단순당 섭취와 건강

이 해 정
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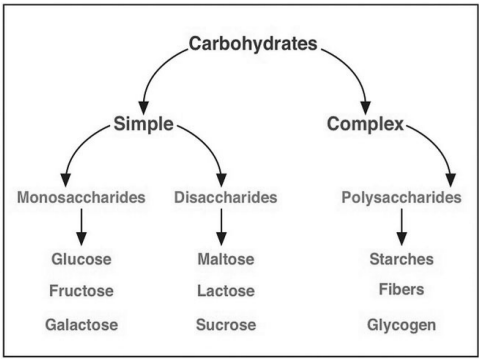
- Simple sugar
- Sugar intake and diseases
- WHO guidance
- Sugar Intake status
- What should we do?

Classification of carbohydrates



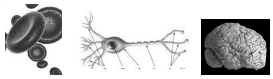
Classification of carbohydrates

Table 1| **Classification of dietary carbohydrates**

Class*	Subgroup	Principal components
Sugars (1-2)	Monosaccharides	Glucose, fructose, galactose
	Disaccharides	Sucrose, lactose, maltose, trehalose
	Polyols (sugar alcohols)	Sorbitol, mannitol, lactitol, xylitol, erythritol, isomalt, maltitol
	Free sugars	All monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer; sugars naturally present in honey, syrups, and fruit juices
Oligosaccharides (3-9)	Malto-oligosaccharides (α glucans)	Maltodextrins
	Non-α glucan oligosaccharides	Raffinose, stachyose, fructo and galacto oligosaccharides, polydextrose, inulin
Polysaccharides (≥10)	Starch (α glucans)	Amylose, amylopectin, modified starches
	Non-starch polysaccharides	Cellulose, hemicellulose, pectin, arabinoxylans, β glucan, glucomannans, plant gums and mucilages, hydrocolloids

*Degree of polymerisation or number of monomeric (single sugar) units in brackets.
Adapted from references 13 and 14.

Function

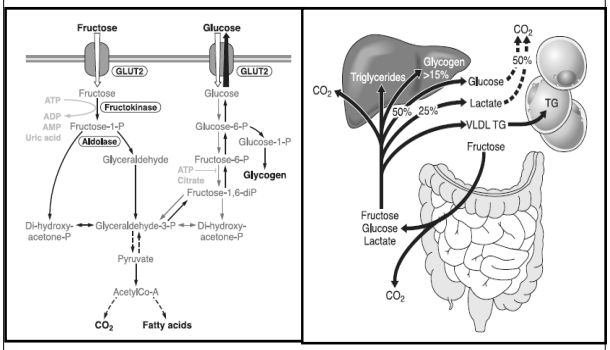


- Your brain and nervous system utilize carboh ydrates for energy
- Carbohydrates are broken down into a molec ule called glucose, which is either used for en ergy or stored for later use.
- Simple sugars are broken down quickly, prod ucing a rapid increase in blood sugar levels
- In contrast, complex carbohydrates take long er to break down and process in the body bec ause of their structure.

Sugar Intake and Health

- Lipogenesis
- Obesity
- Metabolic syndrome
- Diabetes
- Hypertension
- Cardiovascular disease
- Cavity
- Dementia

Fructose metabolism



Luc Tappy et al. *Physiol Rev 2010;90:23-46*

Lipogenesis

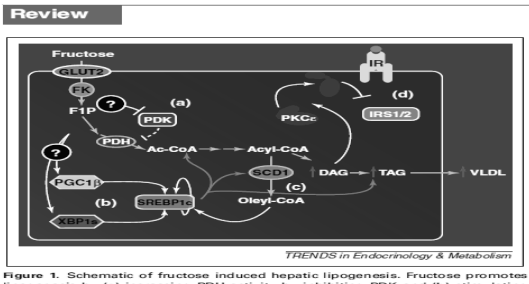
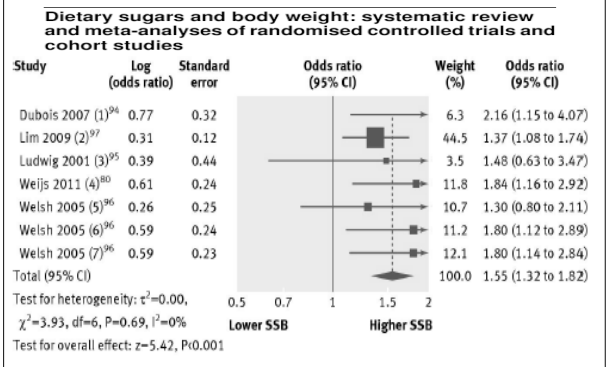


