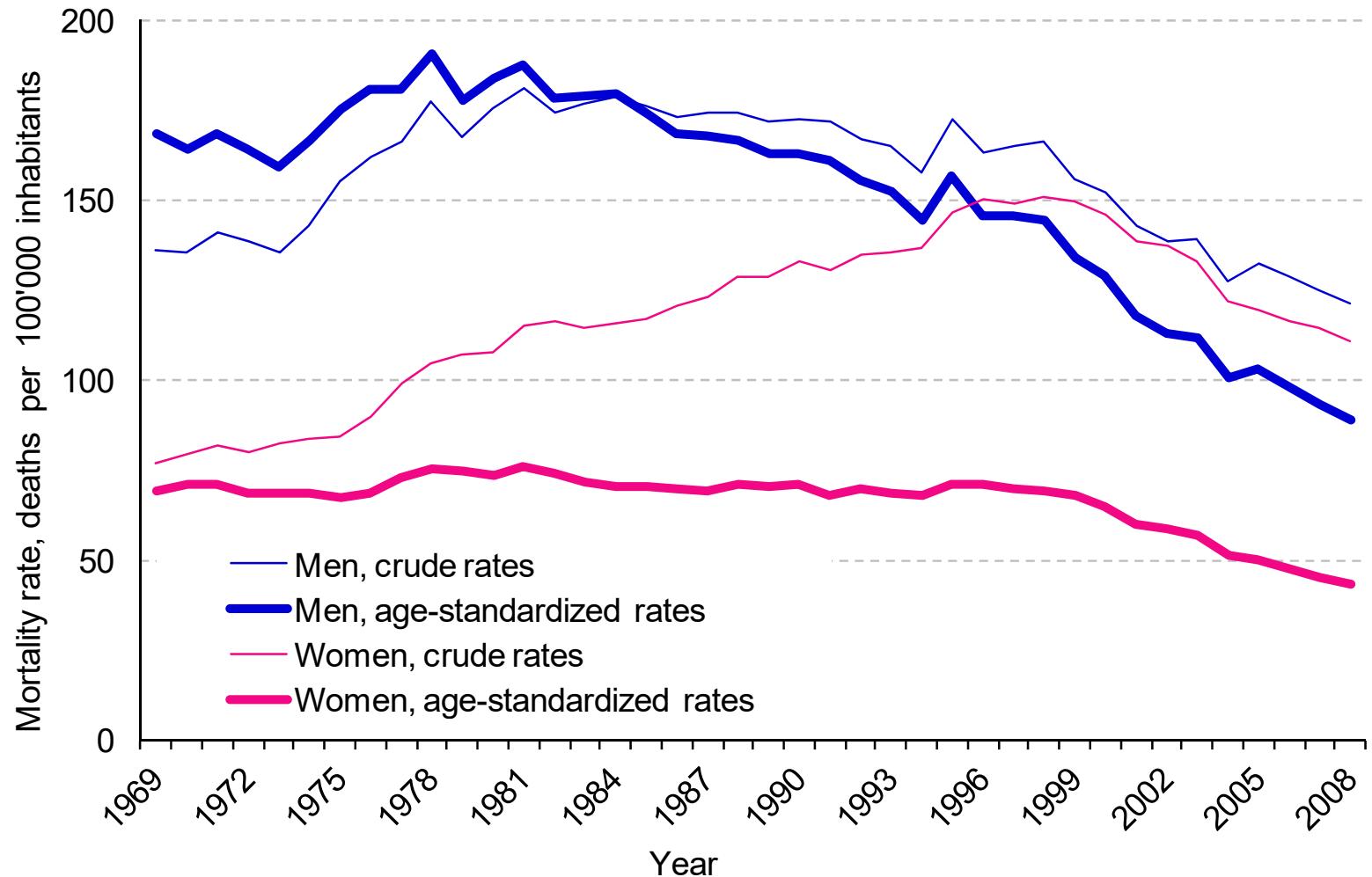
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# CHD: Crude rates vs. age standardized rates



Data BFS: Todesursachenstatistik, Schweiz

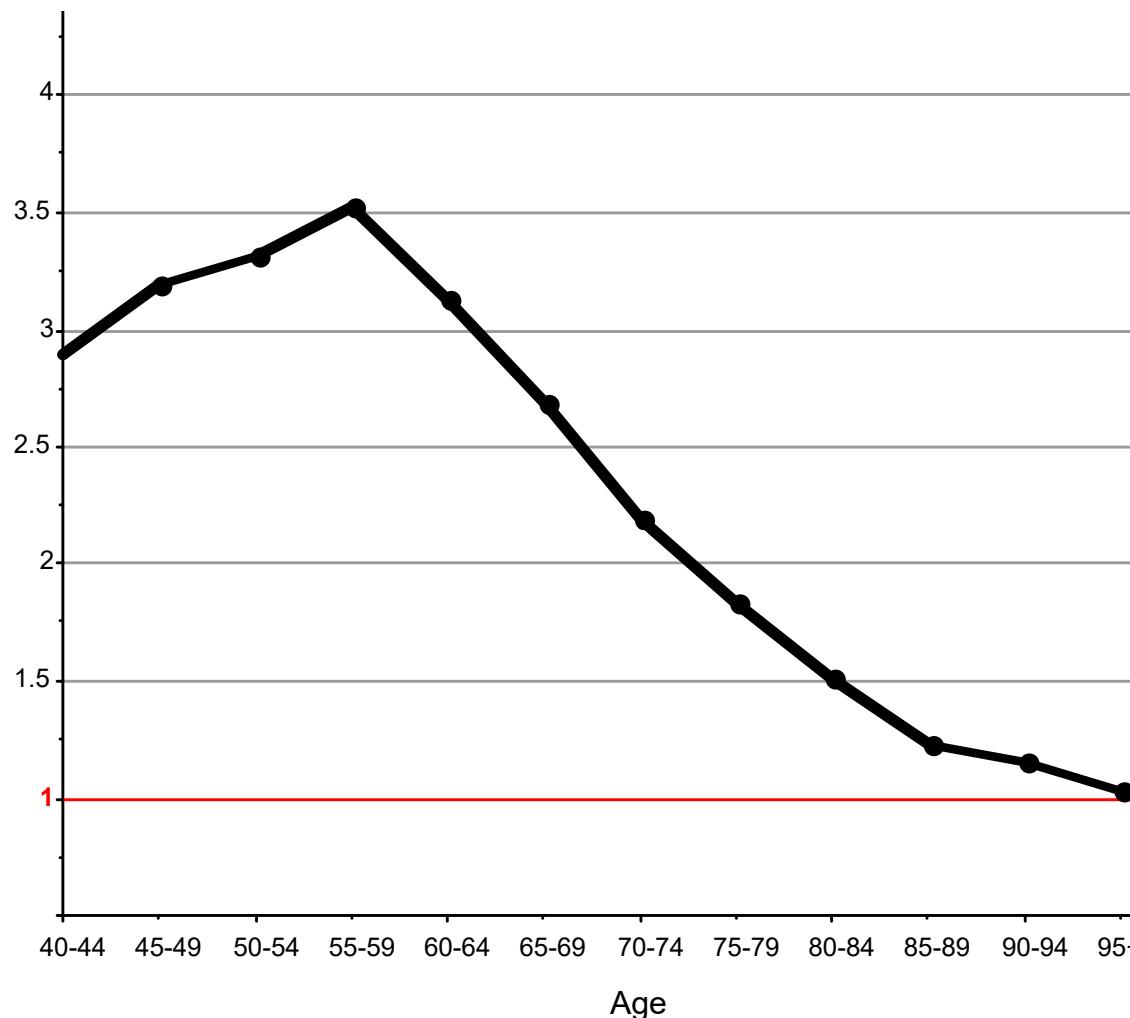
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# Sex-ratio (men vs. women) in CVD-mortality (Switzerland 2001-2005)



Datenquelle: Todesursachenstatistik (BFS)

David Faeh: Cardiovascular Diseases and Blood Lipids, 08.10.2015

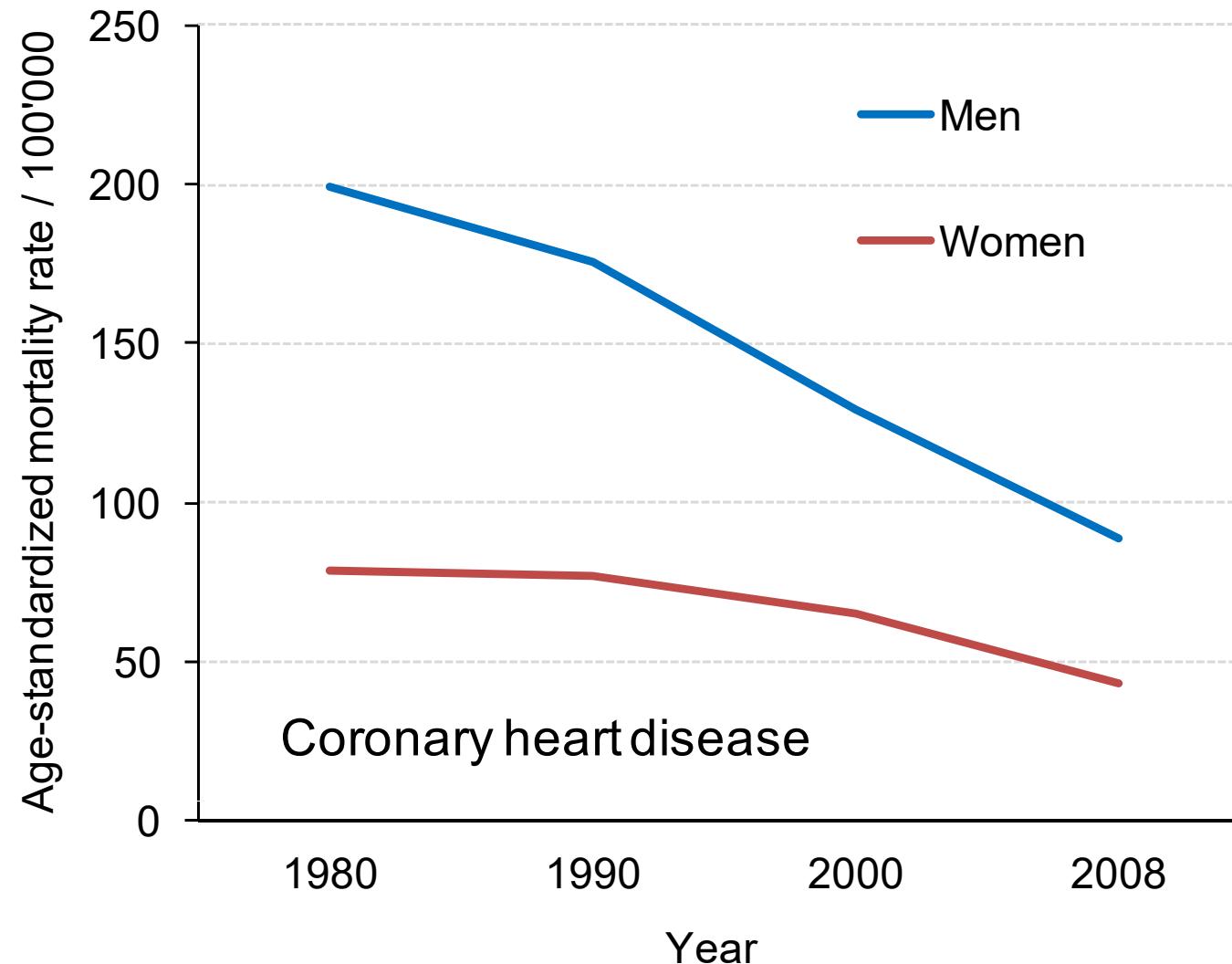
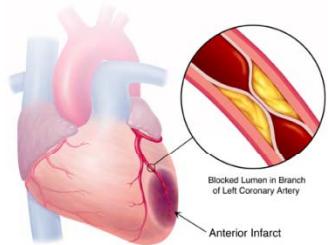
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# CHD mortality, Switzerland, 1980-2008



Data BFS: Todesursachenstatistik, Schweiz

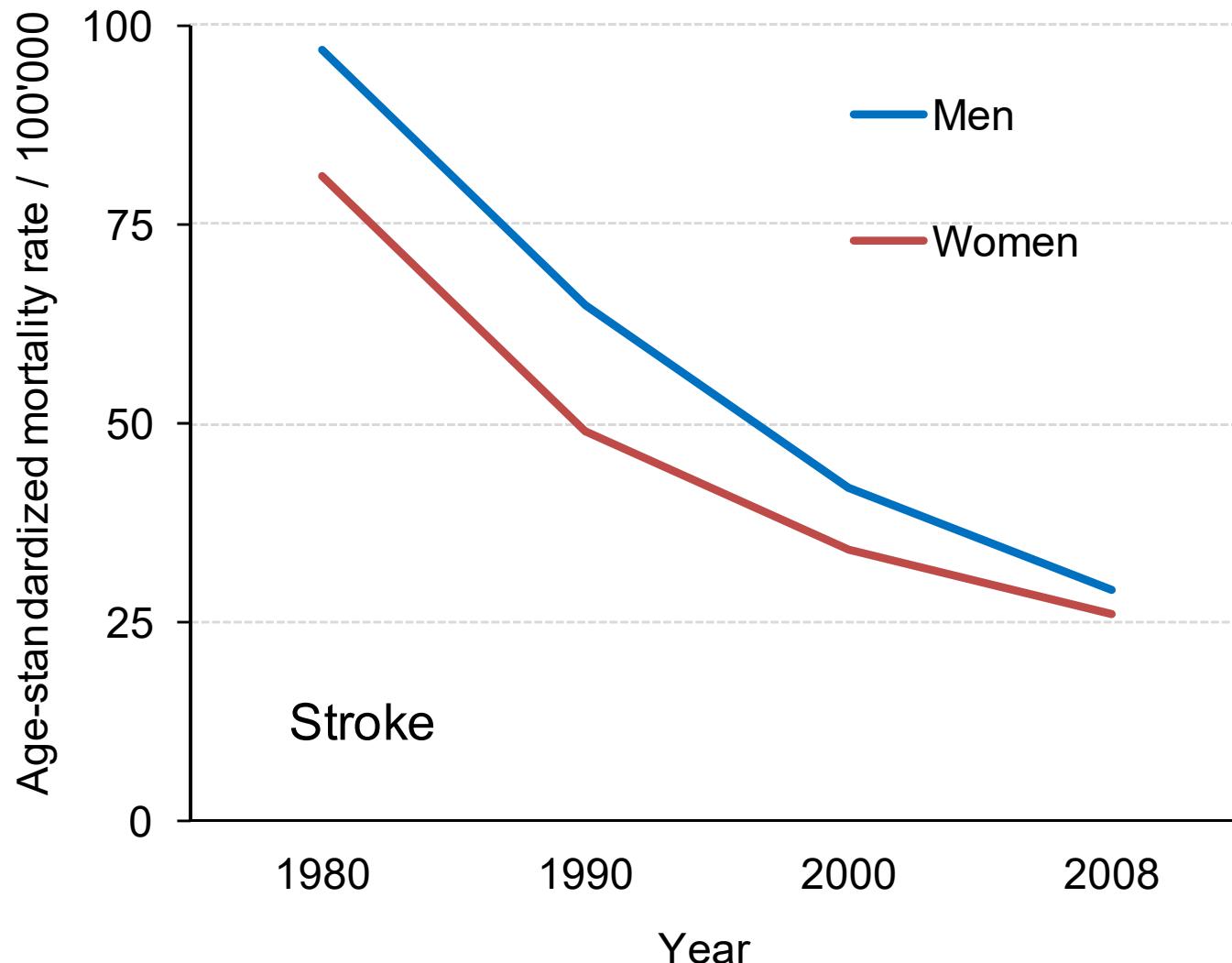
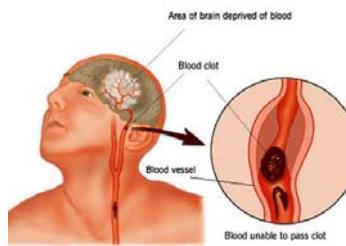
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# Stroke mortality, Switzerland, 1980-2008



Data BFS: Todesursachenstatistik, Schweiz

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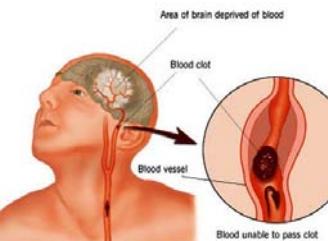
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250