Figure 1. Schematic of fructose induced hepatic lipogenesis. Fructose promotes lipogenesis by (a) increasing PDH activity by inhibiting PDK and (b) stimulating increases in SREBP1c transcription mediated by PGC1β and XBP1 s. SREBP1c can increase its own transcription as well as regulating expression of enzymes involved in lipogenesis and triglyceride synthesis and saturation. (c) SCD1 destaurates fatty acyl-CoA to produce monounsaturated fatty acids such as oleyl-CoA, which might also work to increase SREBP1c expression. (d) The accumulation of DAGs activate PKCε, which then intereferes with insulin signaling, leading to hepatic insulin resistance.

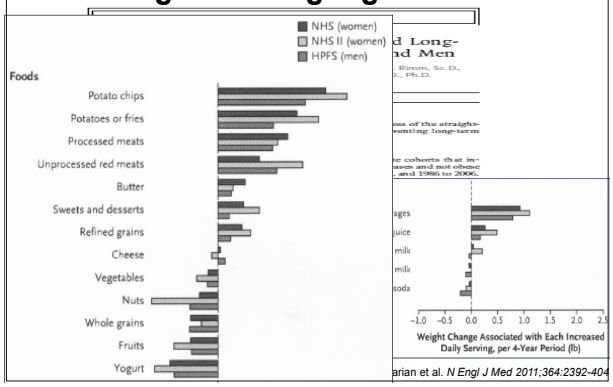
Varman T. Samuel et al. *Trends in Met 2011;22(2):60-65*

Dietary sugar and body weight



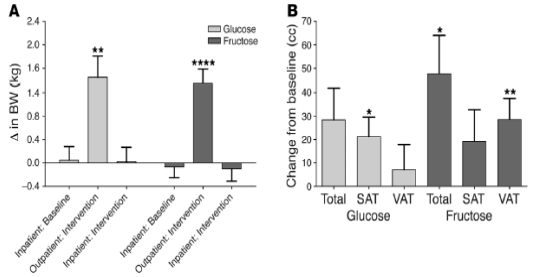
Jim Mann et al. *BMJ 2012;345:e7492*

Changes in diet and lifestyle & long-term weight gain: cohort



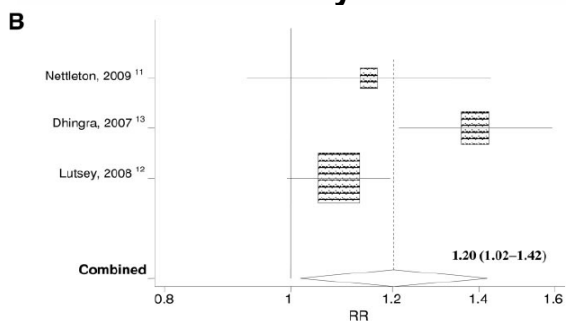
arian et al. *N Engl J Med 2011;364:2392-404*

Consuming fructose-sweetened, not glucose-sweetened, beverages increases visceral adiposity



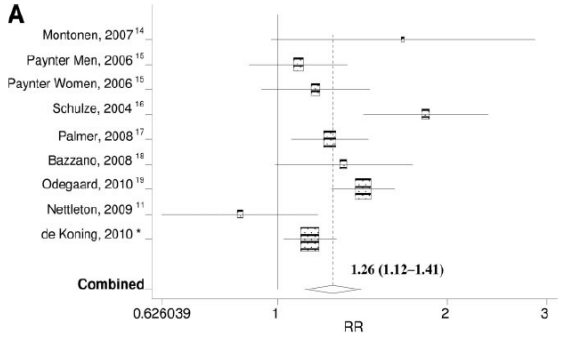
Kimber L. Stanhope et al. *J. Clin. Invest. 2009;119:1322–1334*

Sugar-Sweetened Beverage & Metabolic Syndrome



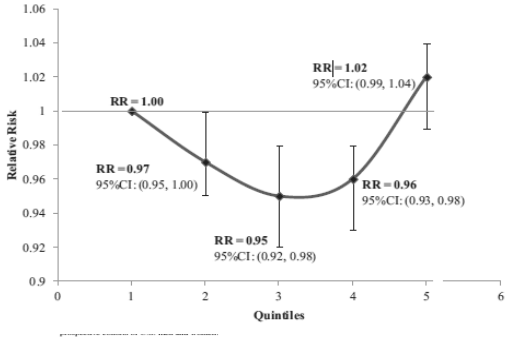
Vasanti S. Malik et al. *DIABEET CARE. 2010;33(11):2477-2483*

Sugar-Sweetened Beverage & Diabetes



Vasanti S. Malik et al. *Diabetes Care 2010;33(11):2477-2483*

Total Fructose Intake & Hypertension



Viranda H. Jayalath et al. *J Am Coll Nutr 2014;0(0):1–12*

Sweetened beverage intake & the risk of Cardiovascular Disease in women

Relative risks and 95% CIs for sugar-sweetened beverage consumption and risk of coronary heart disease by consumption level (n = 88,520)

	Consumption level					
	<1/mo	1–4/mo	2–6/wk	1 to <2/d	≥2/d	*P* for trend
Median intake (servings/d)	0	0.1	0.4	1.2	2.6	
No. of cases	883	723	1198	218	83	
Person-years	574,814	494,831	745,176	134,933	52,455	
Age-adjusted	1	0.94 (0.85, 1.03)	1.08 (0.99, 1.18)	1.51 (1.30, 1.75)	1.93 (1.54, 2.43)	<0.001
Multivariate-adjusted[1]	1	0.97 (0.88, 1.07)	1.06 (0.97, 1.16)	1.27 (1.09, 1.47)	1.39 (1.11, 1.75)	<0.001
Multivariate-adjusted + diet[2]	1	0.96 (0.87, 1.06)	1.04 (0.95, 1.14)	1.23 (1.06, 1.43)	1.35 (1.07, 1.69)	<0.001

[1] Adjusted for age (continuous), smoking [never, past, or current cigarette use (1–14/d, 15–24/d, ≥25/d, or missing)], alcohol intake (0, <5, 5–15, or >15 g/d), family history (yes or no), physical activity (quintiles), aspirin use (<1, 1–2, 3–6, 7–14, or ≥15/wk), menopausal status and postmenopausal hormone use (premenopausal, never, past, or current hormone use), and history of hypertension and high blood cholesterol. Relative risks were computed from a Cox proportional hazard model.

[2] Additionally adjusted for the Alternate Healthy Eating Index (quintiles).

Teresa T. Fung et al. *Am J Clin Nutr 2009;89:1037–1042*

AHA Scientific Statement

Dietary Sugars Intake and Cardiovascular Health
A Scientific Statement From the American Heart Association

Rachel K. Johnson, PhD, MPH, RD, Chair; Lawrence J. Appel, MD, MPH, FAHA; Michael Brands, PhD, FAHA; Barbara V. Howard, PhD, FAHA; Michael Lefevre, PhD, FAHA; Robert H. Lustig, MD; Frank Sacks, MD, FAHA; Lyn M. Steffen, PhD, MPH, RD, FAHA; Judith Wylie-Rosett, EdD, RD; on behalf of the American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity, and Metabolism and the Council on Epidemiology and Prevention

Abstract—High intakes of dietary sugars in the setting of a worldwide pandemic of obesity and cardiovascular disease have heightened concerns about the adverse effects of excessive consumption of sugars. In 2001 to 2004, the usual intake of added sugars for Americans was 22.2 teaspoons per day (355 calories per day). Between 1970 and 2005, average annual availability of sugars/added sugars increased by 19%, which added 76 calories to Americans' average daily energy intake. Soft drinks and other sugar-sweetened beverages are the primary source of added sugars in Americans' diets. Excessive consumption of sugars has been linked with several metabolic abnormalities and adverse health conditions, as well as shortfalls of essential nutrients. Although trial data are limited, evidence from observational studies indicates that a higher intake of soft drinks is associated with greater energy intake, higher body weight, and lower intake of essential nutrients. National survey data also indicate that excessive consumption of added sugars is contributing to overconsumption of discretionary calories by Americans. On the basis of the 2005 US Dietary Guidelines, intake of added sugars greatly exceeds discretionary calorie allowances, regardless of energy needs. In view of these considerations, the American Heart Association recommends reductions in the intake of added sugars. A prudent upper limit of intake is half of the discretionary calorie allowance, which for most American women is no more than 100 calories per day and for most American men is no more than 150 calories per day from added sugars. (*Circulation.* **2009; 120:1011-1020.**)

Key Words: AHA Scientific Statements ■ cardiovascular diseases ■ carbohydrates, dietary ■ diet ■ beverages ■ carbonated beverages ■ lipids

심장혈관건강을 위해
미국 여성은 하루에 100 kcal, 남자는
150kcal 이상 섭취하지 않기를 권장한다.