## Stroke, age-standardized mortality rates (per 100'000), 2008

200

Men  
Women



150

100

50

0



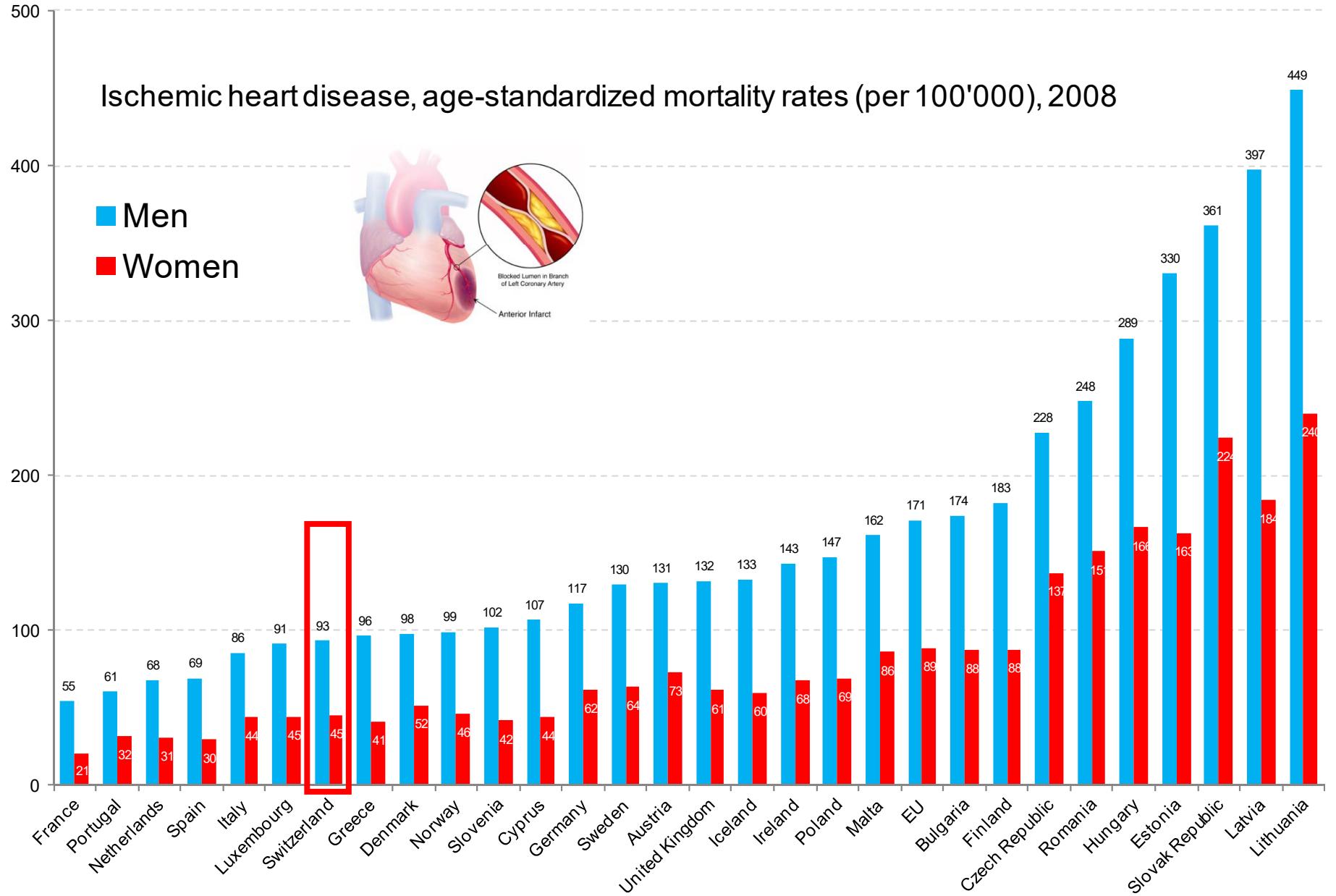
OECD Gesundheitsbericht, 2010

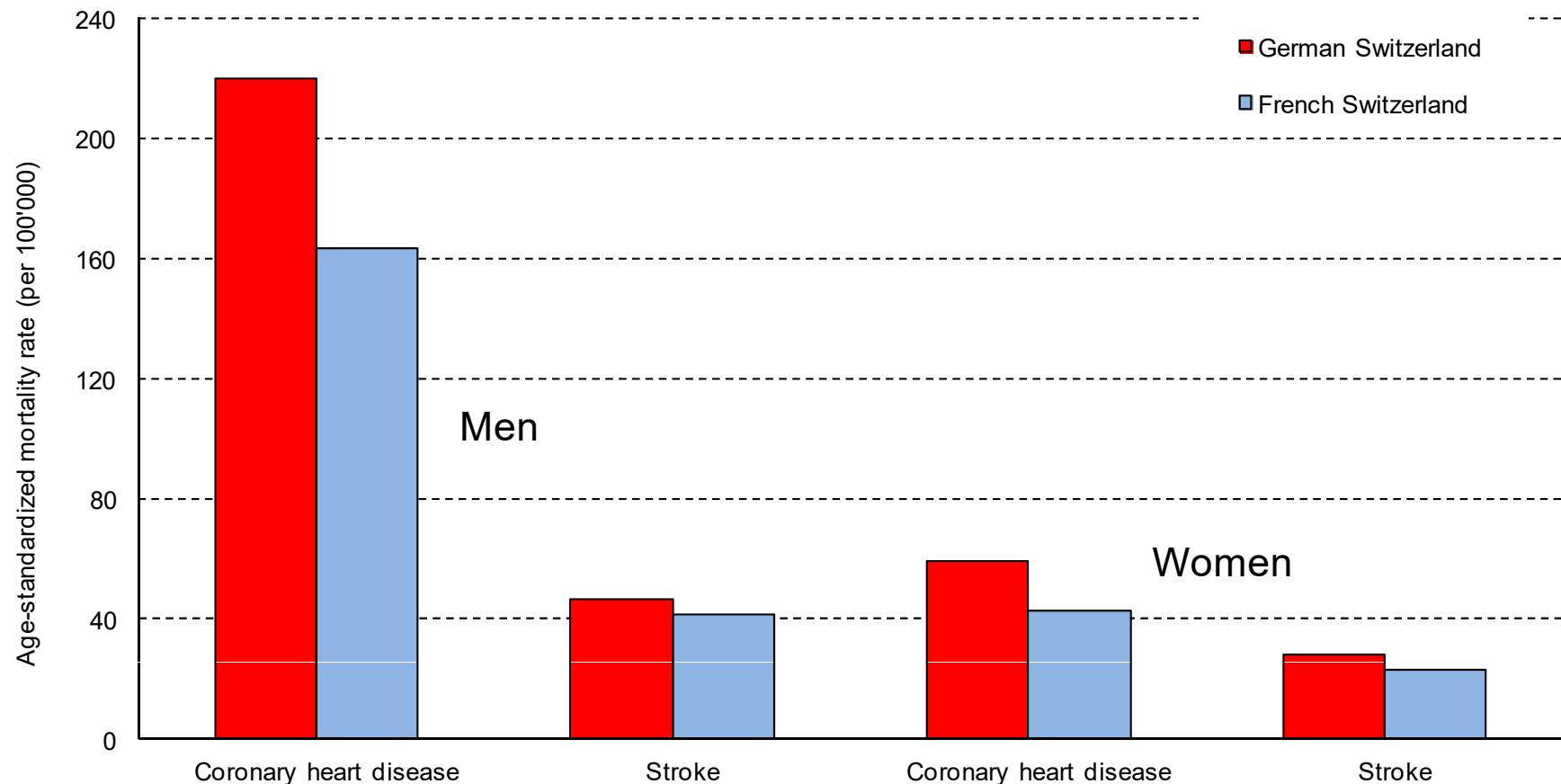
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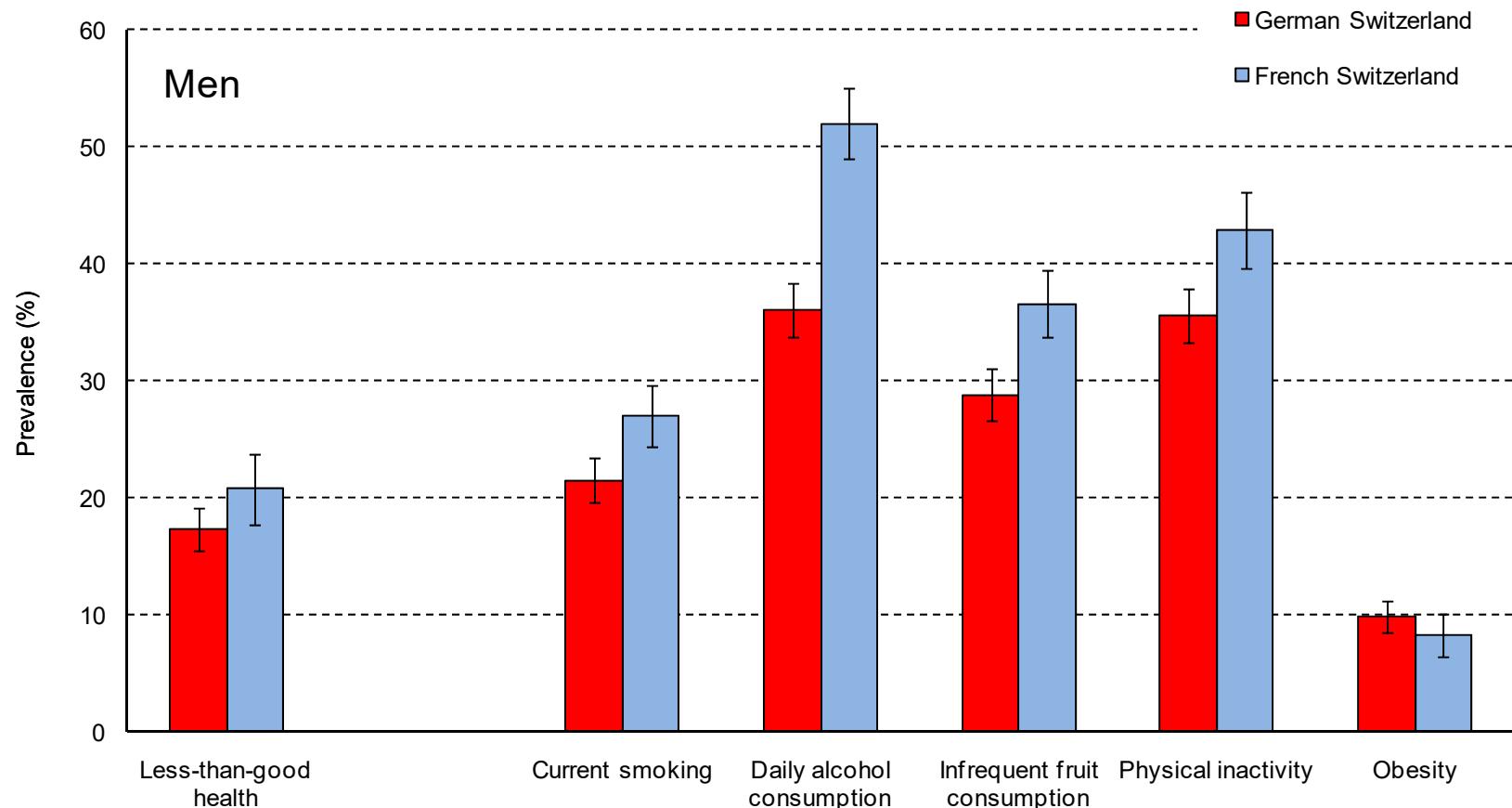
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Data: Swiss Health Survey 1992/93

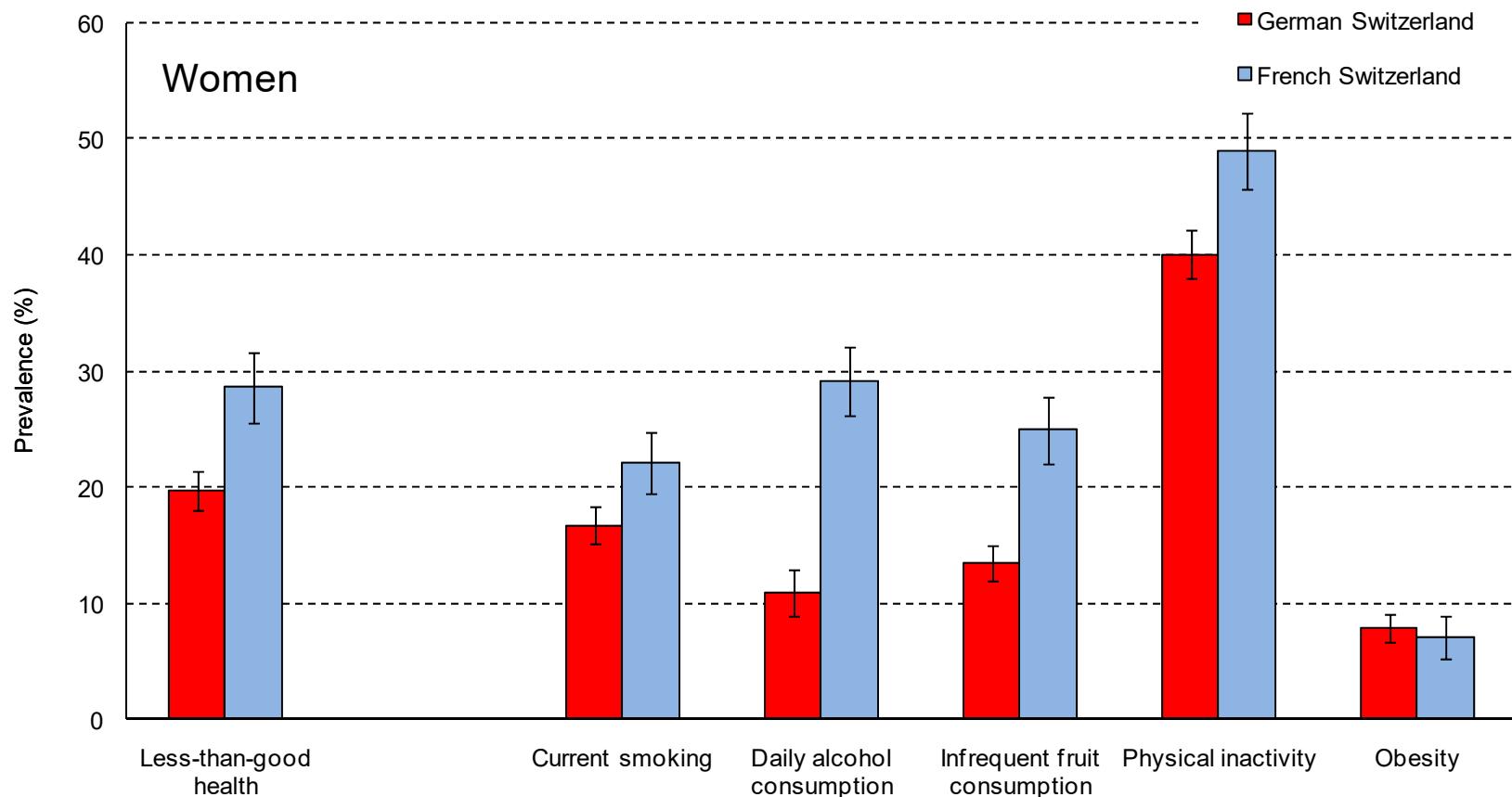
Faeh et al, JECH 2009 Aug;63(8):639-45

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Data: Swiss Health Survey 1992/93

Faeh et al, JECH 2009 Aug;63(8):639-45

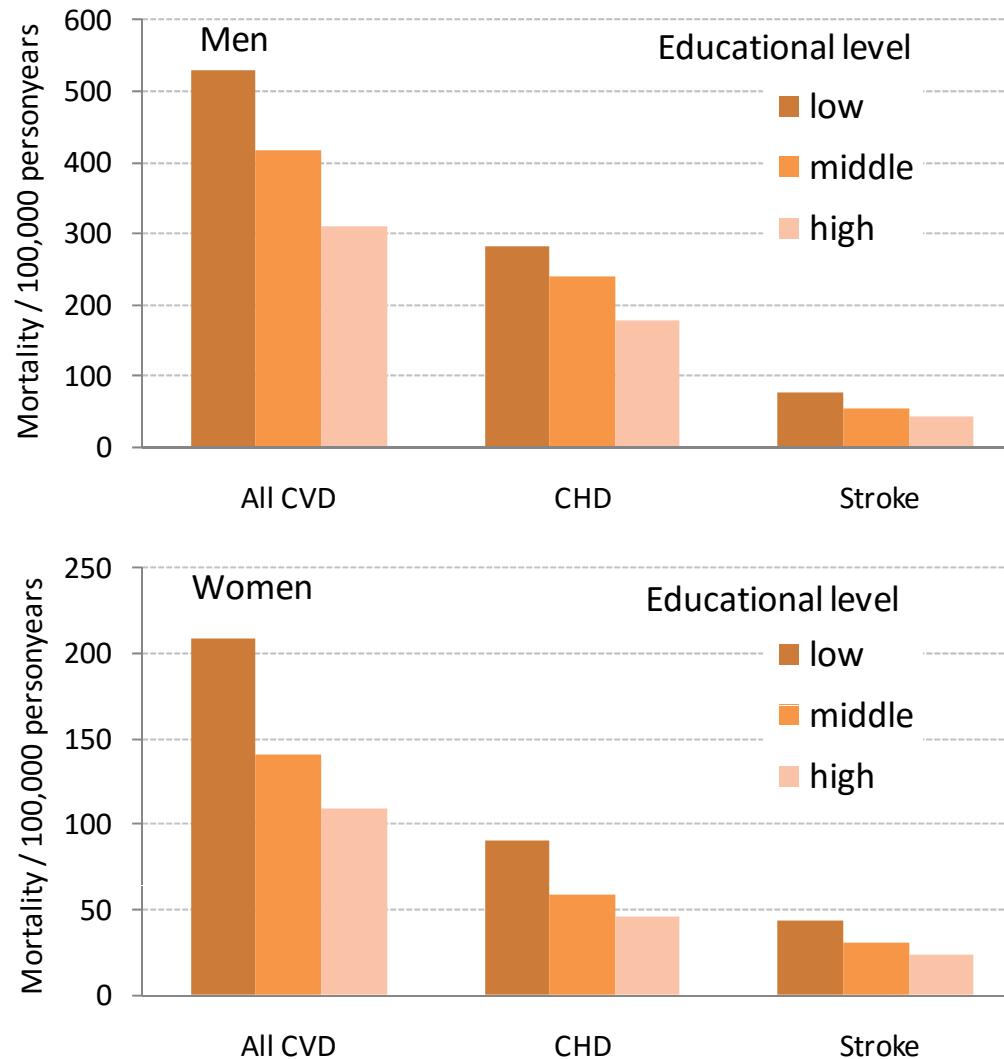
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# Educational inequality in German Switzerland



Data: Swiss National Cohort 2000

Faeh et al, BMC Public Health. 2010 Sep 22;10:567

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# Cardiovascular Diseases and Blood Lipids

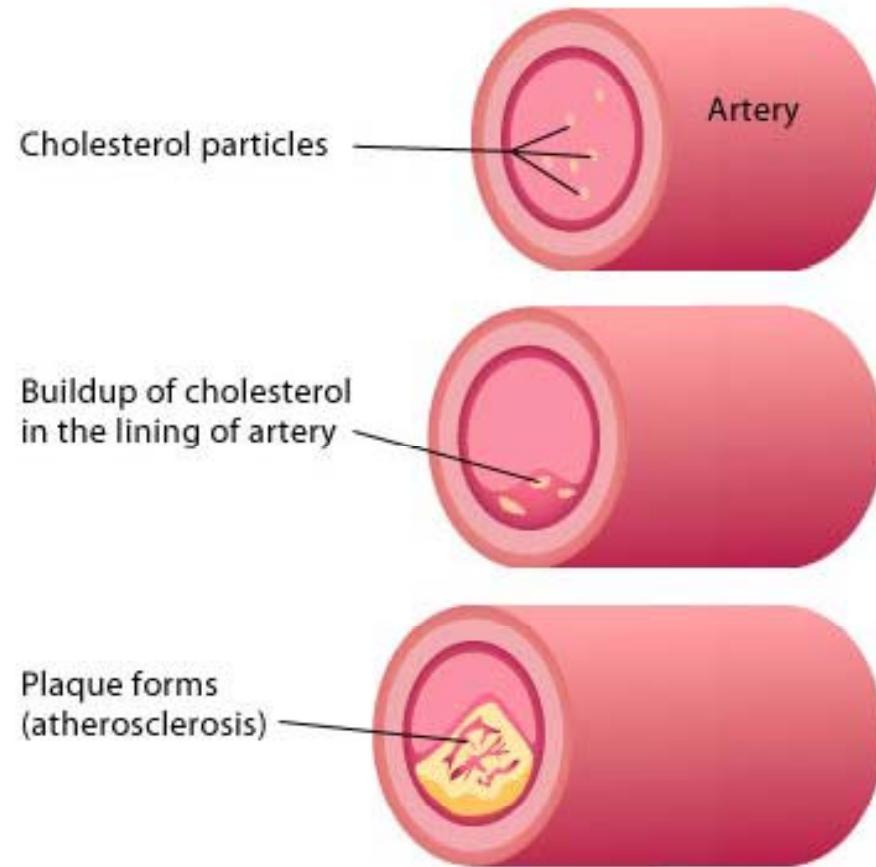
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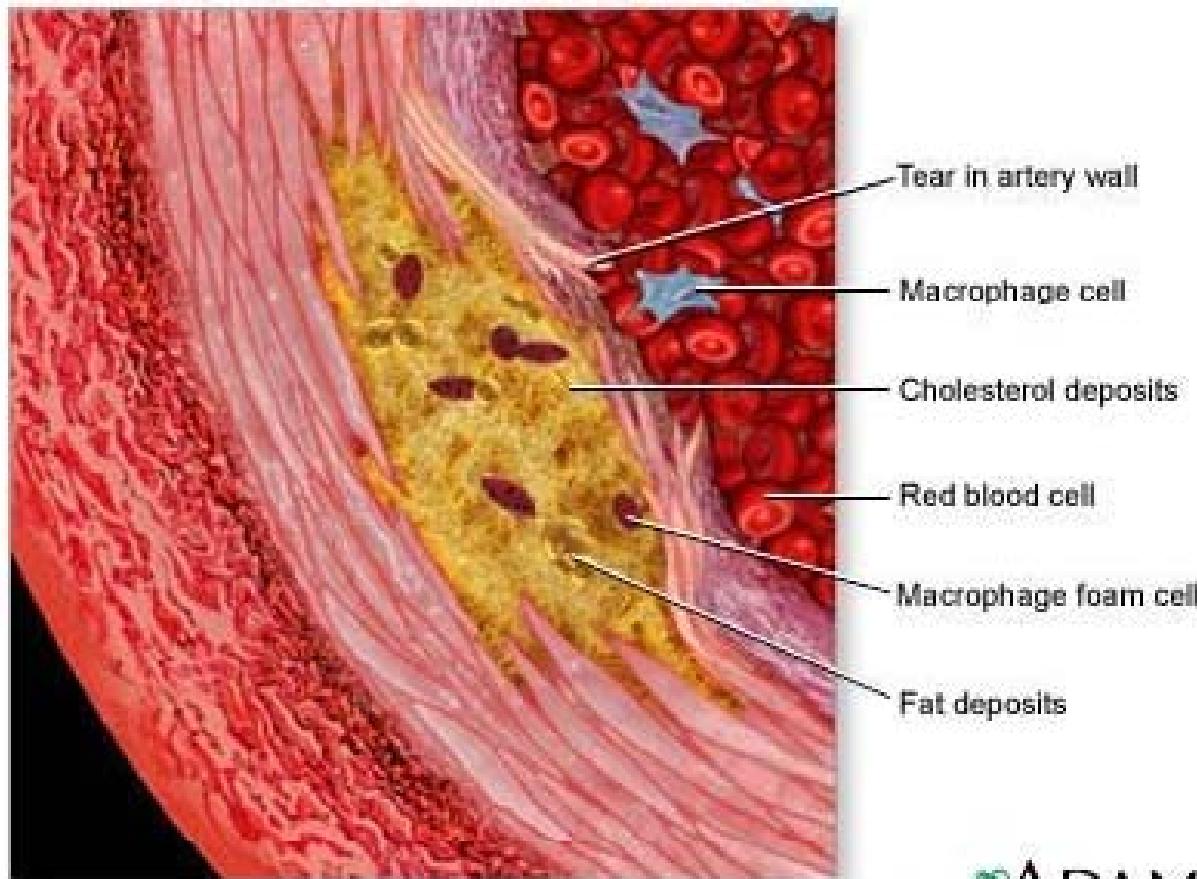
# Blood lipids

- Total cholesterol (TC)
  - High Density Lipoprotein Cholesterol (HDL-C)
  - Low Density Lipoprotein Cholesterol (LDL-C)
- Triglycerides (TG)



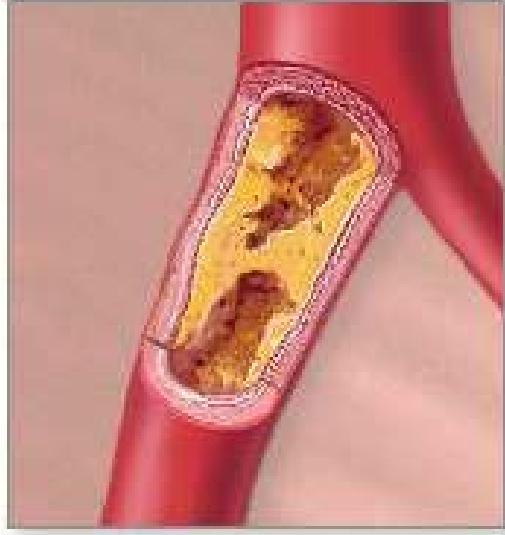


## Cut-section of artery

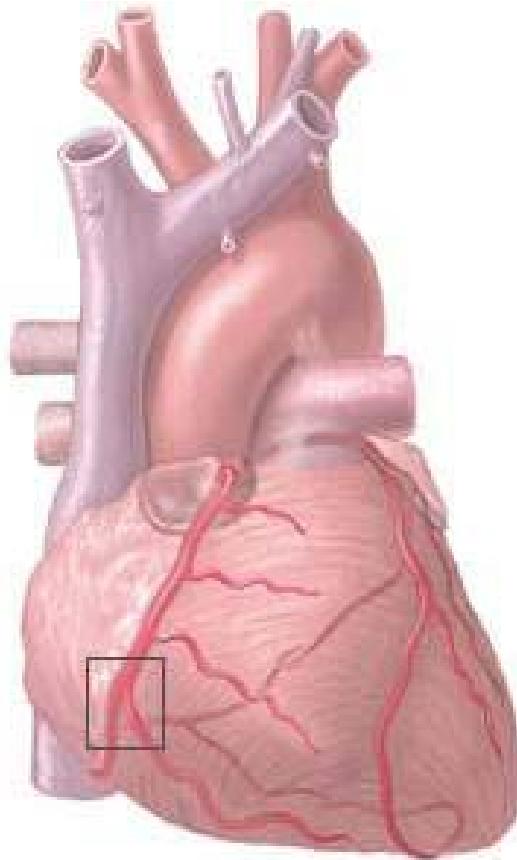


ADAM.