Rachel K. Johnson et al. *Circulation 2009;120(11):1011-1020*

Sugar consumption and Cavity

Table 3. Strength of relationships between sugar exposure and caries development in the 36 studies that scored 55 or higher in evidence tables.

Reference Number	Dentition Studied	Study Design	Quality Score	Strength of Relationship*
12	Permanent	Cross-Sectional	60	Moderate
13	Permanent	Cross-Sectional	72	Weak
14	Permanent	Cross-Sectional	62	Weak
18	Permanent	Cohort	66	Weak
20	Permanent	Cross-Sectional	77	Weak
22	Permanent (Root Caries)	Case-Control	59	Moderate
23	Primary	Cross-Sectional	66	Weak
24	Primary	Cohort	59	Moderate
25	Permanent	Cross-Sectional	74	Moderate
26	Primary	Cross-Sectional	63	Weak
29	Primary	Cohort	72	Weak
30	Primary	Cohort	70	Strong
32	Permanent	Cross-Sectional	55	Weak
34	Primary	Cross-Sectional	58	Weak
35	Primary	Cross-Sectional	70	Moderate
38	Permanent	Cross-Sectional	79	Moderate
39	Permanent	Cross-Sectional	63	Moderate
40	Primary	Cross-Sectional	67	Weak
46	Permanent	Cohort	67	Moderate
48	Permanent	Cross-Sectional	68	Weak
49	Permanent	Cross-Sectional	55	Weak
50	Permanent	Cross-Sectional	72	Weak
51	Permanent	Cross-Sectional	64	Weak
52	Primary	Cohort	70	Moderate
53	Primary	Cohort	60	Moderate
54	Primary	Cross-Sectional	58	Moderate
56	Permanent (Root Caries)	Cross-Sectional	61	Moderate
60	Permanent	Cross-Sectional	65	Strong
62	Primary	Cohort	57	Moderate
65	Permanent	Cohort	75	Weak
66	Primary	Cross-Sectional	60	Moderate
71	Primary	Cross-Sectional	58	Moderate
73	Permanent	Cross-Sectional	59	Weak
74	Permanent	Cohort	66	Weak
78	Primary	Cohort	71	Moderate
79	Primary	Cohort	59	Weak

* Strong : OR (or RR)=2.5 or more; Moderate: OR (or RR)=1.5 – 2.4; Weak: OR (or RR) = 1.4 or less.

Brian A. Burt et al. *J Dent Educ 2001;65(10):1017-1023*

Fruit intake and risk of death: England data

Table 4 Association between portions of fruit or of vegetables consumed and risk of death, from all causes unless specified

Model	Portions of fruit consumed in the previous day HRs (95% CI)				
	0—<1*	1—<2	2—<3	3—<4	4+
Number of participants	*32 428*	*17 862*	*14 727*	*9304*	*11 036*
Deaths	*1574*	*948*	*767*	*452*	*465*
Model 1†	1	0.86 (0.79 to 0.93)	0.82 (0.75 to 0.89)	0.75 (0.67 to 0.83)	0.73 (0.66 to 0.81)
Model 2‡	1	0.91 (0.84 to 0.99)	0.90 (0.82 to 0.98)	0.84 (0.76 to 0.93)	0.86 (0.77 to 0.96)
Model 3§¶: Model 2 Cancer deaths only	1	0.99 (0.86 to 1.14)	0.98 (0.84 to 1.14)	0.85 (0.70 to 1.11)	0.93 (0.77 to 1.11)
Model 4¶: Model 2 CVD deaths only	1	0.90 (0.78 to 1.03)	0.87 (0.76 to 1.01)	0.91 (0.76 to 1.08)	0.82 (0.68 to 0.98)
Model 5: Model 2, excluding deaths within a year	1	0.91 (0.83 to 0.99)	0.90 (0.82 to 0.99)	0.83 (0.74 to 0.93)	0.87 (0.78 to 0.97)
Model 6:§ Model 2, non-smokers only	1	0.96 (0.84 to 1.10)	0.94 (0.82 to 1.09)	0.78 (0.65 to 0.93)	0.86 (0.73 to 1.01)

*Reference category.
†Model 1: Adjusted for age, sex, social class, cigarette smoking and BMI.
‡Model 2: Adjusted for age, sex, social class, cigarette smoking, BMI, physical activity, education, alcohol intake and mutually adjusted for portions of vegetables/portions of fruit consumed.
§Education and alcohol intake were not significant and therefore not included in this model.
¶The number of portions of fruit consumed was not significantly associated with mortality in this model.
CVD, cardiovascular disease.

Oyebode O. et al. *J Epidemiol Commun H 2014;68:856-862*

Various fruit intake and risk of death: England data

Type of fruit or vegetable	HR per portion adjusted for age, sex, social class, cigarette smoking and BMI	p Value	HR per portion adjusted for age, sex, social class, cigarette smoking, BMI and all other fruit and vegetable variables	p Value
Vegetables	0.84 (0.81 to 0.88)	<0.001	0.85 (0.81 to 0.89)	<0.001
Salad	0.87 (0.82 to 0.92)	<0.001	0.87 (0.82 to 0.92)	<0.001
Vegetables in composites	0.92 (0.82 to 1.02)	0.10	0.92 (0.82 to 1.02)	0.10
Pulses	0.95 (0.88 to 1.03)	0.20	0.95 (0.88 to 1.03)	0.20
Fresh Fruit	0.96 (0.95 to 0.98)	<0.001	0.96 (0.95 to 0.98)	<0.001
Dried fruit	0.91 (0.84 to 0.99)	0.03	0.91 (0.84 to 0.99)	0.03
Fruit in composites	0.93 (0.84 to 1.03)	0.17	0.93 (0.84 to 1.03)	0.17
Fruit juice	0.97 (0.91 to 1.04)	0.40	0.97 (0.91 to 1.04)	0.40
Frozen/canned fruit	1.17 (1.07 to 1.28)	0.001	1.17 (1.07 to 1.28)	0.001

Oyebode O. et al . *J Epidemiol Commun H 2014;68:856-862*

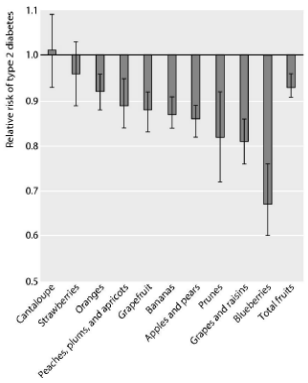
Whole fruit intakes and type2 diabetes

Table 2| **Pooled hazard ratios (95% confidence intervals) of type 2 diabetes for total whole fruit consumption in Nurses' Health Study, Nurses' Health Study II, and Health Professionals Follow-up Study**

Variables	Consumption levels						P values	
	<4 servings/week	5-6 servings/week	1 serving/day	2 servings/day	≥3 servings/day	Linear trend*	For trend	For heterogeneity
Nurses' Health Study†:	478/94 121	523/105 022	1141/237 302	2068/459 062	2148/498 620			
Adjusted hazard ratio‡	1.00	0.93 (0.82 to 1.06)	0.86 (0.77 to 0.97)	0.81 (0.72 to 0.91)	0.82 (0.72 to 0.92)	0.97 (0.95 to 0.99)		
Nurses' Health Study II†:	995/358 762	620/287 918	718/368 180	598/295 904	222/105 347			
Adjusted hazard ratio‡	1.00	0.86 (0.77 to 0.95)	0.84 (0.76 to 0.94)	0.88 (0.78 to 0.98)	0.92 (0.78 to 1.08)	0.99 (0.96 to 1.02)		
Health Professionals Follow-up Study†:	219/48 762	236/47 865	482/107 372	799/199 357	951/251 047			
Adjusted hazard ratio‡	1.00	1.10 (0.91 to 1.33)	1.07 (0.90 to 1.27)	0.99 (0.83 to 1.17)	0.99 (0.82 to 1.19)	0.98 (0.95 to 1.01)		
Pooled results‡§	1.00	0.91 (0.85 to 0.99)	0.88 (0.82 to 0.95)	0.87 (0.81 to 0.94)	0.88 (0.81 to 0.96)	0.98 (0.96 to 0.99)	0.002	0.48