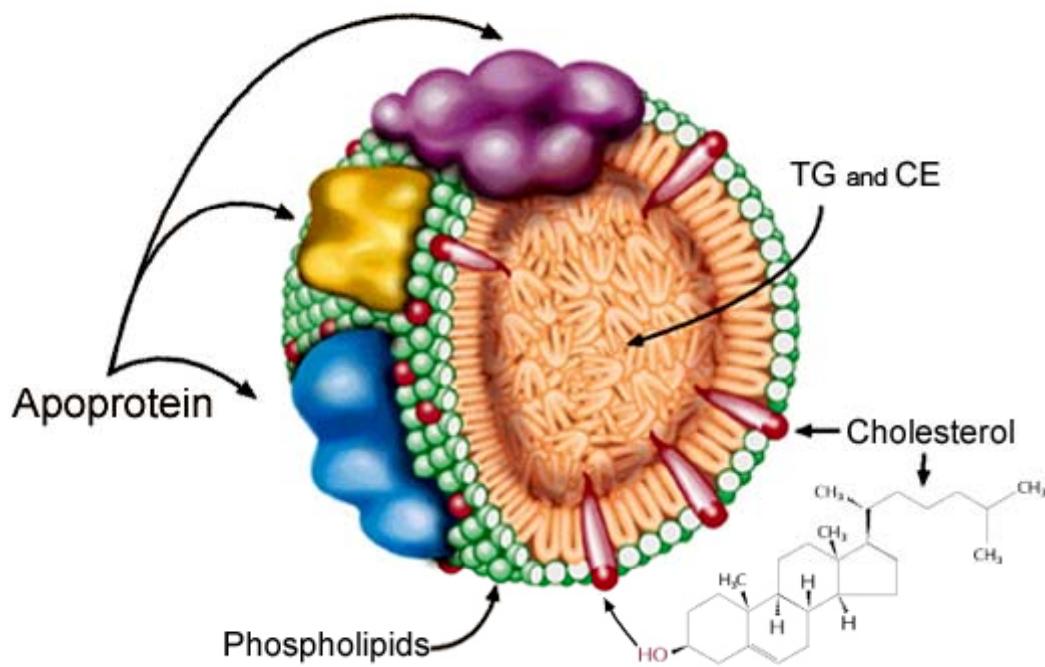




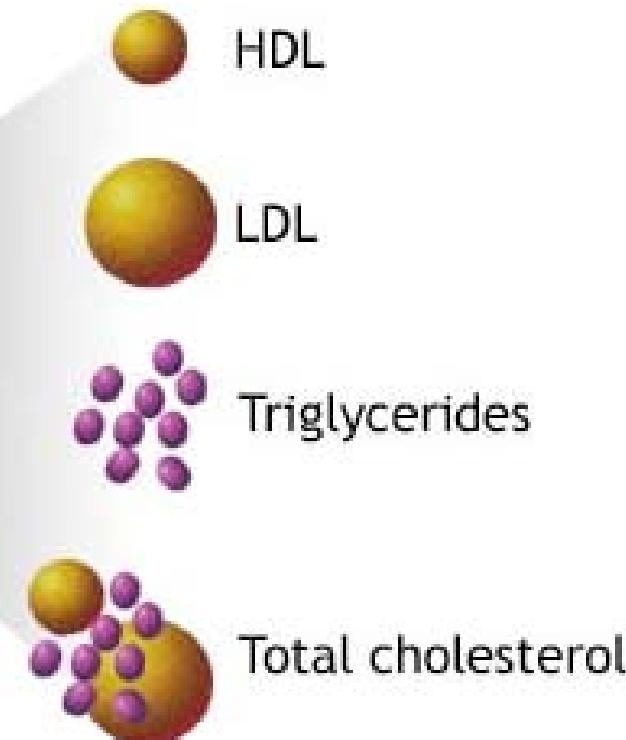
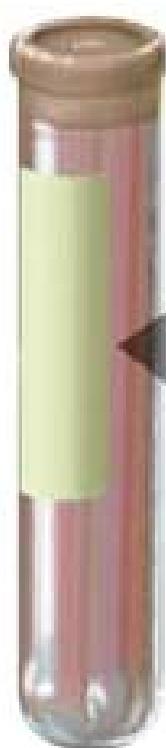
Blockage in right coronary artery



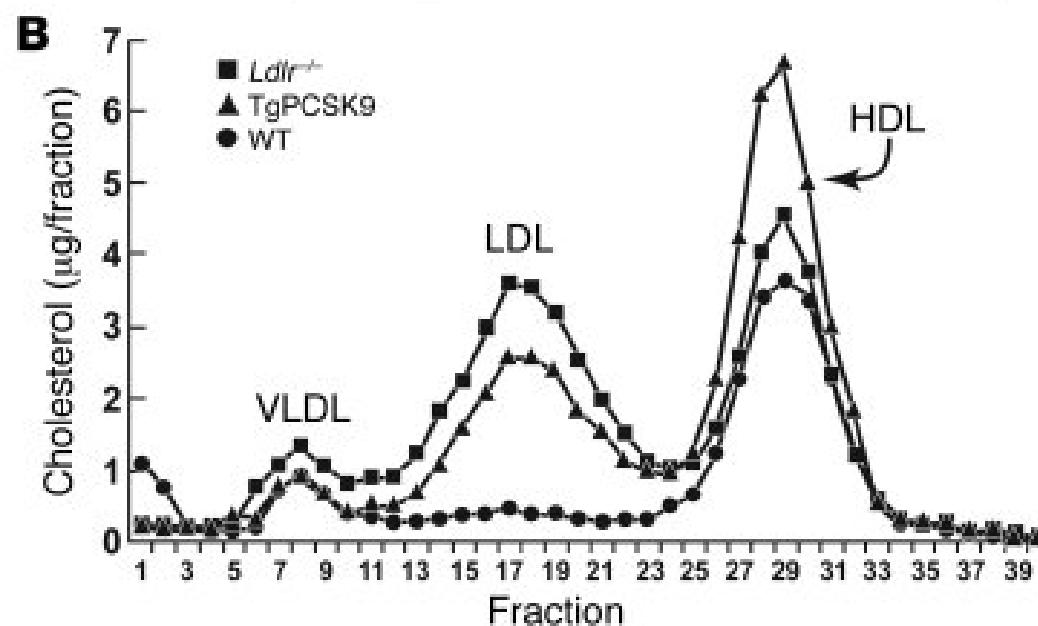
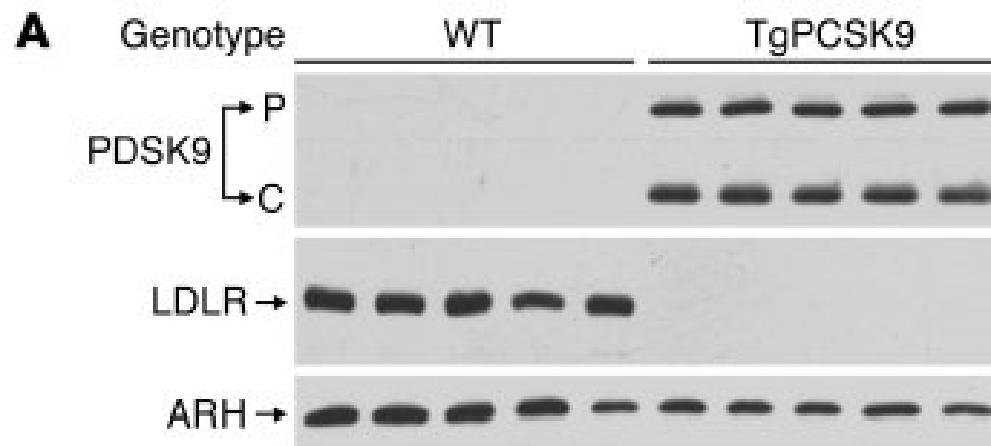
ADAM

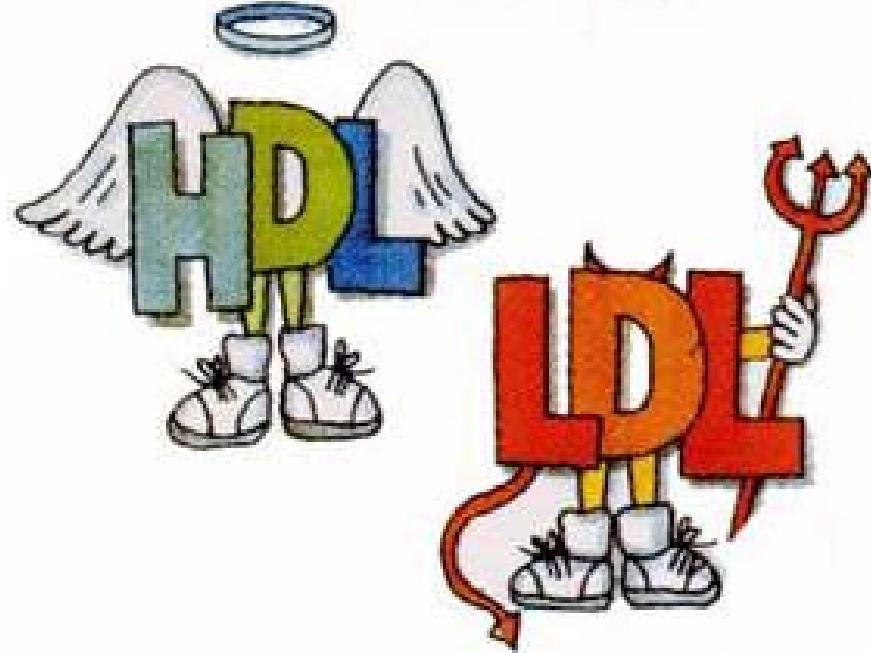


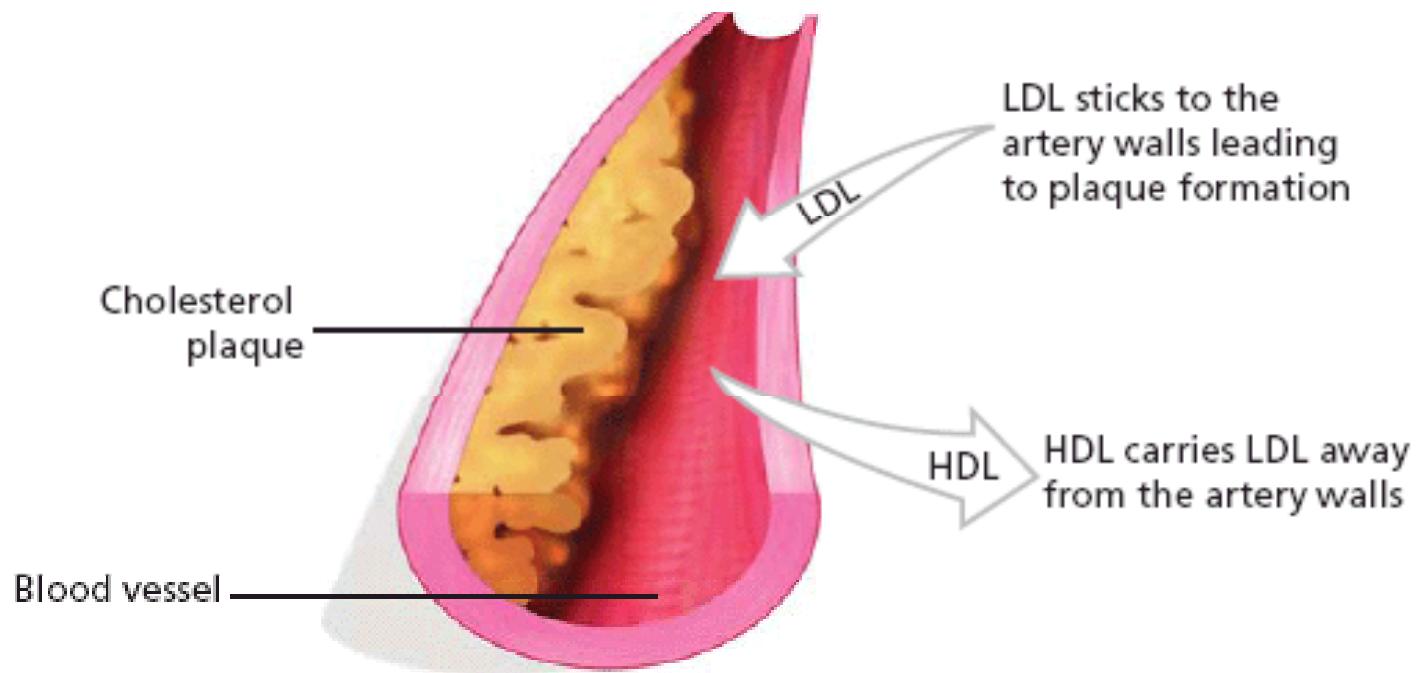
A lipoprotein profile measures the level of cholesterol in the blood

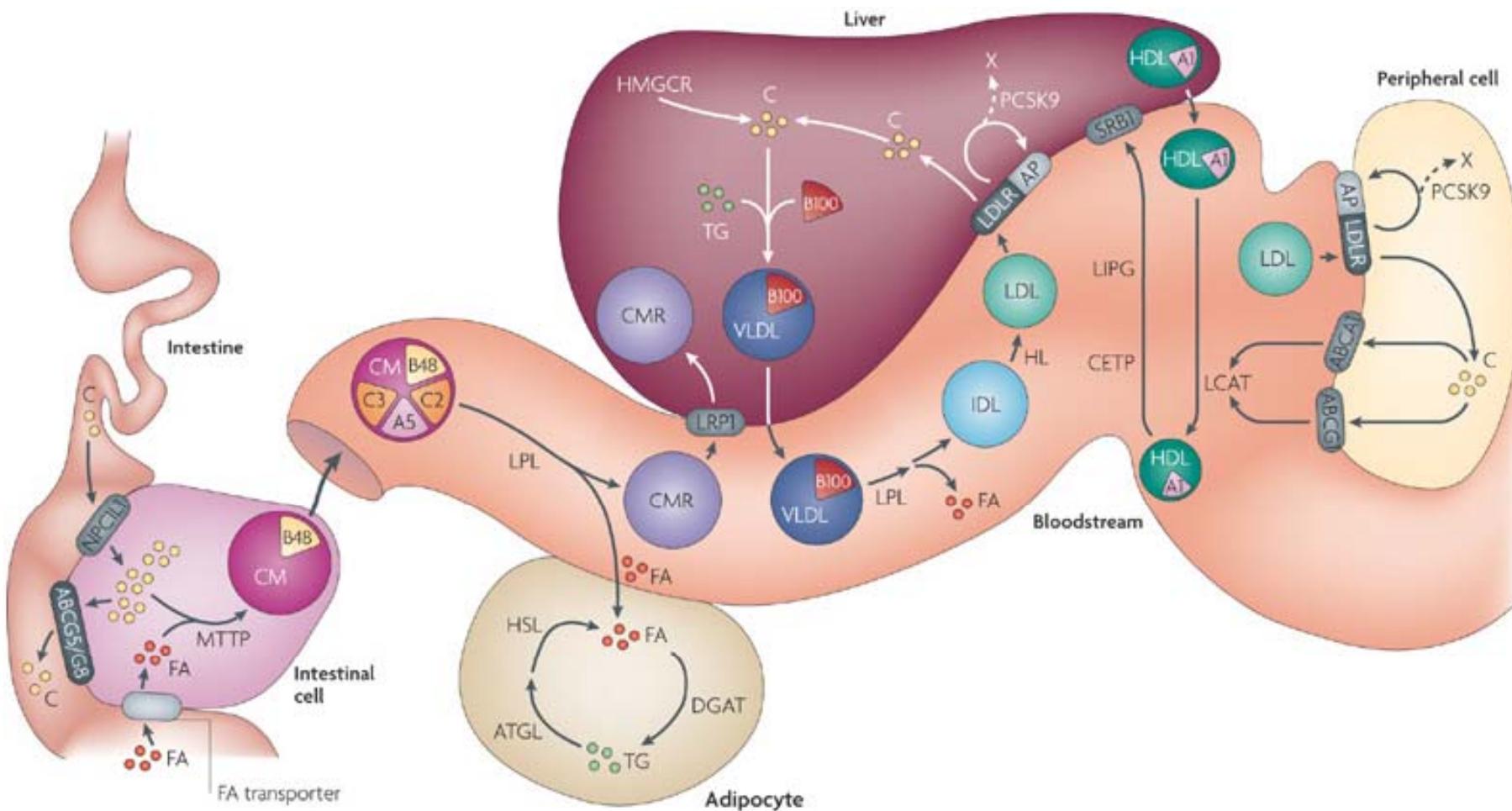


A.D.A.M.



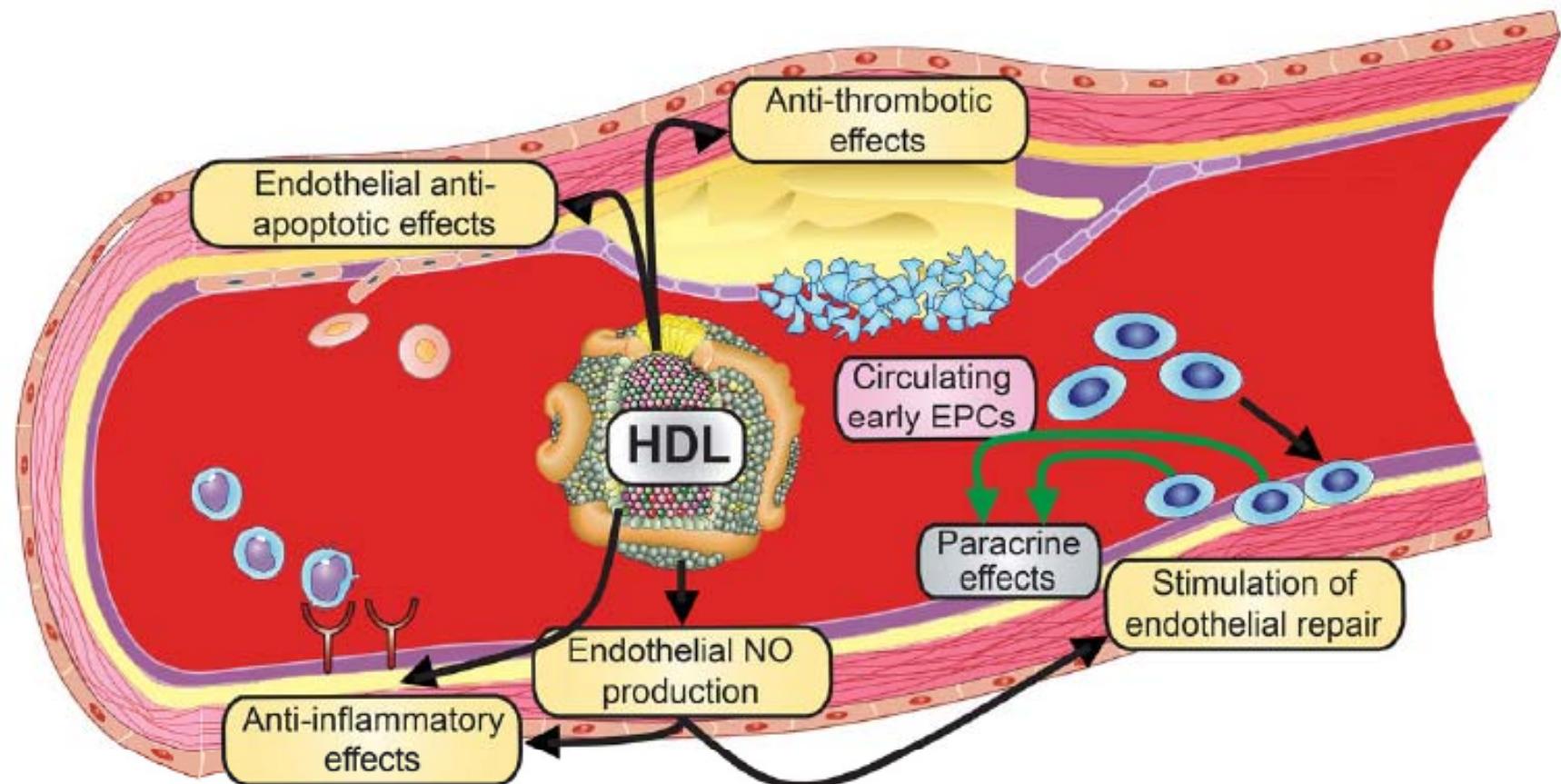






Nature Reviews | Genetics



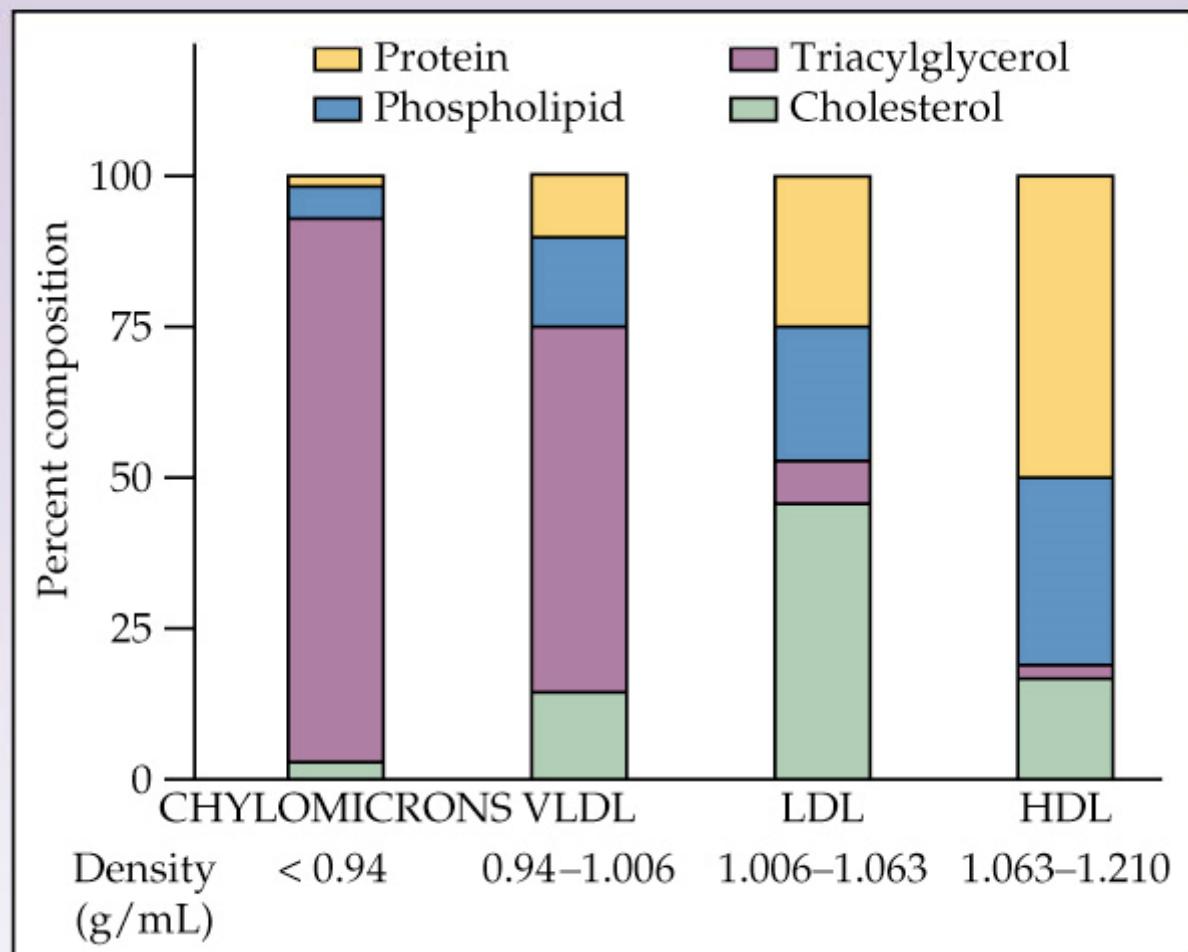


EPC: Endothelial progenitor cells

**Table I: General Characteristics of Plasma Lipoproteins.**

LP Particle	Size	Density (g/ml)*	TG/CE Ratio*	L/P Ratio*	Associated Apoproteins
CM	1000nm	<0.95	28.83	65.66	<b>apoB-48, apoA, apoC, apoE, apoH</b>
VLDL	70nm	0.98	3.89	10.76	<b>apoE, apoB-100, apoC</b>
IDL	40nm	1.01	0.82	8.09	<b>apoE, apoB-100, apoC</b>
LDL	20nm	1.04	0.18	3.76	<b>apoB-100, apoC, apoE, apo(a)</b>
HDL	10nm	1.13	0.16	1.22	<b>apoA-1, apoC, apoD, apoE</b>

LEGEND: \* Average values, TG-triglycerides, CE-cholesteryl esters, L/P- lipid/protein, **Bold** represents the major apoprotein

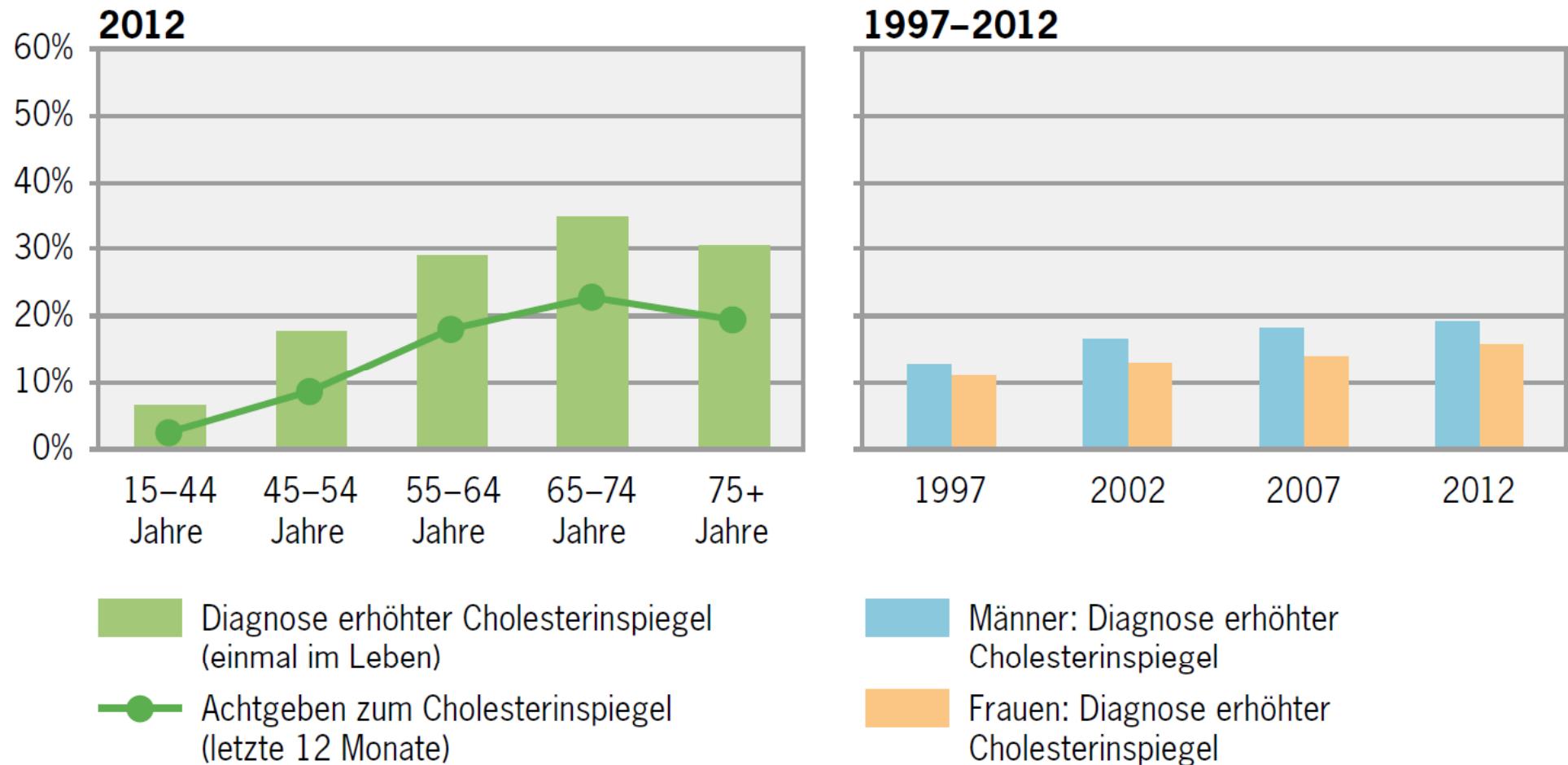


## (b) Density and composition of lipoproteins

# Self-reported hypercholesterolemia 1997-2012

## Erhöhter Cholesterinspiegel

G 7



Quelle: SGB

Data BFS: Swiss Health Survey

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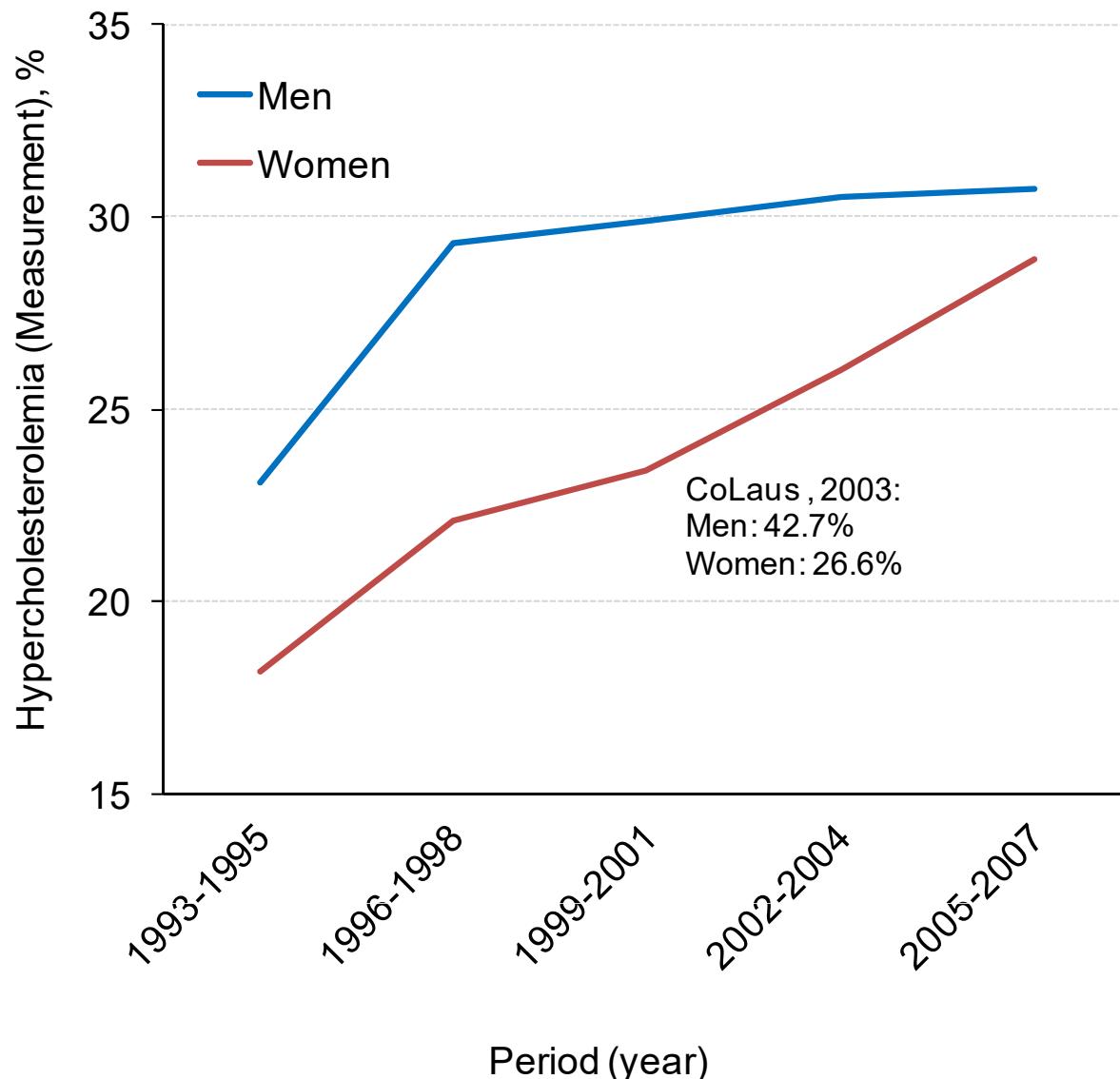
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# Hypercholesterolemia, Switzerland, 1993-2007



Data Bus Santé, Geneva, Switzerland

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# Cardiovascular Diseases and Blood Lipids

- Epidemiology of CVD
- Blood lipids: types and functions
- Association of blood lipids with other CVD risk factors and with CVD events
- Lifestyle and blood lipids
- Recommendations

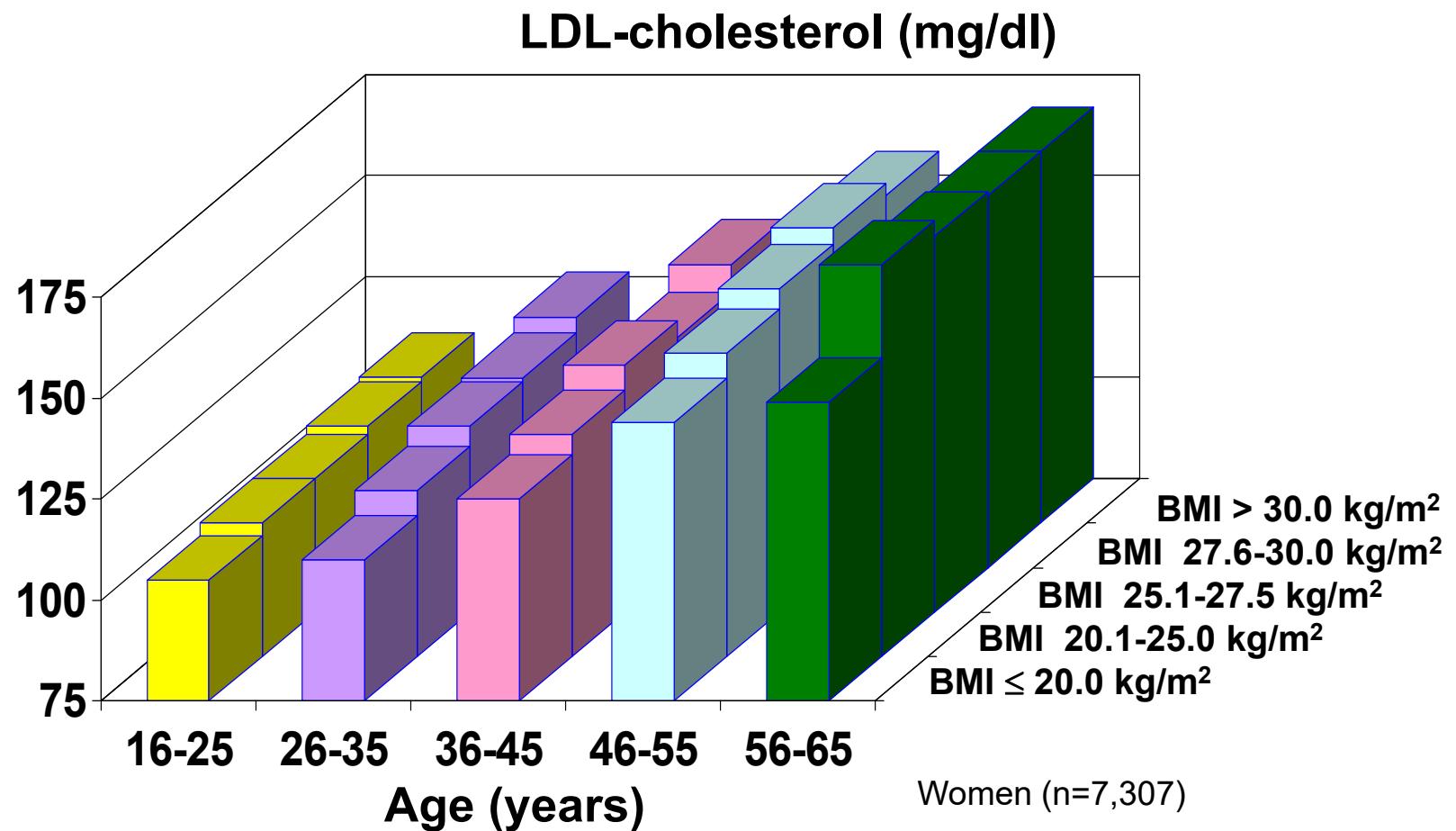


# Factors influencing blood lipids

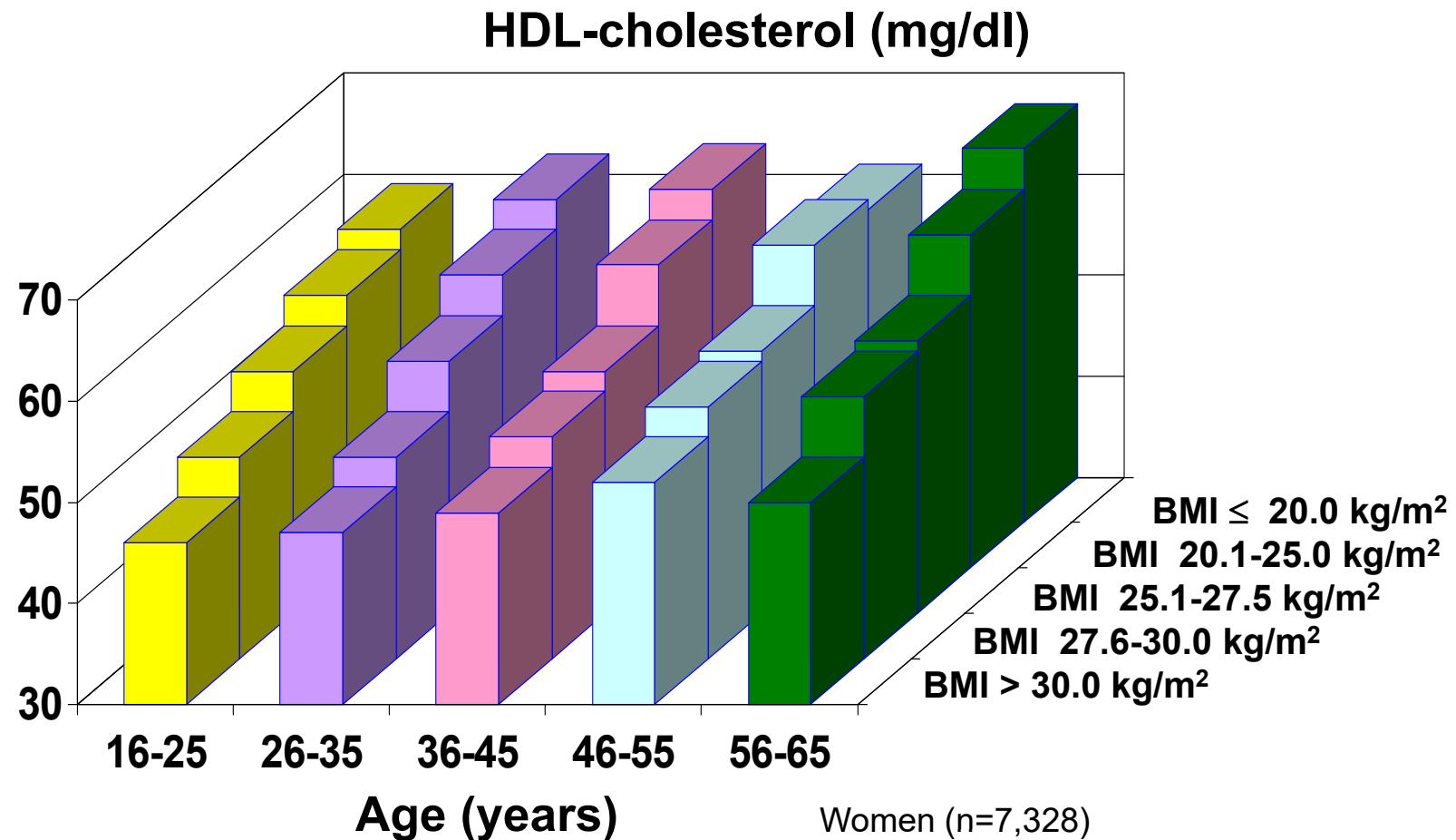
- Age
- Sex
- Genetic background
- Body weight
- Diabetes
- Smoking
- Other lifestyles (diet, physical activity)



# LDL-Cholesterol According to Age and BMI



# HDL-Cholesterol According to Age and BMI



PROCAM (Münster Heart Study)

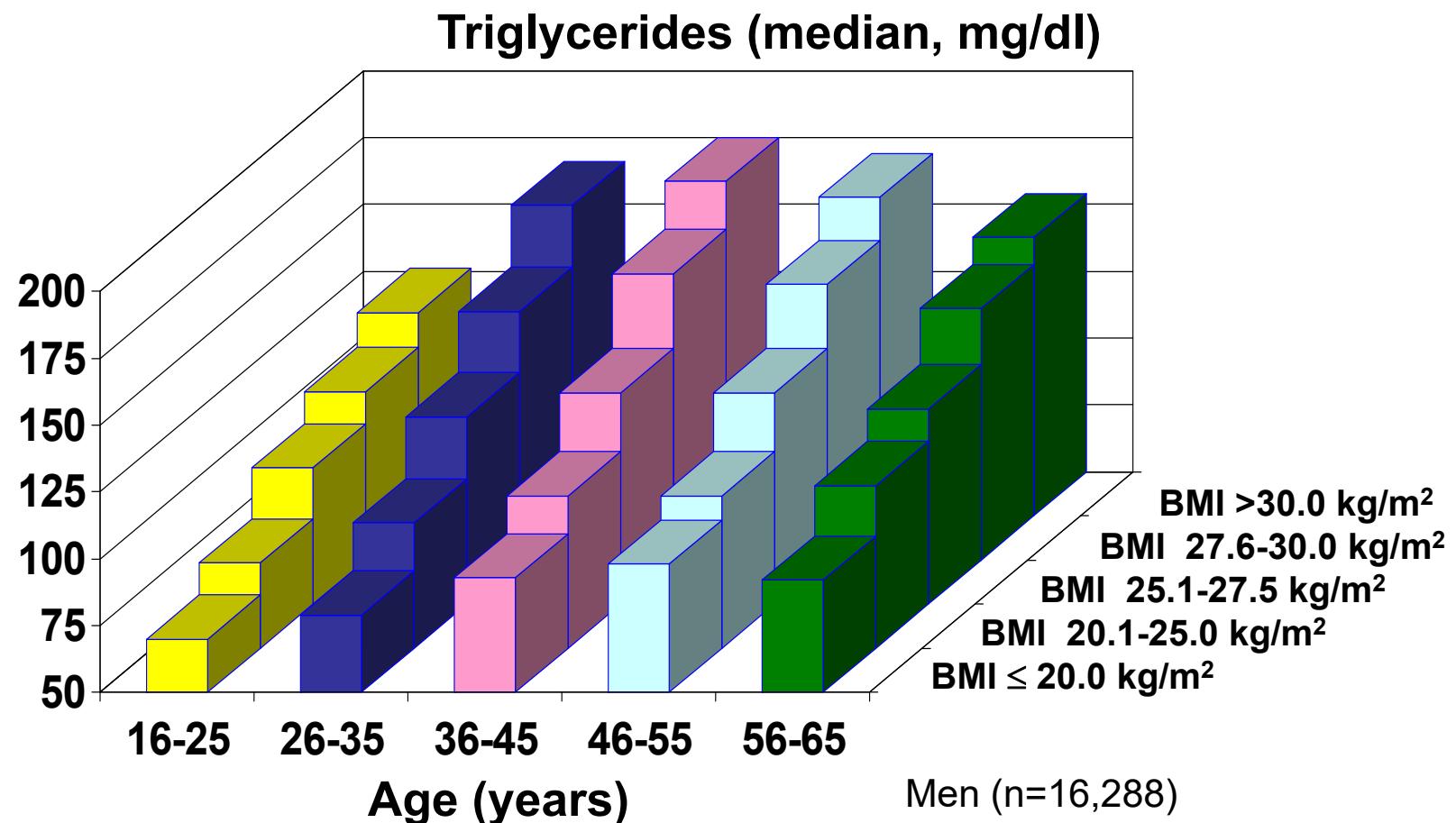
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# Triglycerides According to Age and BMI



# Prevalence of Risk Factors in Men by HDL-C

HDL-C	< 35 mg/dl (n=1003)	≥ 35 mg/dl (n=5698)	p
Cigarette smoking	44.7	29.8	< 0.001
Diabetes mellitus	11.2	6.7	< 0.001
BMI > 30 kg/m <sup>2</sup>	18.7	8.5	< 0.001
Triglycerides > 200 mg/dl	42.2	15.3	< 0.001
Hypertension	29.5	26.5	< 0.05
Family history of MI	18.0	16.1	n.s.
LDL cholesterol > 160 mg/dl	32.5	34.0	n.s.
MI incidence (in 10 years)	11.9	5.1	< 0.001

# Relationship of blood lipids with CVD

Depending on...