*Estimated based on every three servings/week increment.
†Cases/person years of observation.
‡Adjusted for age (years), ethnicity (white, African-American, Hispanic, or Asian), body mass index (<23, 23.0-24.9, 25.0-26.9, 27.0-28.9, 29.0-30.9, 31.0-32.9, 33.0-34.9, 35.0-36.9, 37.0-38.9, 39.0-40.9, 41.0-42.9, 43.0-44.9, ≥45.0, or missing), smoking status (never, former, current (1–14, 15–24, or ≥25 cigarettes/day), or missing), multivitamin use (yes or no), physical activity (<3, 3.0-8.9, 9.0-17.9, 18.0-26.9, ≥27.0 MET (metabolic equivalent of task) hours/week, or missing), family history of diabetes (yes or no), menopausal status and post-menopausal hormone use (premenopause, post-menopause (never, former, or current hormone use), or missing, for women), oral contraceptive use (yes, no, or missing, for Nurses' Health Study II) total energy intake (kcal/day), fruit juice consumption (<1, 1, 2-4, 5-6, ≥7 servings/week) and the modified alternate healthy eating index score (fifths). Individual fruit consumption was mutually adjusted.
§Study estimates from three cohorts were pooled using a fixed effects model.

JoAnn E Manson et al. BMJ 2013;347:f5001



Pooled multivariate adjusted hazard ratios and 95% confidence intervals (error bars) of type 2 diabetes for substituting three servings/week of total or specific f ruit for the same amount of fruit juice

JoAnn E Manson et al. BMJ 2013;347:f5001

Sugar-Sweetened Beverages, Weight Gain, and Incidence of Type 2 Diabetes in Young and Middle-Aged Women

Table 3. Relative Risk of Type 2 Diabetes According to Frequencies of Sugar-Sweetened Beverage Consumption in 91 249 Women

	Sugar-Sweetened Soft Drink Intake				*P* Value for Trend
	<1/mo	1-4/mo	2-6/wk	≥1/d	
All sugar-sweetened soft drinks					
Cases	368	163	95	115	
Person-years	381 275	188 501	80 086	66 438	
Age-adjusted RR (95% CI)	1.00	0.93 (0.78-1.12)	1.32 (1.06-1.66)	1.98 (1.60-2.44)	<.001
Multivariate-adjusted RR (95% CI)*	1.00	1.06 (0.87-1.28)	1.49 (1.16-1.91)	1.83 (1.42-2.36)	<.001
Sugar-sweetened cola					
Cases	403	142	96	100	
Person-years	420 598	166 656	75 778	53 267	
Age-adjusted RR (95% CI)	1.00	0.92 (0.76-1.12)	1.44 (1.16-1.81)	2.14 (1.72-2.67)	<.001
Multivariate-adjusted RR (95% CI)*	1.00	0.99 (0.80-1.23)	1.56 (1.21-2.02)	1.87 (1.43-2.45)	<.001
Fruit punch					
Cases	589	85	38	29	
Person-years	525 780	124 932	45 958	19 630	
Age-adjusted RR (95% CI)	1.00	0.95 (0.73-1.24)	1.24 (0.86-1.77)	2.31 (1.55-3.45)	<.001
Multivariate-adjusted RR (95% CI)*	1.00	0.90 (0.68-1.18)	1.15 (0.79-1.66)	2.00 (1.33-3.03)	.001

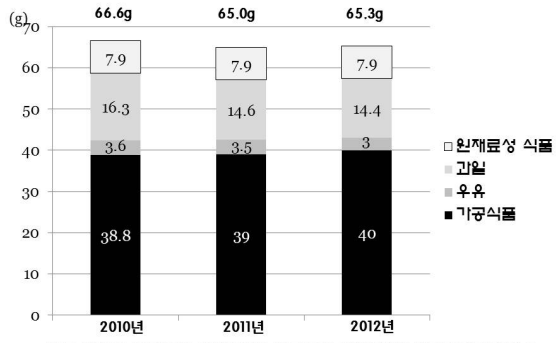
Abbreviations: CI, confidence interval; RR, relative risk.
*Relative risks are adjusted for age; alcohol intake (0, 0.1-4.9, 5.0-9.9, or ≥10 g/d); physical activity (quintiles); family history of diabetes; smoking (never, past, or current); post-menopausal hormone use (never or ever); oral contraceptive use (never, past, or current); intake (quintiles) of cereal fiber, magnesium, trans fat, and ratio of polyunsaturated to saturated fat; and consumption of sugar-sweetened soft drinks, diet soft drinks, fruit juice, and fruit punch (other than the main exposure, depending on model).