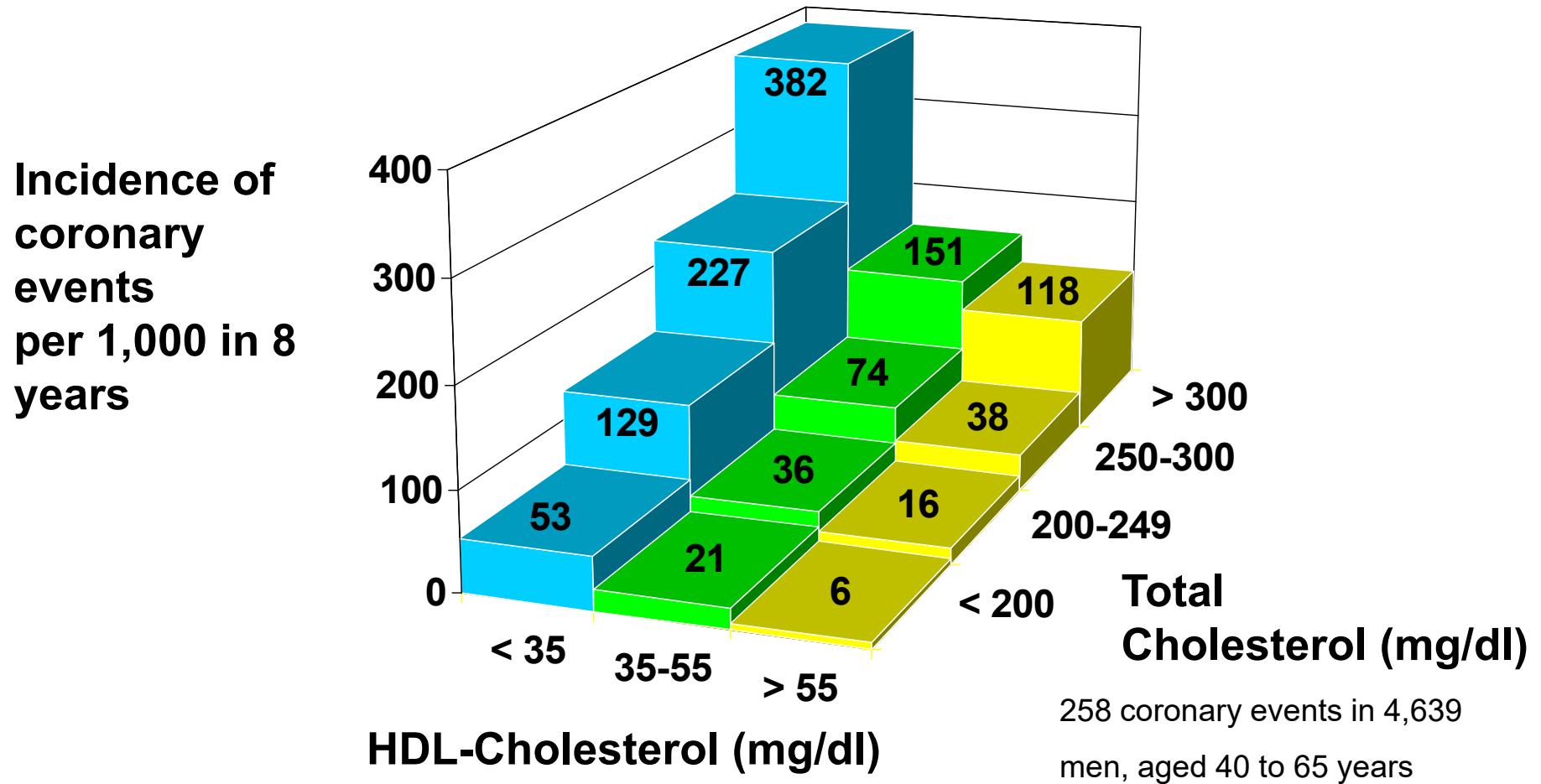
- Age
- Sex
- Smoking status
- Body weight
- Blood glucose
- Relationship of blood lipids



# Sudden cardiac deaths (SCD) vs. surviving (24h) myocardial infarction (MI)-patients (25–74y)

Known disease	SCD	MI
High blood pressure	65%	65%
High cholesterol levels	40%	60%
Diabetes	35%	30%
Coronary heart disease	65%	30%
None	25%	25%

# Incidence of Coronary Events According to HDL-Cholesterol and total Cholesterol



PROCAM (Münster Heart Study)

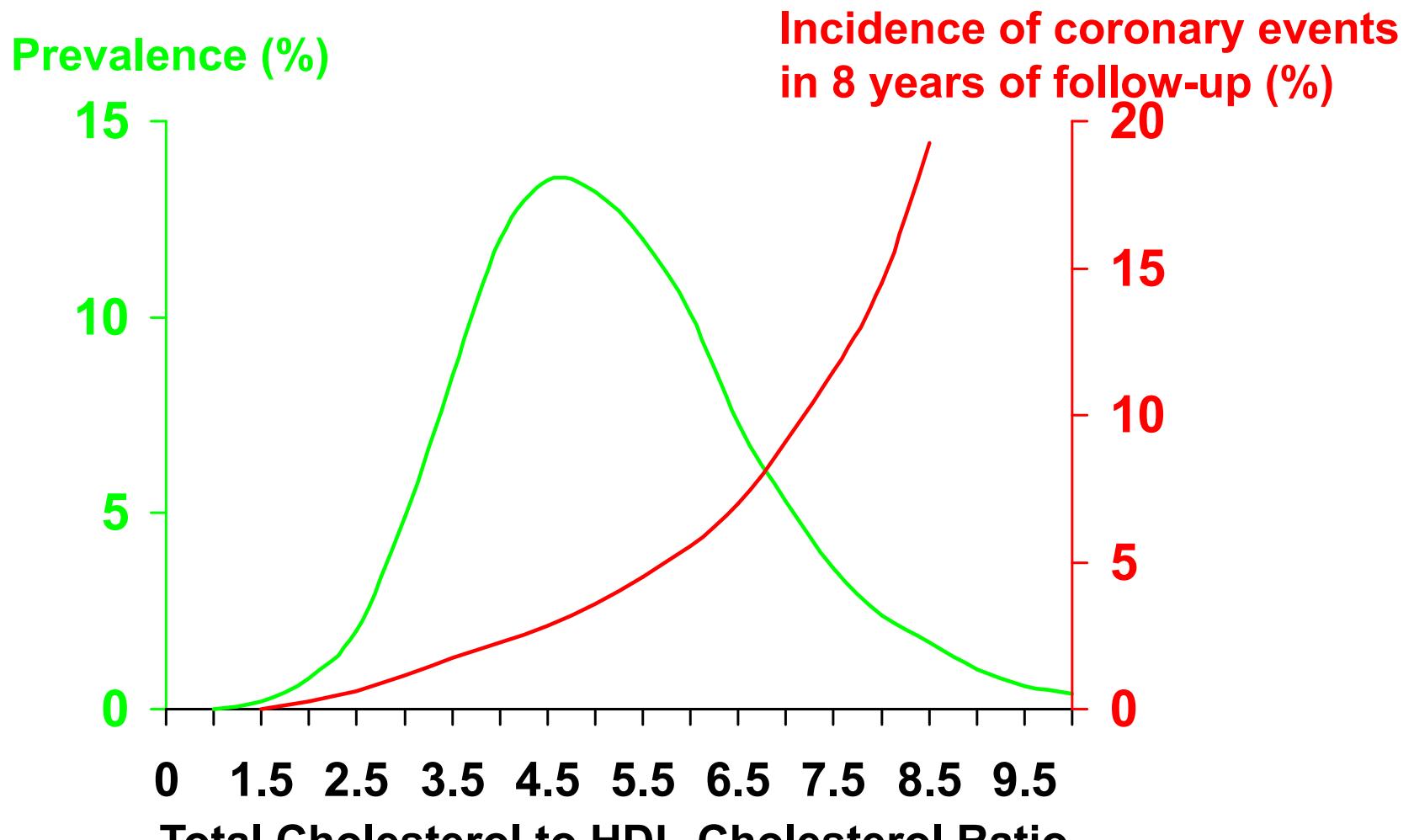
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# Distribution of Cholesterol to HDL-Cholesterol Ratio and Incidence of Coronary Events



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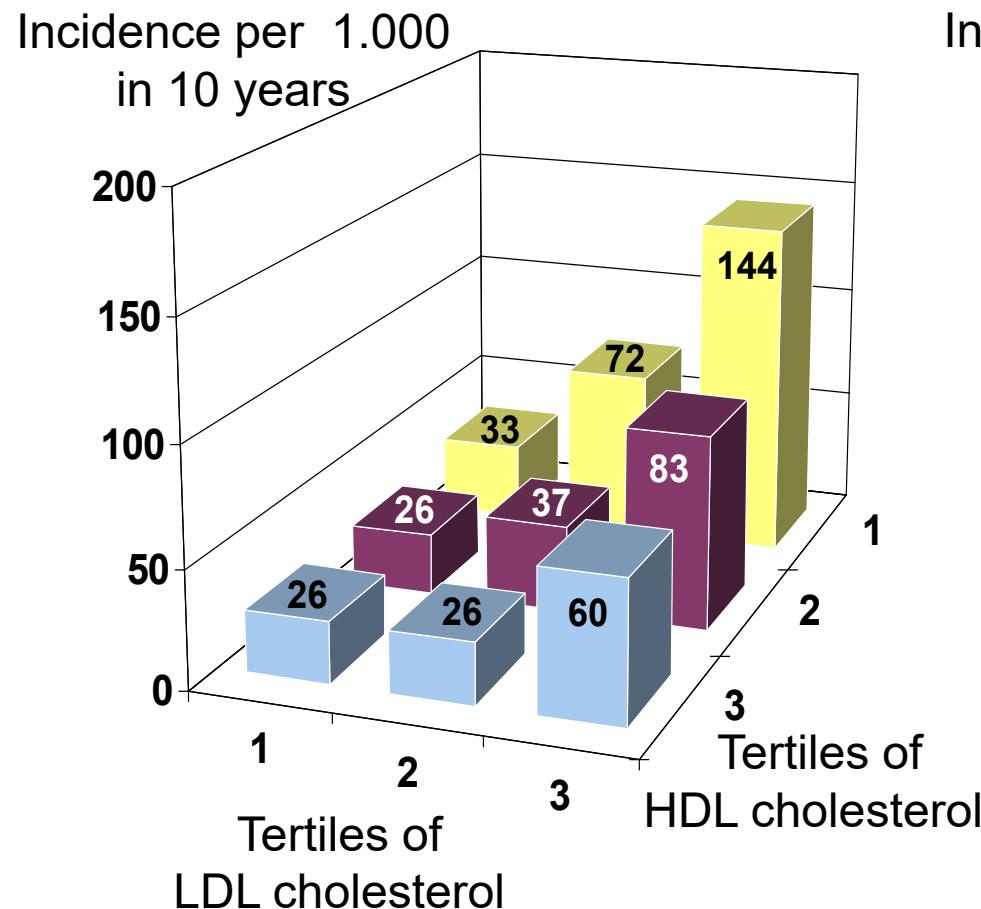
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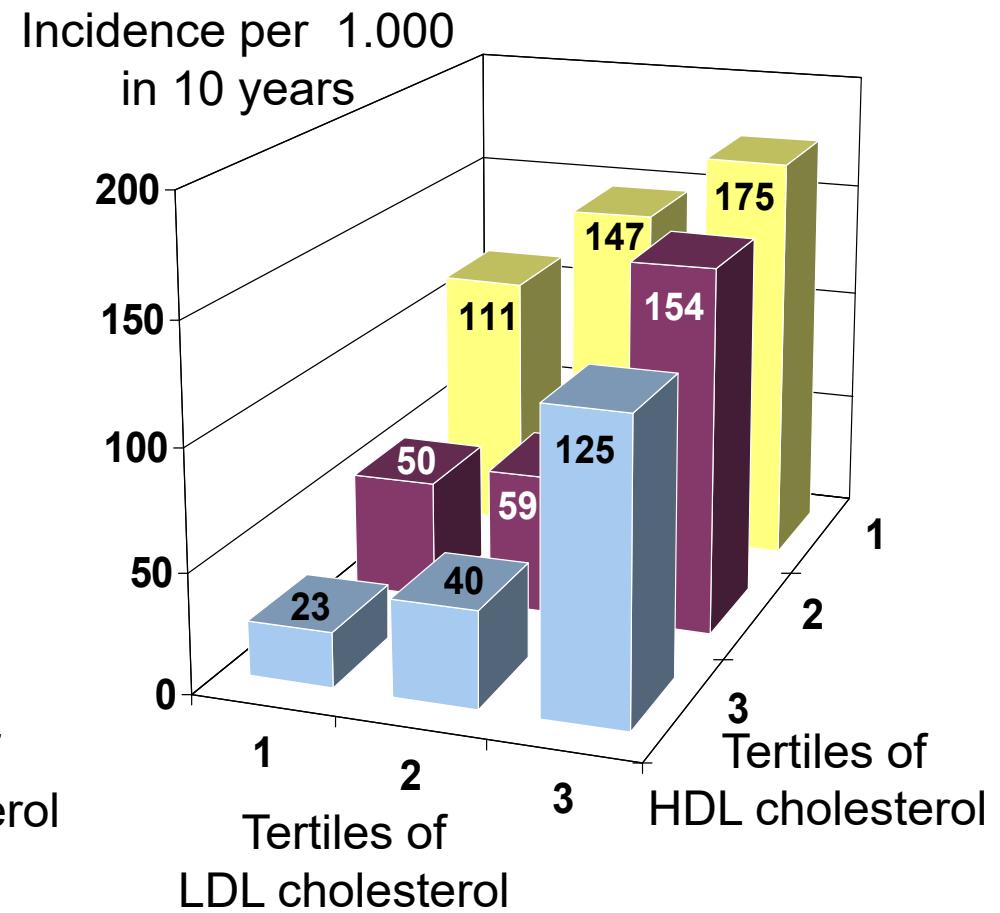
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# Incidence of Coronary Events According to HDL- & LDL Cholesterol and Glycemic State

Normal fasting glucose  
(n=5679, 297 events)



Impaired fasting glucose or  
diabetes mellitus (n=1022, 107 events)



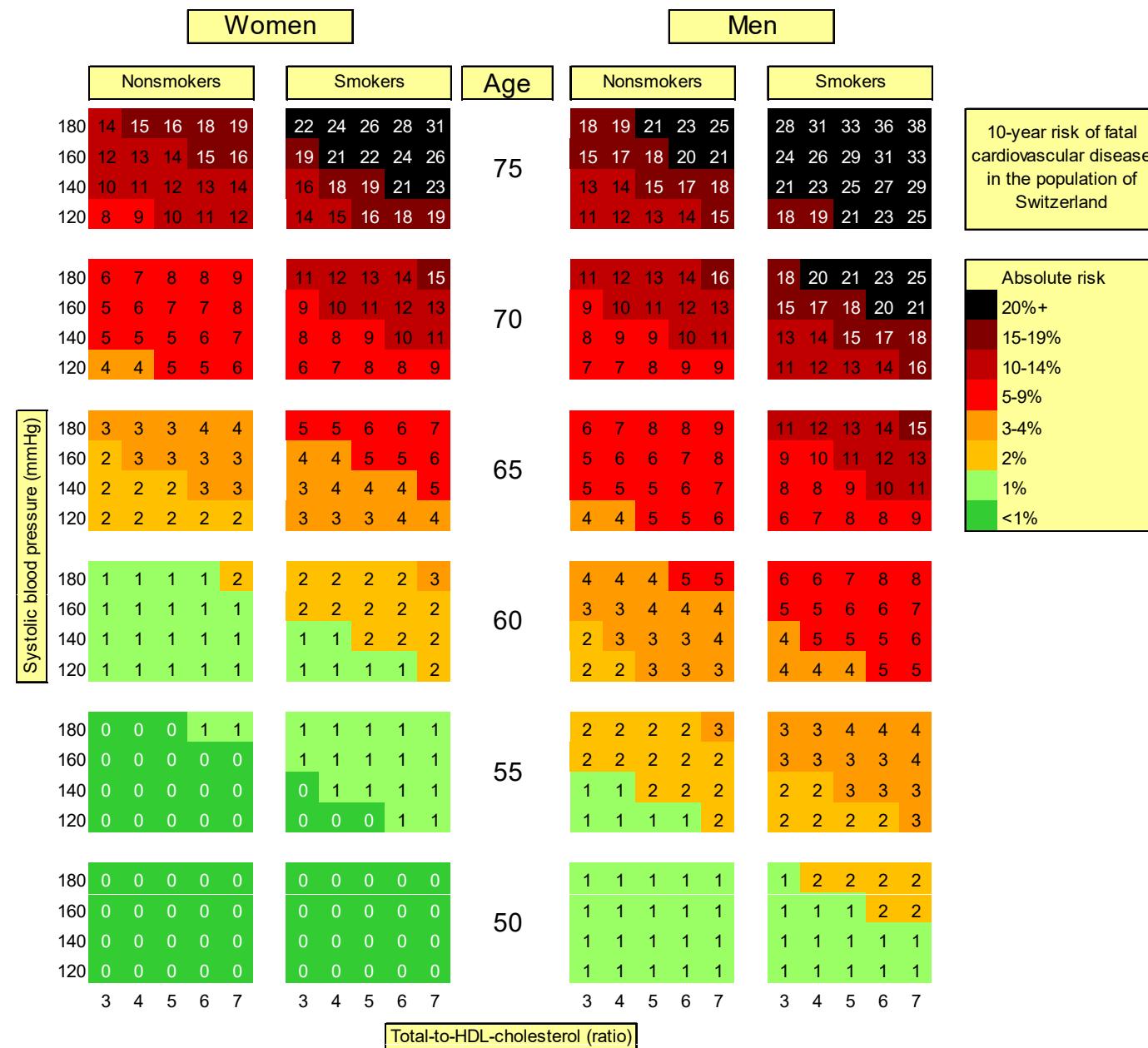
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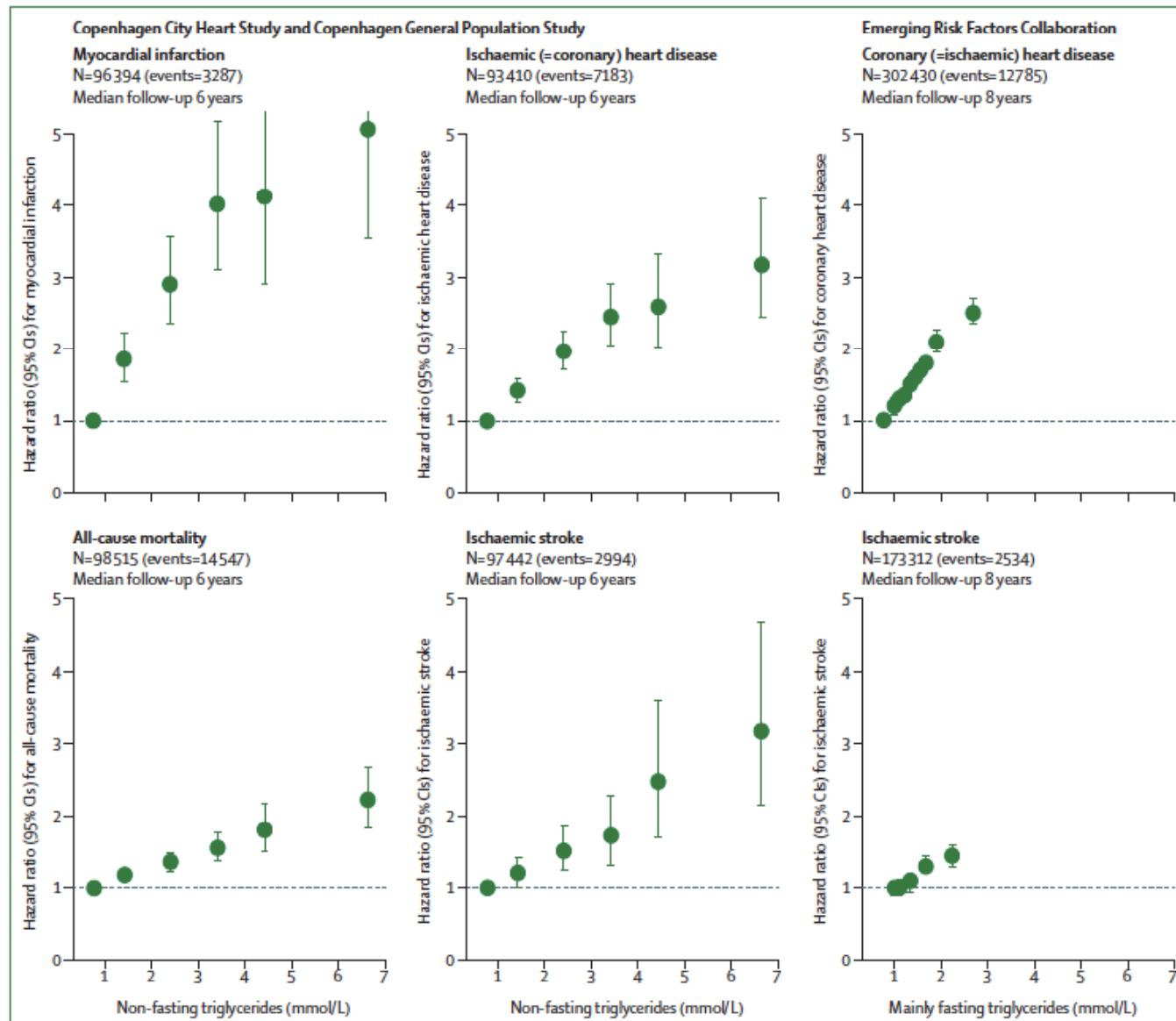
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# Triglycerides and CVD



JAMA. 2008 Nov 12;300(18):2142-52

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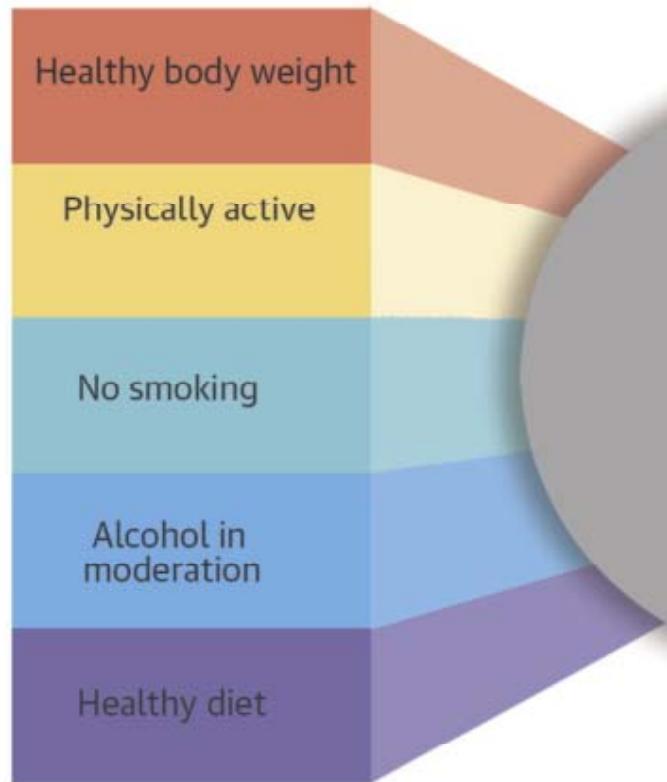
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# Cardiovascular Diseases and Blood Lipids

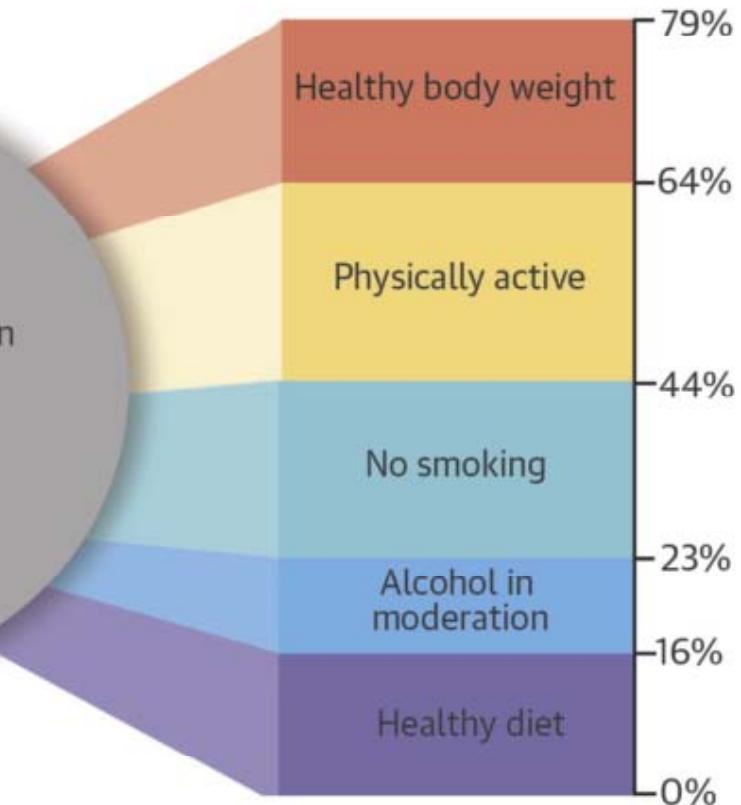
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## Low-risk lifestyle practices



## Myocardial infarction Population preventable proportions



4 out of 5 cases of MI could be prevented with lifestyle modifications

J Am Coll Cardiol. 2014;64(13):1299-1306

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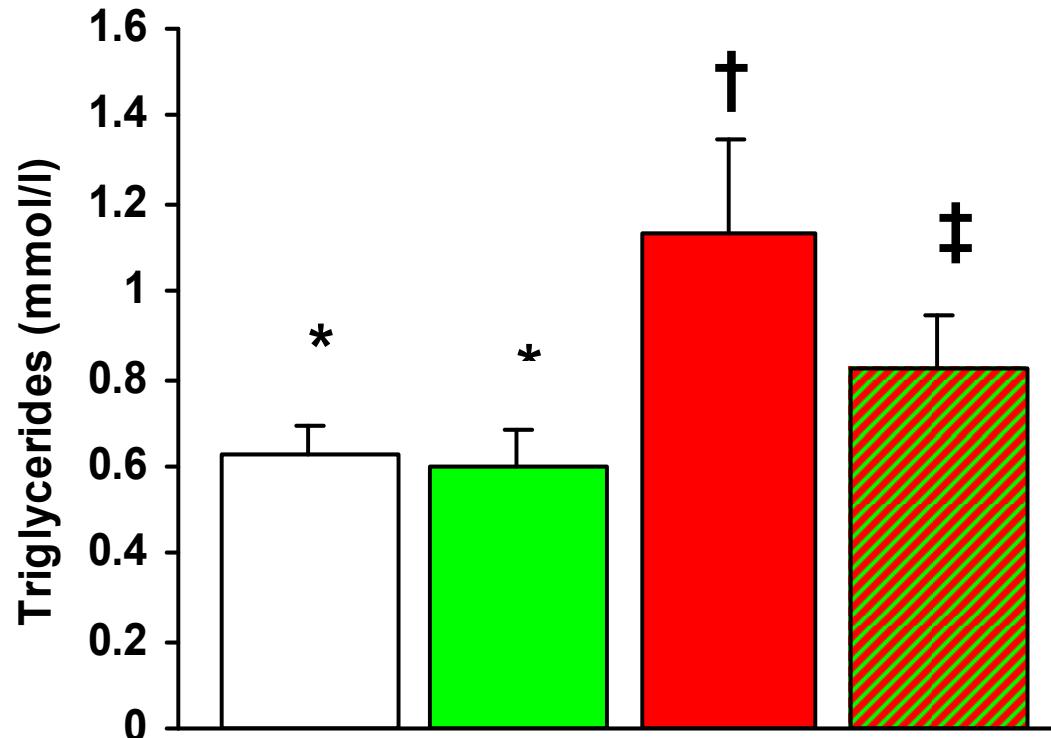
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# Lifestyle and blood lipids

- Risk factors
  - Carbohydrates (fructose, glucose)
  - Saturated and trans-fat, animal products
  - Obesity, being sedentary, smoking
- Protective factors
  - Unsaturated fat, plant products, alcohol (mod.)
  - Fibres, fruits, vegetables
  - Physical activity



# Effect of dietary fructose on fasting triglycerides



**white bar: control**

**green bar: fish oil**

**red bar: high-fructose**

**striped red and green bar: fish oil & high-fructose**

Faeh et al, Diabetes. 2005 Jul;54(7):1907-13.

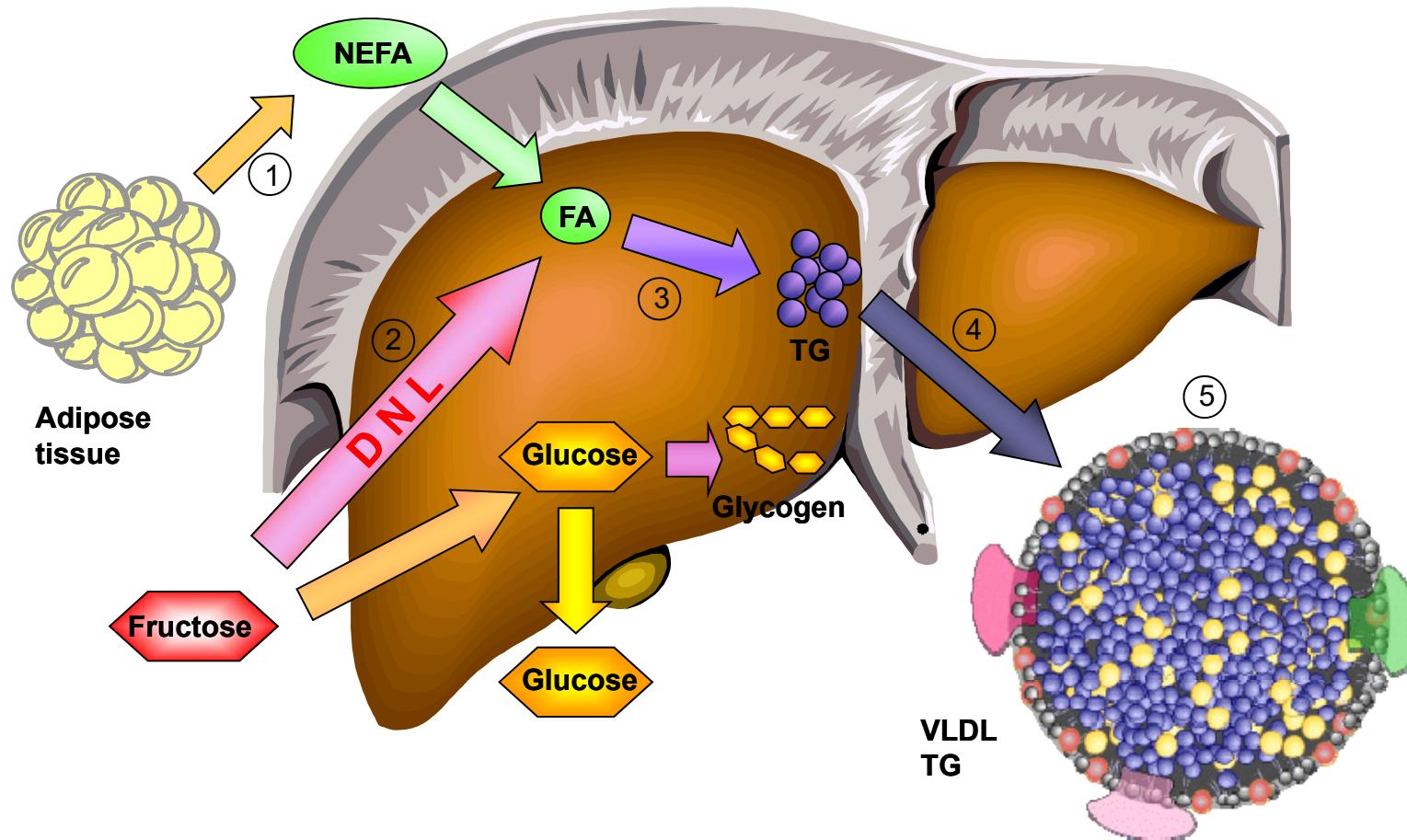
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# Increase in triglycerides by fructose-induced DNL



DNL: De Novo Lipogenesis

Faeh et al, Diabetes. 2005 Jul;54(7):1907-13.

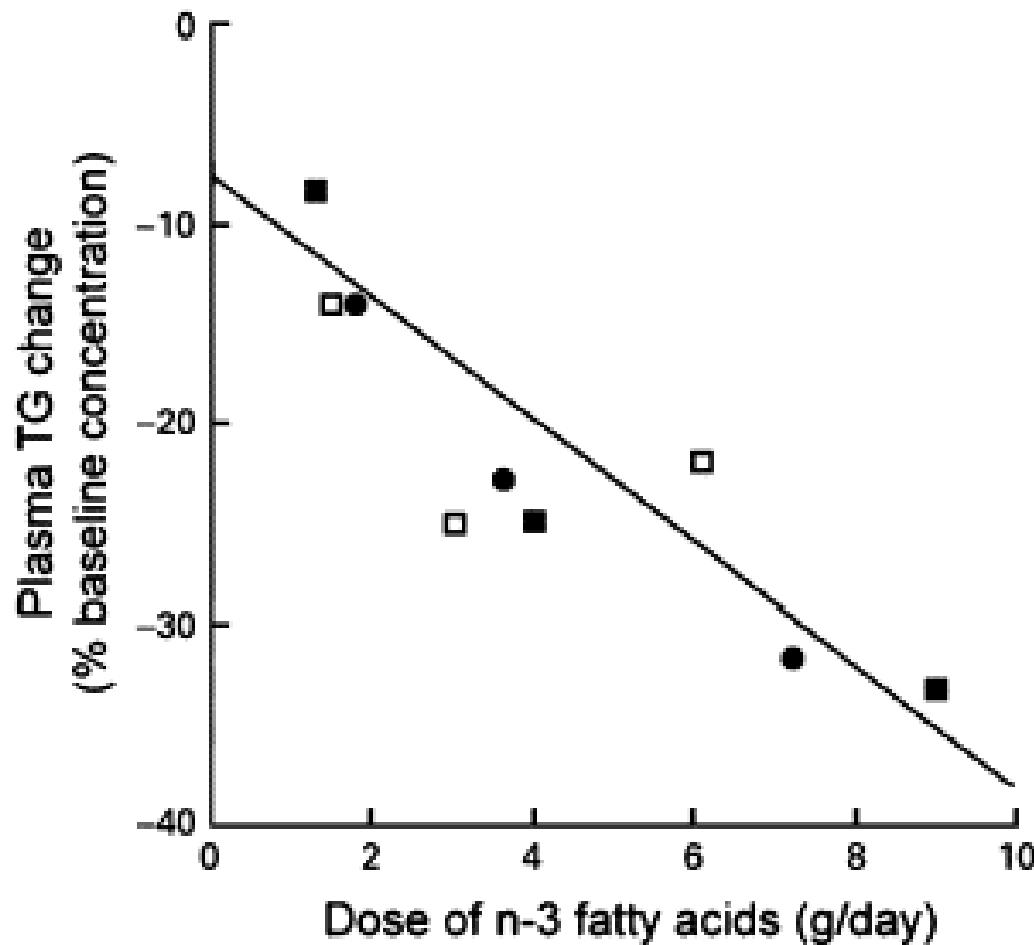
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# Metaanalysis: Dose-dependent hypotriglyceridemic effect of omega-3 fatty acids.



Proc Nutr Soc 1999;58(2):397–401

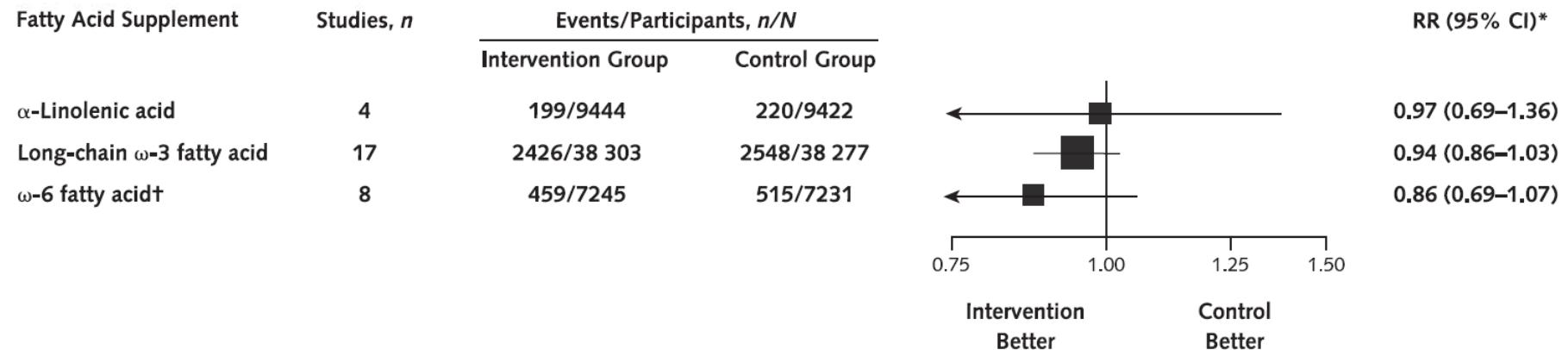
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**Figure 3. Effect of fatty acid supplementation on risk for coronary event, derived from available randomized, controlled trials.**



Ann Intern Med. 2014;160:398-406.

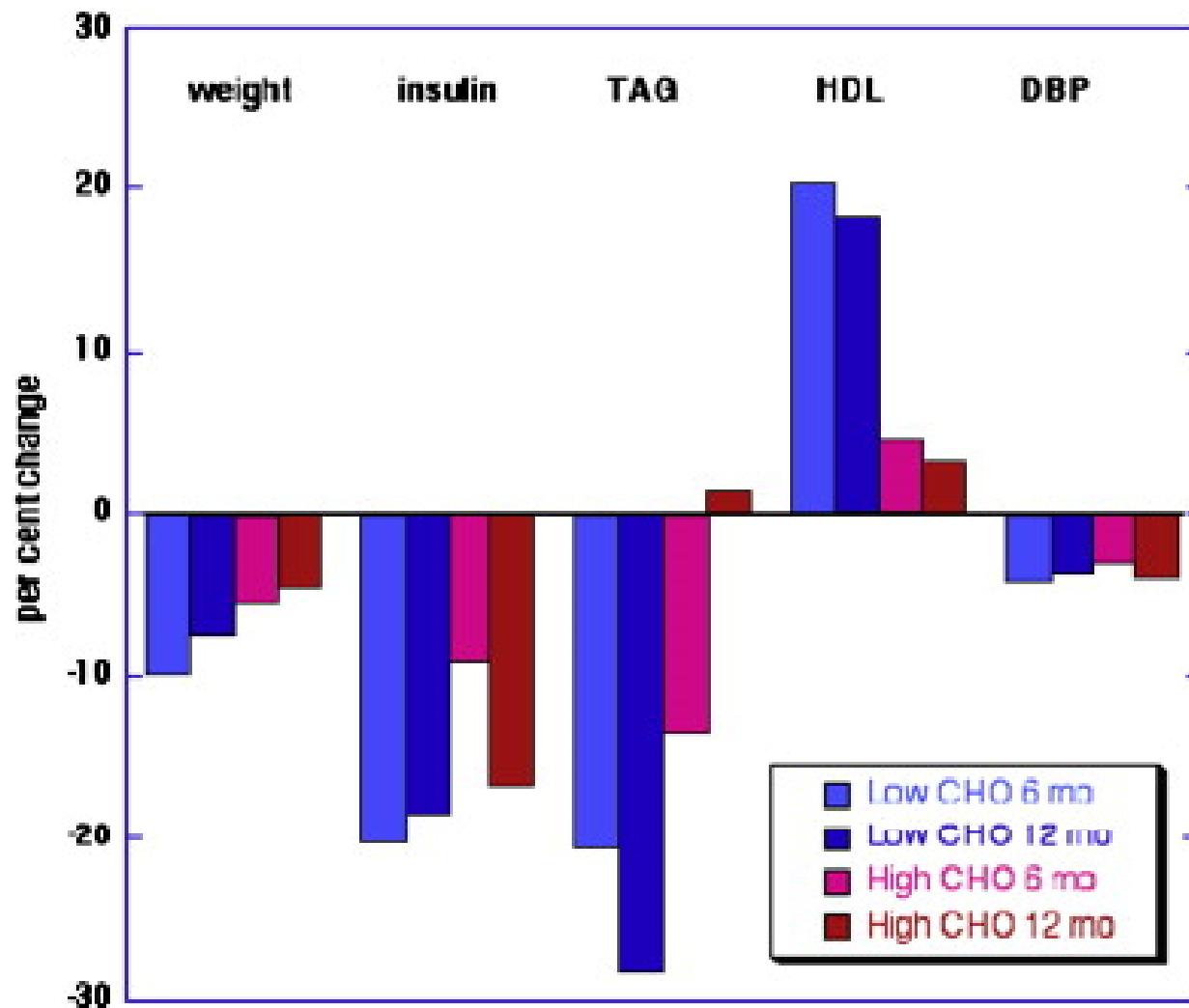
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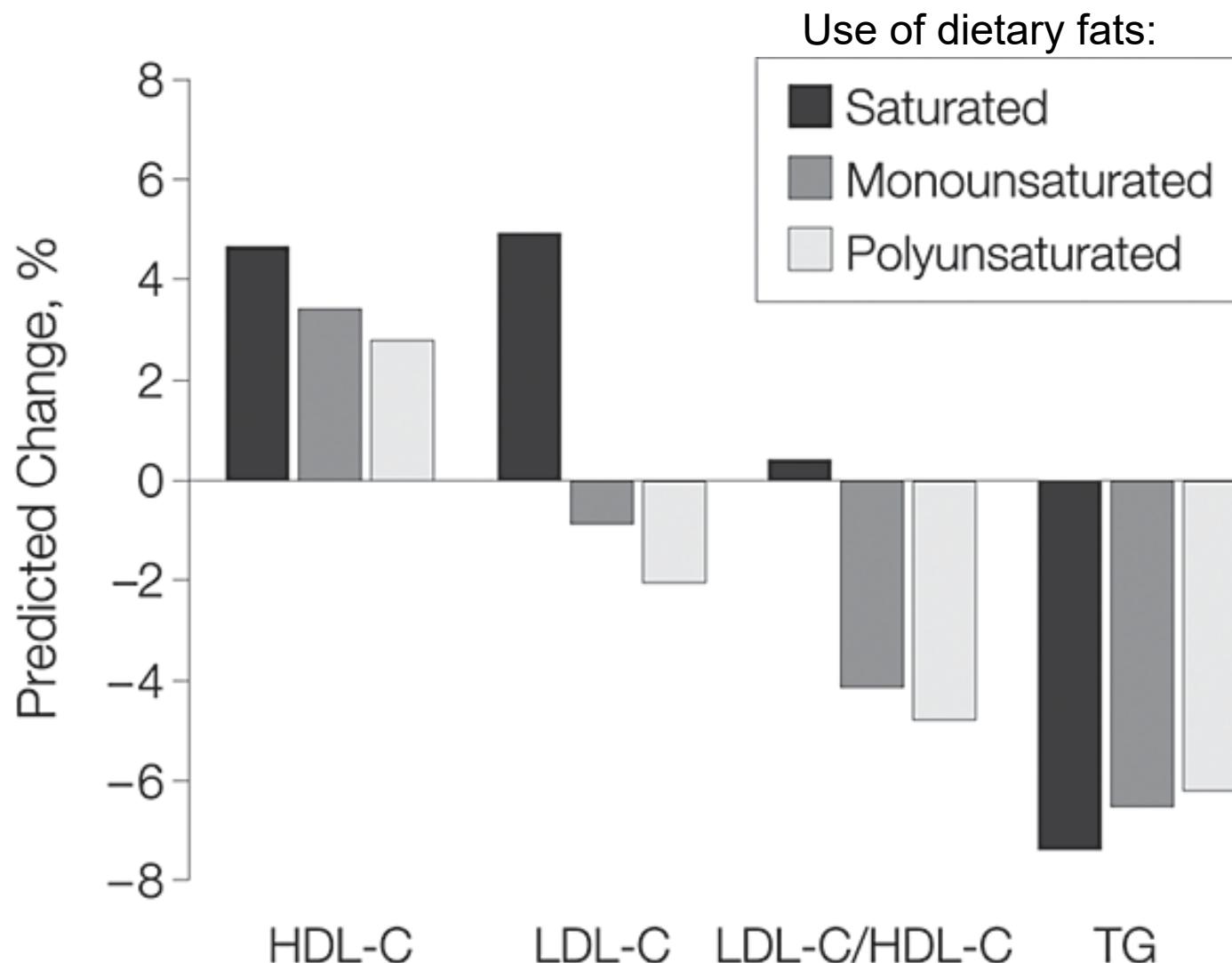