Schulze MB, et al. JAMA 2004: 292:297-934

WHO Guideline

- WHO current recommendation from 2002 : sugars should make up less than 10% of total energy intake per day
- The new draft guideline : sugars should be less than 10% of total energy intake per day. It further suggests that a reduction to below 5% of total energy intake per day would have additional benefits.
- Guidance on sugars intake is expected to be published in late 2014.

Sugar intake status in Korea



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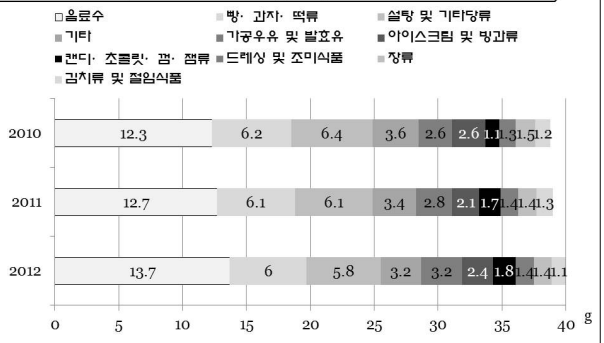
Food categories contributing to sugar consumption through processed foods



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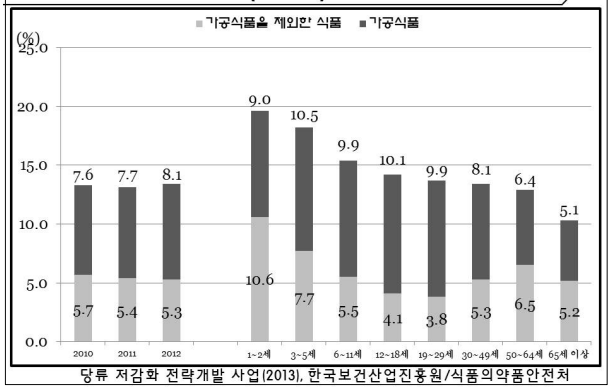
Sugar intake rate of total energy by age (2012)



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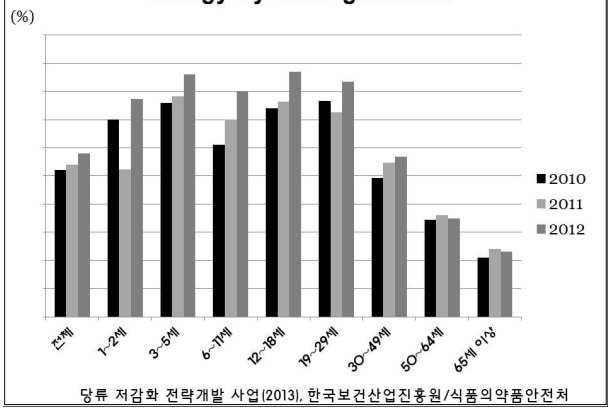
People who intake more than 10% of total energy by WHO guideline



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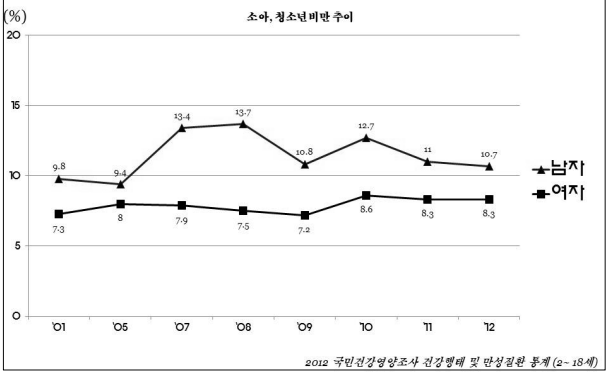
childhood and adolescence obesity by sex in Korea



2012 국민건강영양조사 건강행태 및 만성질환 통계 (2~18세)

Conclusion

- ✓ 단순당: 가공식품으로부터 섭취 제한
- ✓ 과일 유래 당 : Good, but not too much
- ✓ 영양표시 체크! & 제품 유형과 원재료명 !