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# Low-carbohydrate vs. high-carbohydrate diets



# Predicted Changes in Serum Lipids and Lipoproteins



Hu et al, JAMA 2002;288:2569-2578

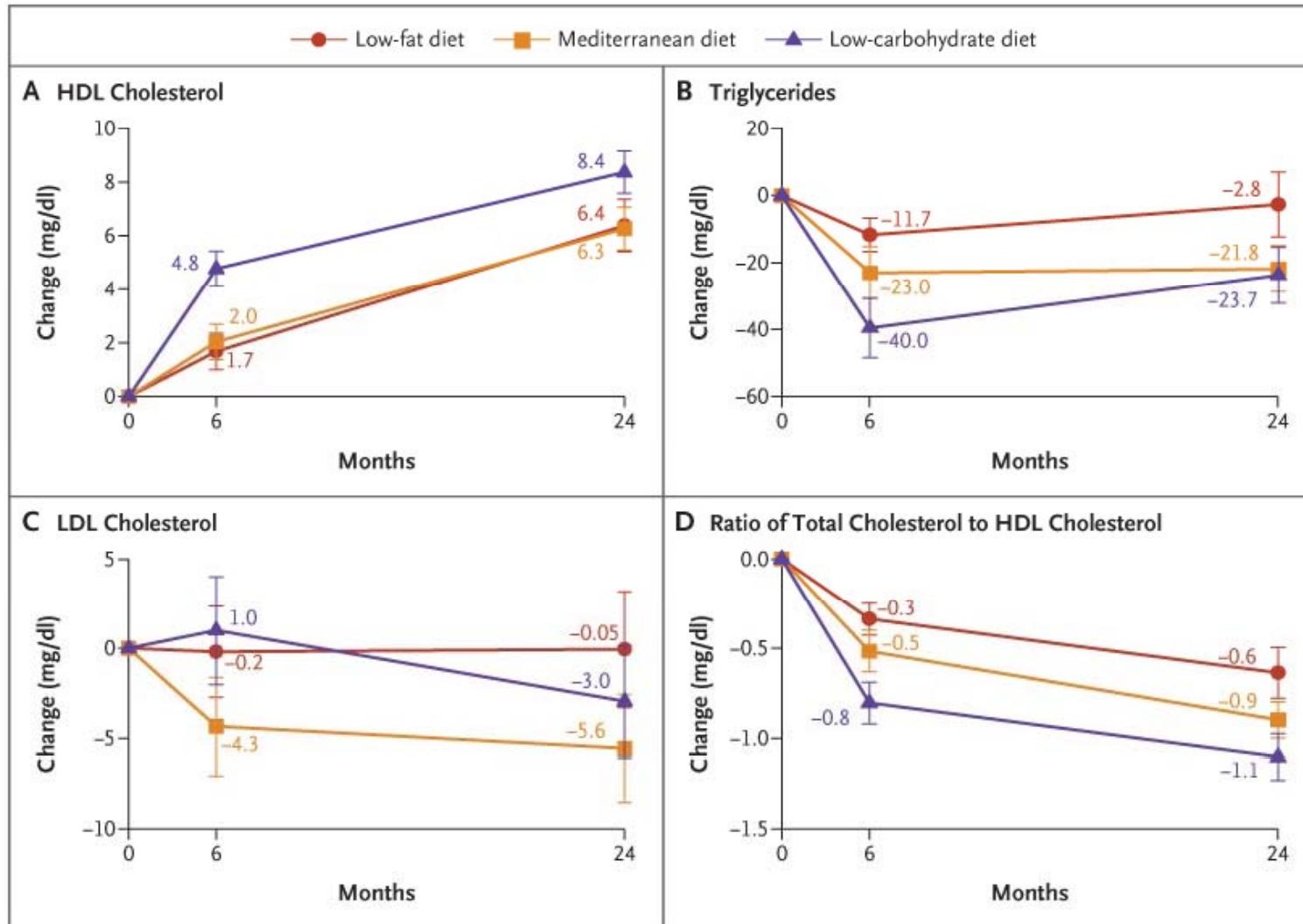
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# Changes by Diet Group during the Maximum Weight-Loss Phase (1 to 6 Months) and the Weight-Loss Maintenance Phase (7 to 24 Months) of the 2-Year Intervention



Shai et al, N Engl J Med. 2008 Jul 17;359(3):229-41

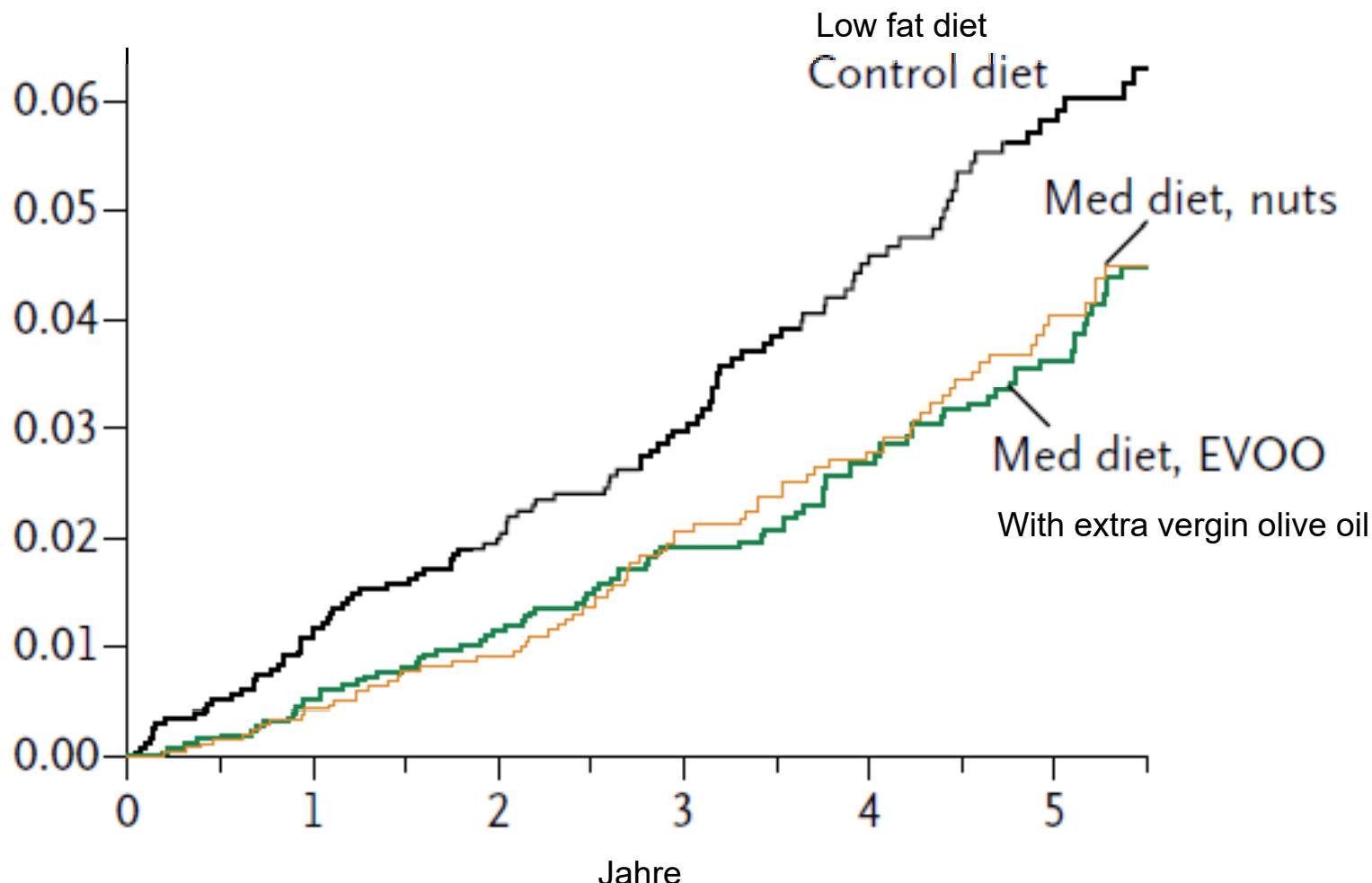
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# Incidence of CVD in persons without preexisting CVD



N Engl J Med 2013; 368:1279-1290

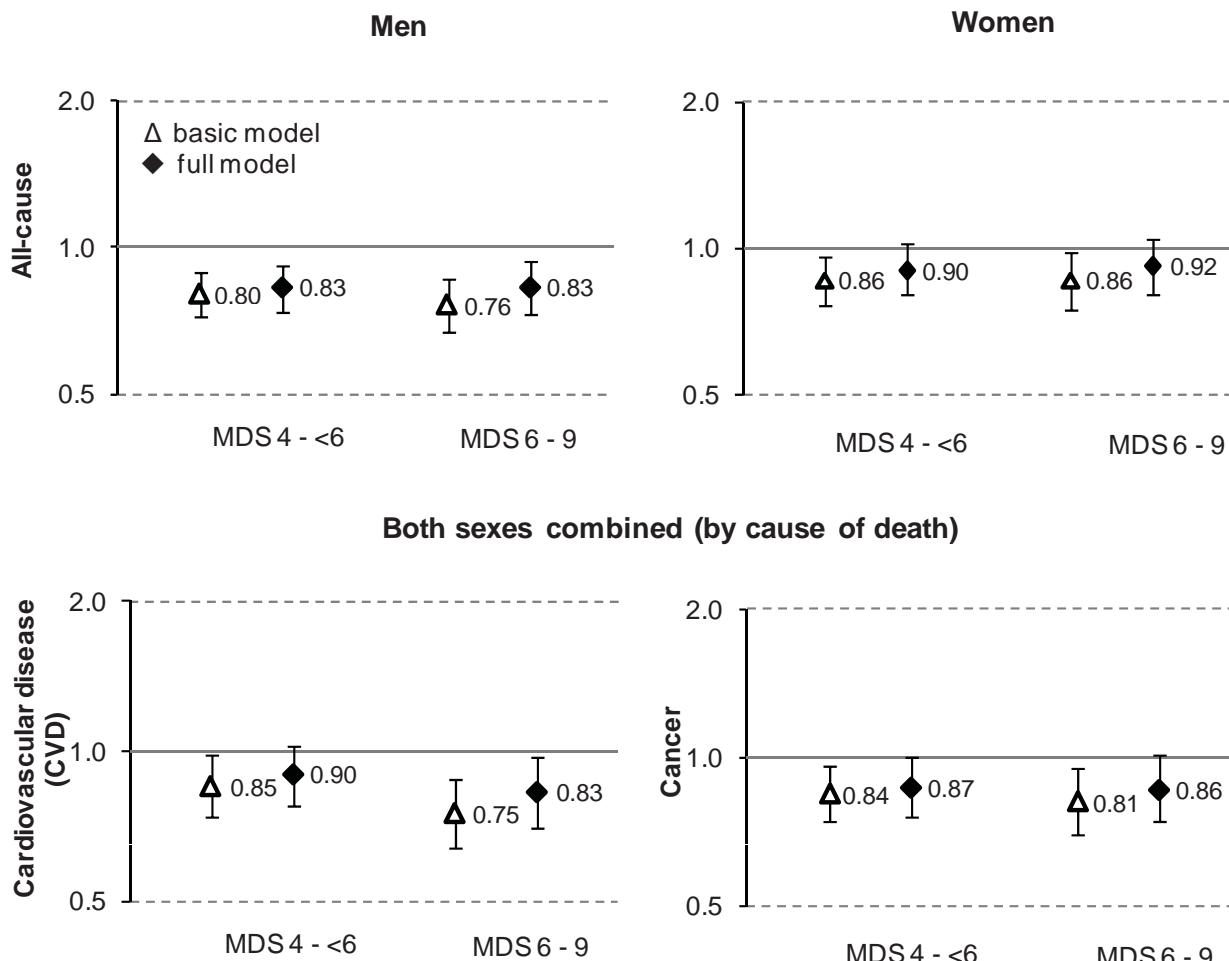
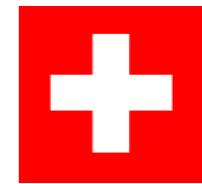
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# Adherence to Mediterranean Diet (MD) in Switzerland and CVD, cancer and all-cause mortality



MDS: Mediterranean Diet Score from 0 (no adherence) to 9 (perfect adherence)

Eur J Nutr. 2014 Apr 8; DOI 10.1007/s00394-014-0695-y

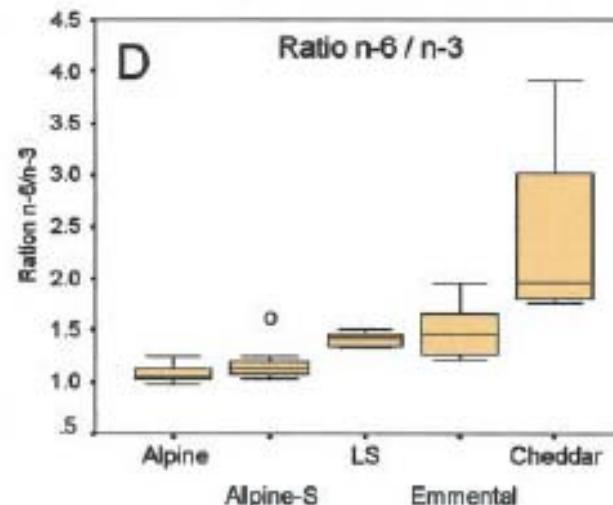
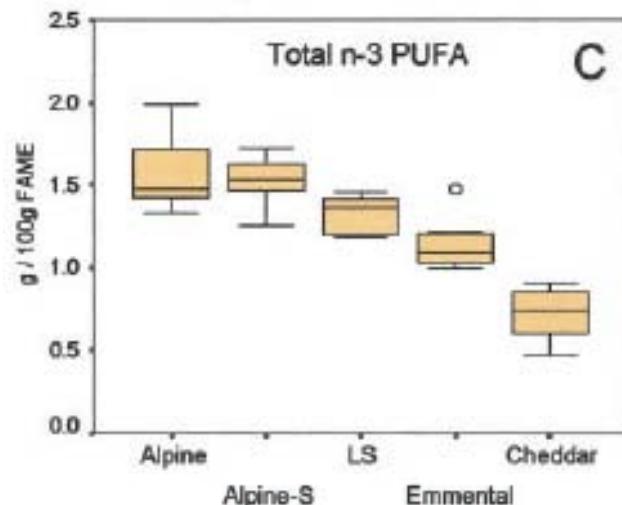
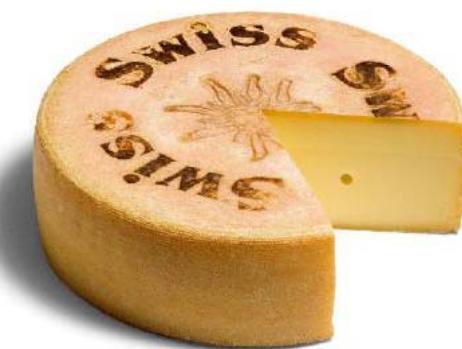
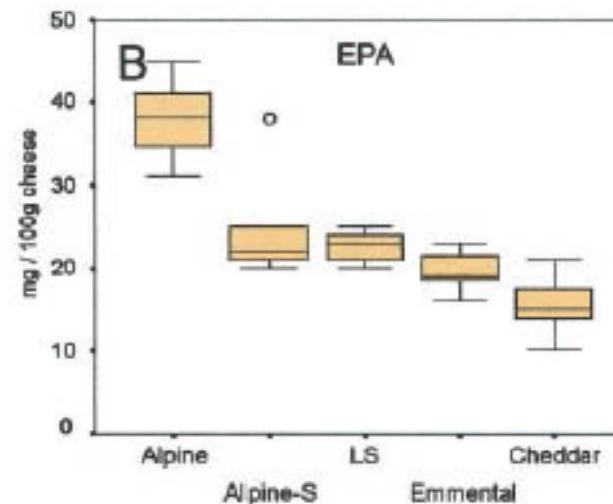
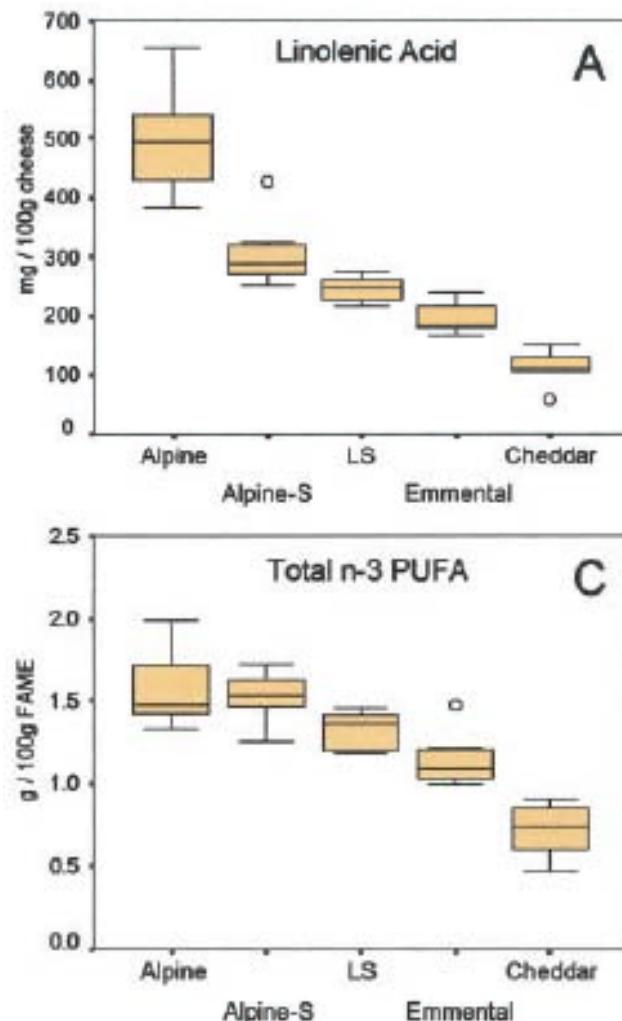
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# Fatty acids composition of cheeses



Circulation. 2004;109:103-107

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# Summary of the strength of evidence of dietary fat and coronary heart disease (CHD)

Type of fat	Fatal CHD	CHD events
Total fat	C-NR	C-NR
TFA	P↑	C↑
SFA for CHO	P-NR	P-NR
MUFA for SFA		
PUFA for SFA	C↓	C↓
Linoleic		
α-linolenic		
n-3 LCPUFA	P↓	C↓

**C↑ = Convincing increase risk; C↓ = convincing decrease risk;**  
**C-NR = convincing, no relation; P↑ = probable increase risk; P↓ =**  
**probable decrease risk; P-NR = probable no relation.**

n-3 LCPUFA: fishoil, T: trans, S: saturated, MU: momo-unsaturated, PU: poly-unsaturated, CHO: carbohydrates

Ann Nutr Metab 2009;55:173–201

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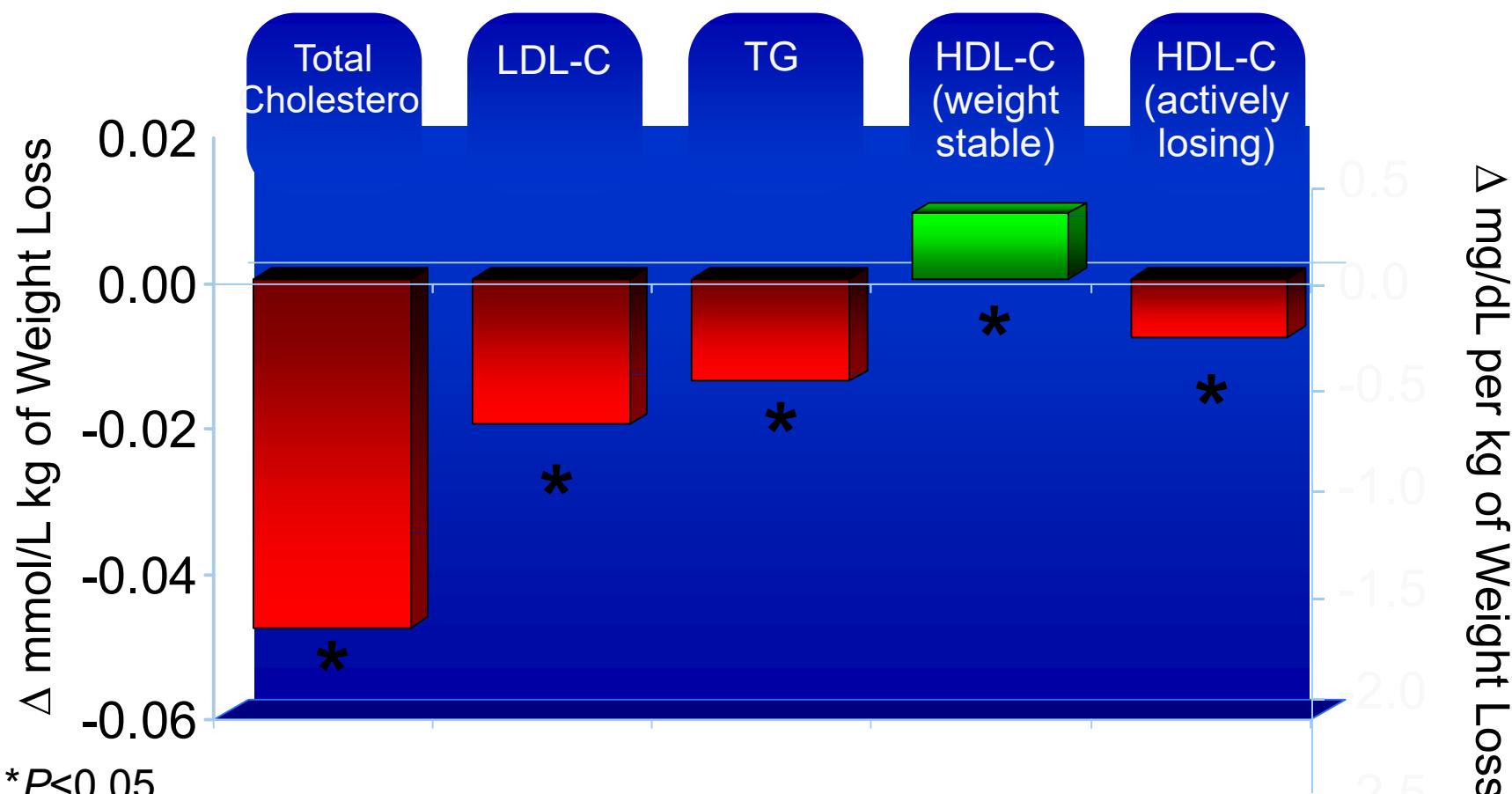
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# Plasma Lipids Improve with Weight Loss

## Meta-analysis of 70 Clinical Trials



\* $P < 0.05$ .

LDL-C=low density lipoprotein cholesterol; HDL-C=high-density lipoprotein cholesterol;  
TG=triglycerides

Dattilo et al. Am J Clin Nutr 1992;56:320.

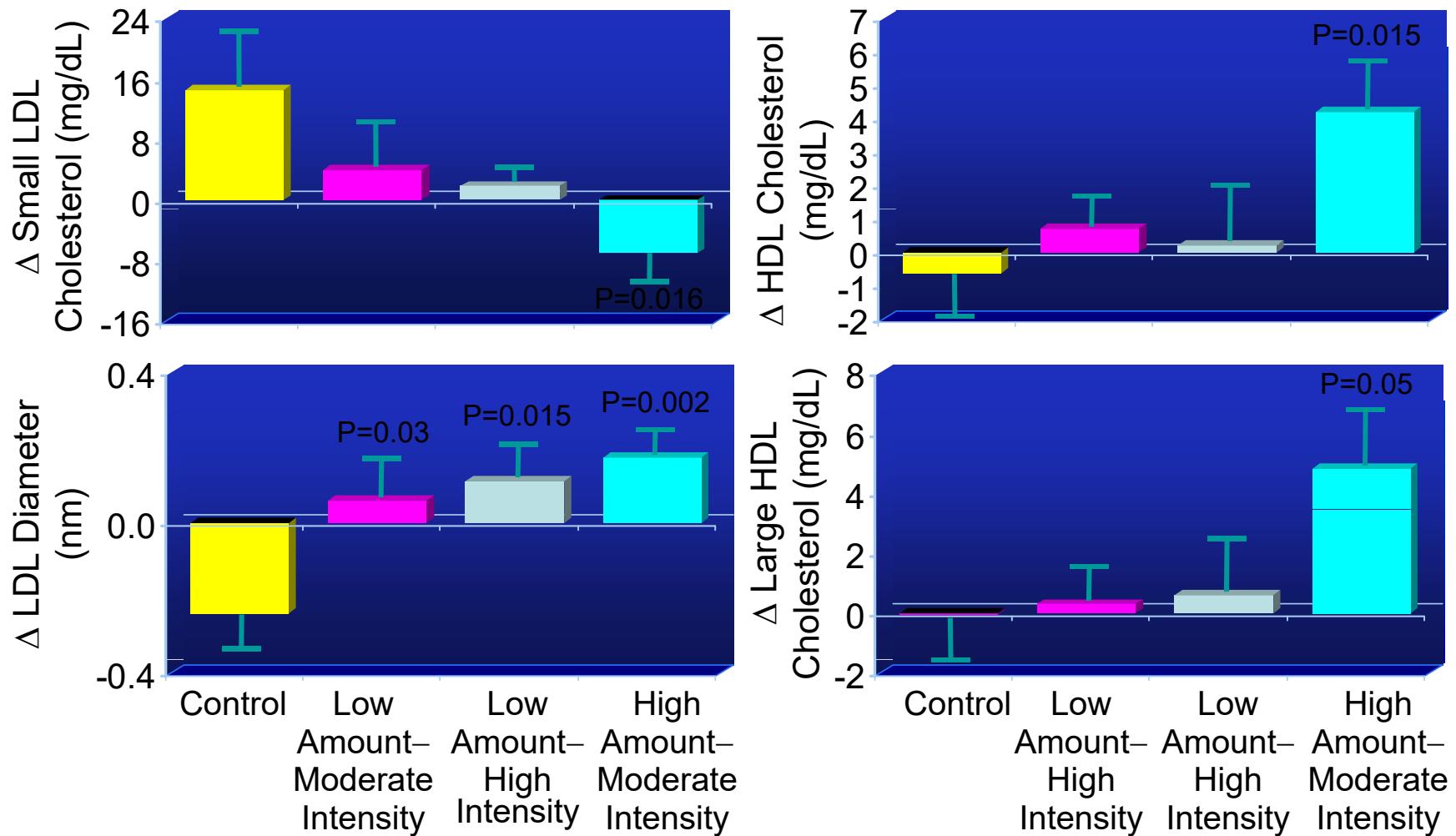
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# Effects of Exercise Level and Intensity on LDL and HDL Particles in Overweight/Obese Men



Kraus et al. N Engl J Med. 2002;347:1483-1492.

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# Cardiovascular Diseases and Blood Lipids

- Epidemiology of CVD
- Blood lipids: types and functions
- Association of blood lipids with other CVD risk factors and with CVD events
- Lifestyle and blood lipids
- Recommendations



# Recommendations

- Mediterranean diet
- DASH: Dietary Approaches to Stop Hypertension
- TLC: Therapeutic Lifestyle Changes
- VLCD: Very Low Carbohydrate Diet

# Examples of daily dietary patterns consistent with AHA-recommended dietary goals at 2000 calories

Eating Pattern	DASH	TLC
Grains	6–8 sv/d	7 sv/d
Vegetables	4–5 sv/d	5 sv/d
Fruits	4–5 sv/d	4 sv/d
Fat-free or low-fat dairy products	2–3 sv/d	2–3 sv/d
Lean meats, poultry and fish	<6oz./d	≤5 oz./d
Nuts, seeds, legumes	4–5 sv/wk	Counted in vegetable servings
Fats and oils	2–3 sv/d	Amount depends on calorie level
Sweets and added sugars	5 or less sv/wk	No recommendation

# Mediterranean Diet

1. An abundance of plant foods: fruits, vegetables, grains, nuts, seeds
2. Starchy food should contain fibres: legumes, quinoa, amaranth
3. Minimally processed and seasonally fresh foods
4. Fresh fruits as the typical daily dessert
5. Extra Vergine olive oil as the principal source of dietary fat
6. Dairy, poultry, and fish in low to moderate amounts
7. Less than five eggs per week
8. Red meat in low frequency and amounts
9. Wine in low to moderate amounts (one to two glasses per day for men and one glass per day for women)



# Risk of death associated with the Mediterranean Diet (MD): What remains after subtraction of single MD-components?

Variable	Relative risk of death	P-value	Reduction of effect (%)
ME total	0.864	<0.001	0
ME minus vegetables	0.886	0.002	16.2
ME minus legumes	0.877	<0.001	9.7
ME minus fruits and nuts	0.879	0.001	11.2
ME minus fibres	0.872	<0.001	6.1
ME minus monounsaturated / saturated fats (quotient)	0.878	0.003	10.6
ME minus abstinence of dairy products	0.870	<0.001	4.5
ME minus abstinence of meat / -products	0.887	0.001	16.6
ME minus alcohol	0.896	0.002	23.5

BMJ. 2009 Jun 23;338:b2337.

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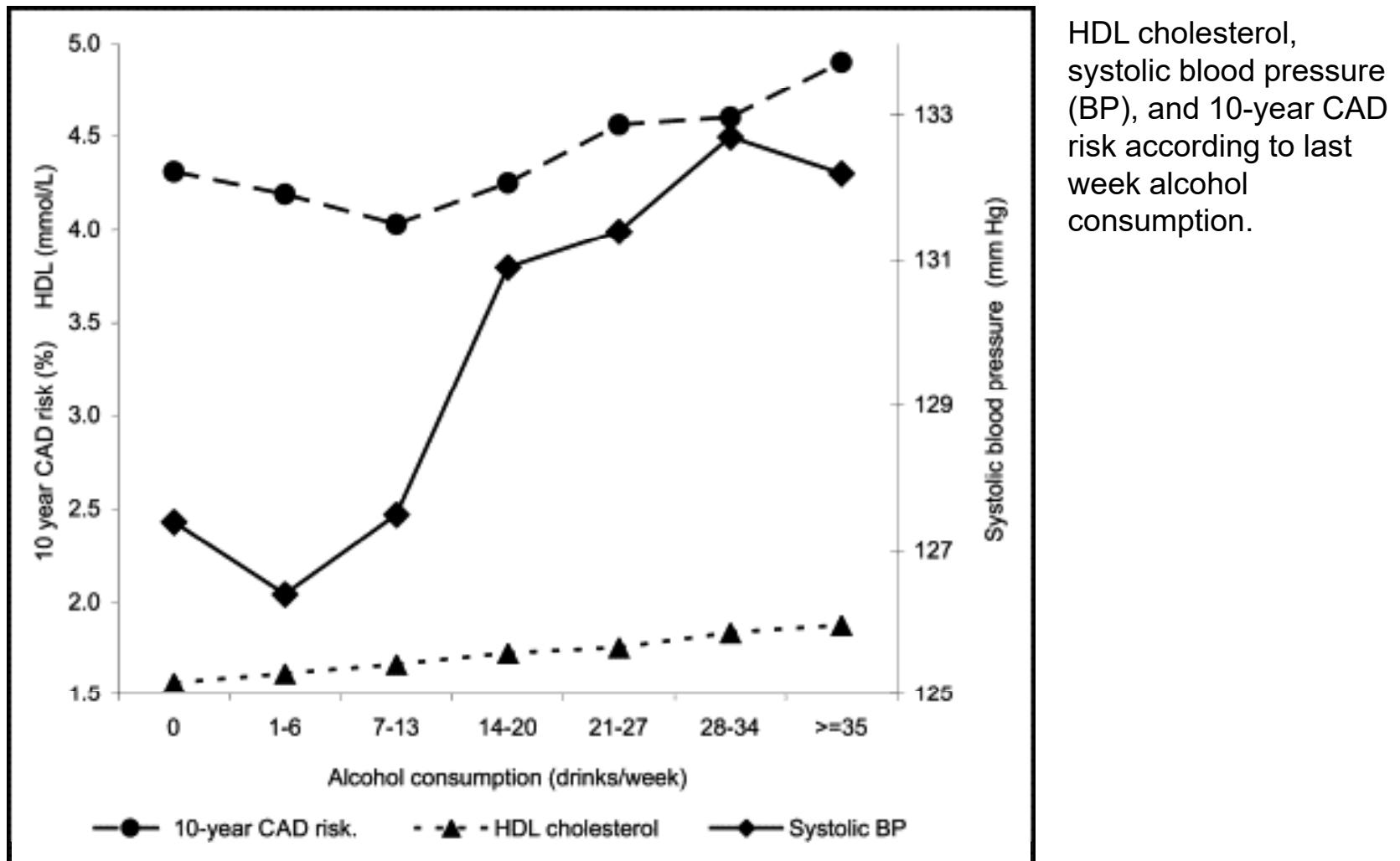


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# Adjusted odds ratio for prevalence in 8,125 subjects from NHANES III by increasing quantities of alcohol consumption

	< Alcoholic Drink/Month	1–19 Alcoholic Drinks/Month	≥20 Alcoholic Drinks/Month
Low serum HDL-C <sup>b</sup>	1.0	0.69 (0.60–0.78)	0.22 (0.16–0.29)
Elevated triglycerides <sup>c</sup>	1.0	0.73 (0.62–0.87)	0.56 (0.43–0.74)

# Association between alcohol consumption, cardiovascular risk factors, and 10-year CAD risk.



Am J Cardiol. 2009 Feb 1;103(3):361-8

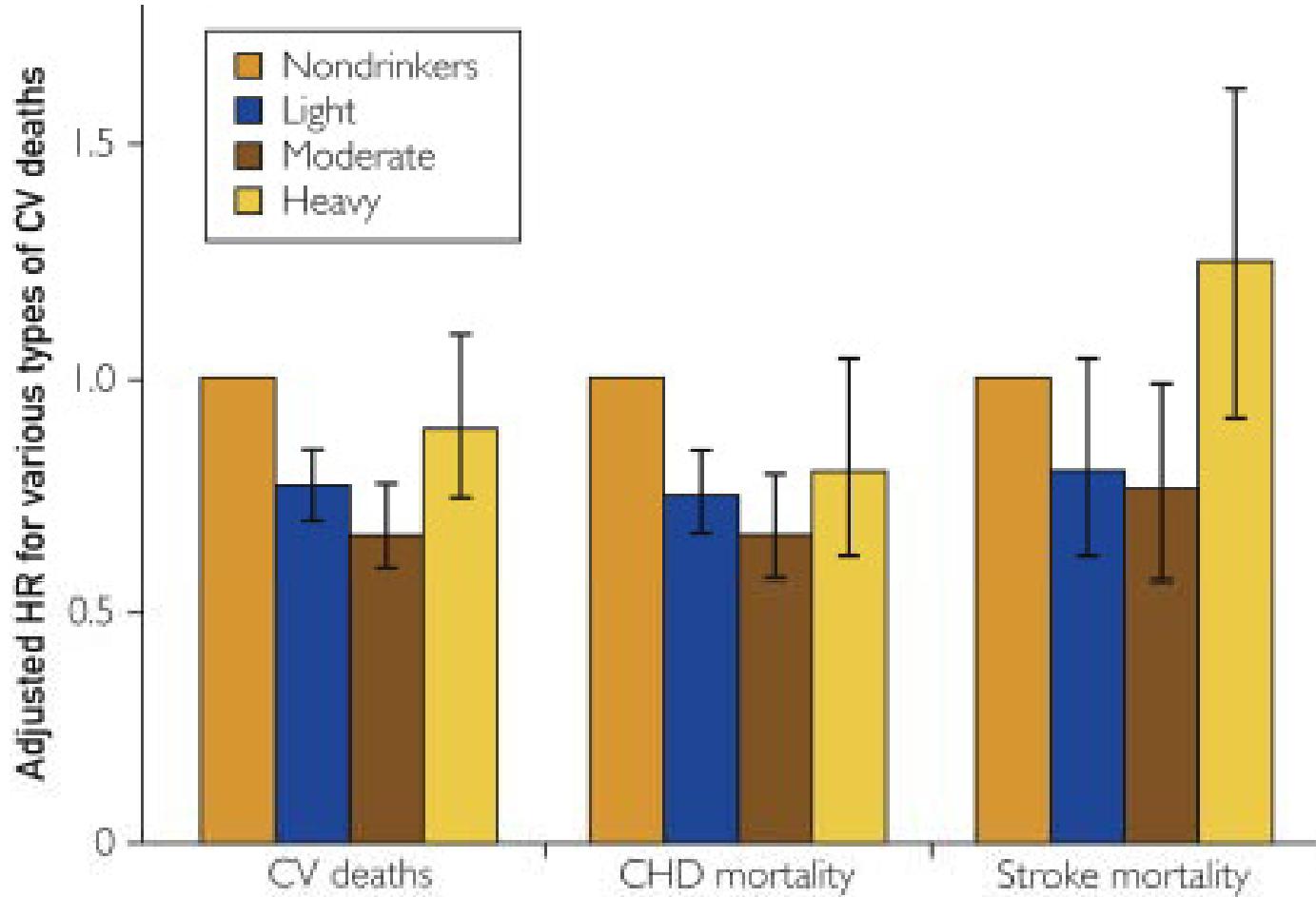
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# Alcohol consumption and CVD risk



Mayo Clin Proc. 2014 Mar;89(3):382-93

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# Approximate and cumulative LDL-C reduction achievable by dietary modification

Dietary Component	Dietary Change	LDL-C Reduction
<b>Major</b>		
Saturated fat	<7% of calories	8%–10%
Dietary cholesterol	<200 mg/d	3%–5%
Weight reduction	Lose 10 lbs (4.5 kg)	5%–8%
<b>Other LDL-lowering options</b>		
Viscous fiber	5–10 g/d	3%–5%
Plant sterol/stanol esters	2 g/d	6%–15%
<b>Cumulative estimate</b>		<b>20%–30%</b>

# Take-Home-Messages

- CVD mortality is decreasing in Switzerland but CVD are still a major cause of death
- As in many other countries there is insufficient data on CVD incidence and on prevalence and significance of risk factors
- Unfavourable blood lipid profile is a major risk factor for CVD and is likely becoming more frequent in Switzerland

# Take-Home-Messages (cont.)

- Blood lipids should be interpreted individually and in the context of other CVD risk factors
- Besides age and sex, lifestyle factors strongly influence blood lipids
- An unfavorable blood lipid profile can substantially be improved with lifestyle changes and this decreases CVD risk

# Take-Home-Messages (cont.)

Lifestyle changes include

1. Keeping a healthy body weight
2. Replace saturated by unsaturated FA
3. Choose plant instead of animal products
4. Avoid simple sugar, particularly fructose
5. Increase fibre intake
6. Consume alcohol in moderation
7. Avoid smoking
8. Being physically active



## Umrechnungstabelle für Plasma-Lipide

LDL-Cholesterin		Triglyzeride		Gesamt-Cholesterin		HDL-Cholesterin	
mg/dl	mmol/l	mg/dl	mmol/l	mg/dl	mmol/l	mg/dl	mmol/l
50	1,29	40	0,45	100	2,59	20	0,52
60	1,55	50	0,58	110	2,84	22	0,57
70	1,81	60	0,68	125	3,23	24	0,62
80	2,07	70	0,79	135	3,49	26	0,67
90	2,33	80	0,90	150	3,88	28	0,72
100	2,59	90	1,02	160	4,14	30	0,78
110	2,84	100	1,13	175	4,53	32	0,83
120	3,10	110	1,24	185	4,78	34	0,88
130	3,36	120	1,35	200	5,17	36	0,93
140	3,62	130	1,47	210	5,43	38	0,98
150	3,88	140	1,58	225	5,82	40	1,03
160	4,14	150	1,69	235	6,08	42	1,09
170	4,40	160	1,81	250	6,47	44	1,14
180	4,65	170	1,92	260	6,72	46	1,19
190	4,91	180	2,03	275	7,11	48	1,24
200	5,17	190	2,15	285	7,37	50	1,29
210	5,43	200	2,26	300	7,76	52	1,34
220	5,69	210	2,37	310	8,02	54	1,40
230	5,95	220	2,48	325	8,40	56	1,45
240	6,21	230	2,60	335	8,66	58	1,50
250	6,47	240	2,71	350	9,05	60	1,55
260	6,72	250	2,82	360	9,31	62	1,60
270	6,98	260	2,94	375	9,70	64	1,66
280	7,24	270	3,05	385	9,96	66	1,71
290	7,50	280	3,16	400	10,34	68	1,76
300	7,76	290	3,27	410	10,60	70	1,81
310	8,02	300	3,39	425	10,99	72	1,86
320	8,28	310	3,50	435	11,25	74	1,91
330	8,53	320	3,61	450	11,64	76	1,97
340	8,79	330	3,73	460	11,90	78	2,02
350	9,05	340	3,84	475	12,28	80	2,07
360	9,31	350	3,95	485	12,54	82	2,12
370	9,57	360	4,06	500	12,93	84	2,17
<b>Umrechnungsfaktor*</b>		<b>Umrechnungsfaktor</b>		<b>Umrechnungsfaktor</b>		<b>Umrechnungsfaktor</b>	
<b>1 mg/dl = 0,02586 mmol/l</b>		<b>1 mg/dl = 0,01129 mmol/l</b>		<b>1 mg/dl = 0,02586 mmol/l</b>		<b>1 mg/dl = 0,02586 mmol/l</b>	

\*Labor und Diagnose, Hrg. Lothar Thomas, 5.Aufl., TH-Books Verlagsgesellschaft mbH