Do sugars cause chronic metabolic diseases?

John L Sievenpiper, MD, PhD, FRCPC[1,2,3,4]

[1]Associate Professor, Department of Nutritional Sciences, University of Toronto

[2]Staff Physican, Division of Endocrinology & Metabolism, St. Michael's Hospital

[3]Scientist, Li Ka Shing Knowledge Institute, St. Michael's Hospital

[4]Lifesteyle Medicine Lead, MD Program, University of Toronto

Advancing risk assessment science: Nutrition

EFSA Conference 2018 Science, Food, Society

Parma, Italy

Sep 19, 2018

UNIVERSITY OF TORONTO

St. Michael's

Inspired Care.
Inspiring Science.

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

Disclosures (past 36 months)

Board Member/Advisory Panel

–Diabetes Canada 2018 Clinical Practice Guidelines Expert Committee for Nutrition therapy

–Canadian Cardiovascular Society (CCS) 2016 Dyslipidemia Guidelines Update

–European Association for the Study of Diabetes (EASD) Clinical Practice Guidelines Expert Committee for Nutrition therapy

–American Society for Nutrition (ASN) writing panel for a scientific statement on sugars

–International Life Science Institute (ILSI) North America

–Transcultural Diabetes Algorithm (tDNA) Group

–Diabetes Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD) Board

–European Fruit Juice Association Scientific Expert Panel

Research Support

–Canadian Institutes of Health Research (CIHR)

– Diabetes Canada

–PSI Foundation

–American Society for Nutrition (ASN)

–Banting and Best Diabetes Centre (BBDC)

–Tate & Lyle Nutritional Research Fund at the University of Toronto

–INC International Nut and Dried Fruit Council Foundation

–National Dried Fruit Trade Association

–Glycemic Control and Cardiovascular Disease in Type 2 Diabetes Fund at the University of Toronto (a fund established by the Alberta Pulse Growers)

–Nutrition Trialists Fund at the University of Toronto (a fund established by the Calorie Control Council)

"In-kind" food product donations for trials

Almond Board of California, California Walnut Commission, American Peanut Council, Barilla, Unilever, Unico/Primo, Loblaw Companies, Quaker (Pepsico), Kellogg Canada, and WhiteWave Foods

Ad Hoc Consulting Arrangements

–Tate & Lyle

–Winston Strawn LLP

–Perkins Coie LLP

Honoraria or Speaker Fees

–Mott's LLP

–Dairy Farmers of Canada

–Alberta Milk

–FoodMinds LLC

–Pulse Canada

–Memac Ogilvy & Mather LLC

–PepsiCo

–Nestle Nutrition Institute (NNI)

–Wirtschaftliche Vereinigung Zucker e.V

Other

–Spouse is an employee of Unilever Canada

–Editorial Board, *American Journal of Clinical Nutrition*

–Editorial Board, *Nutrients*

–Associate Editor, *Frontiers in Nutrition, Nutrition Methodology*

–Director, Toronto 3D Knowledge Synthesis and Clinical Trials foundation

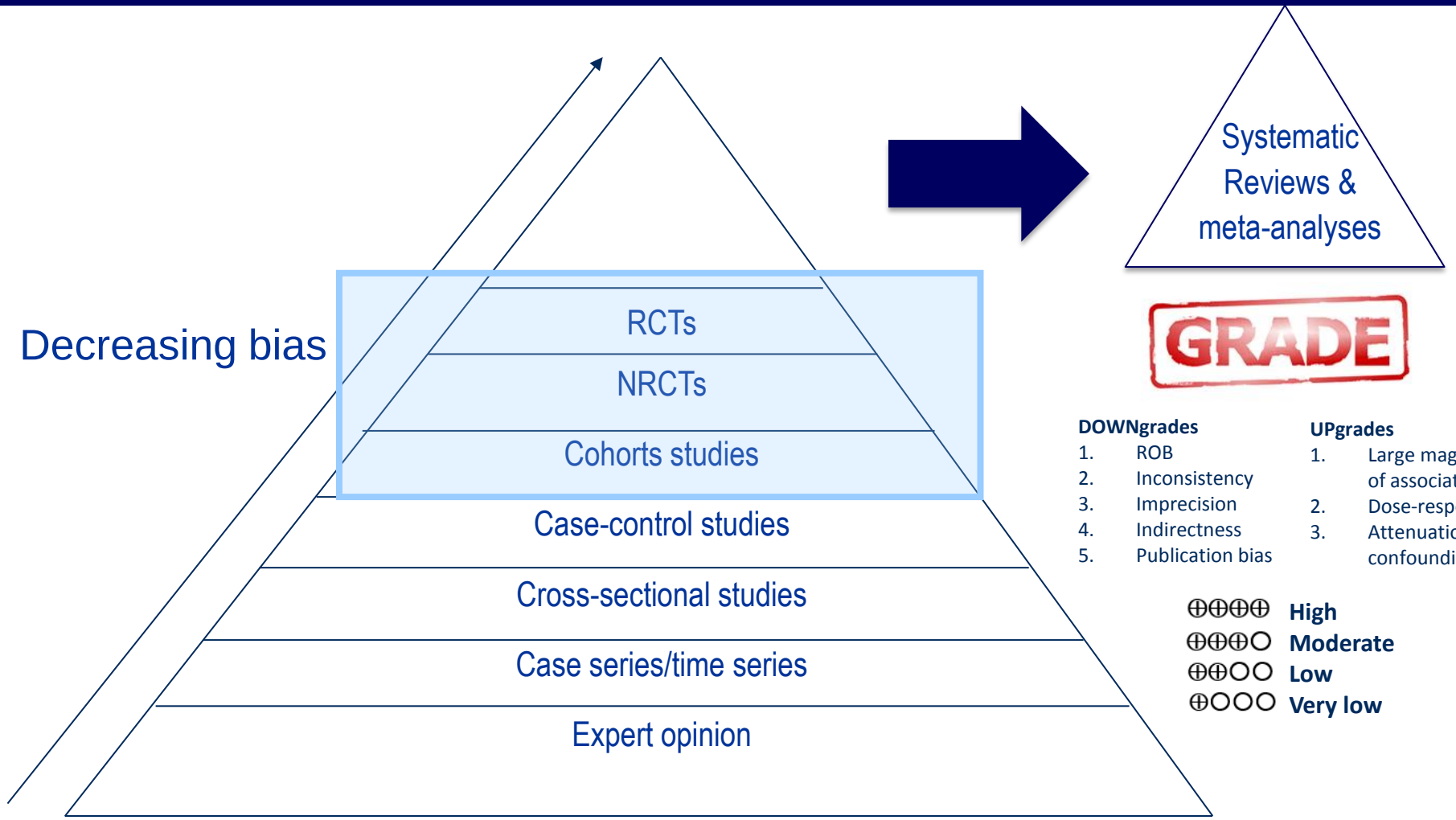
Questions

1. Are **sugars <u>in</u>dependent** of **food form** and **energy** linked with cardiometabolic outcomes?

2. What about **sugar Sweetened Beverages (SSBs)?**

3. What about **<u>other</u> important food sources** of **sugars**?

Hierarchy of evidence in evidence based medicine



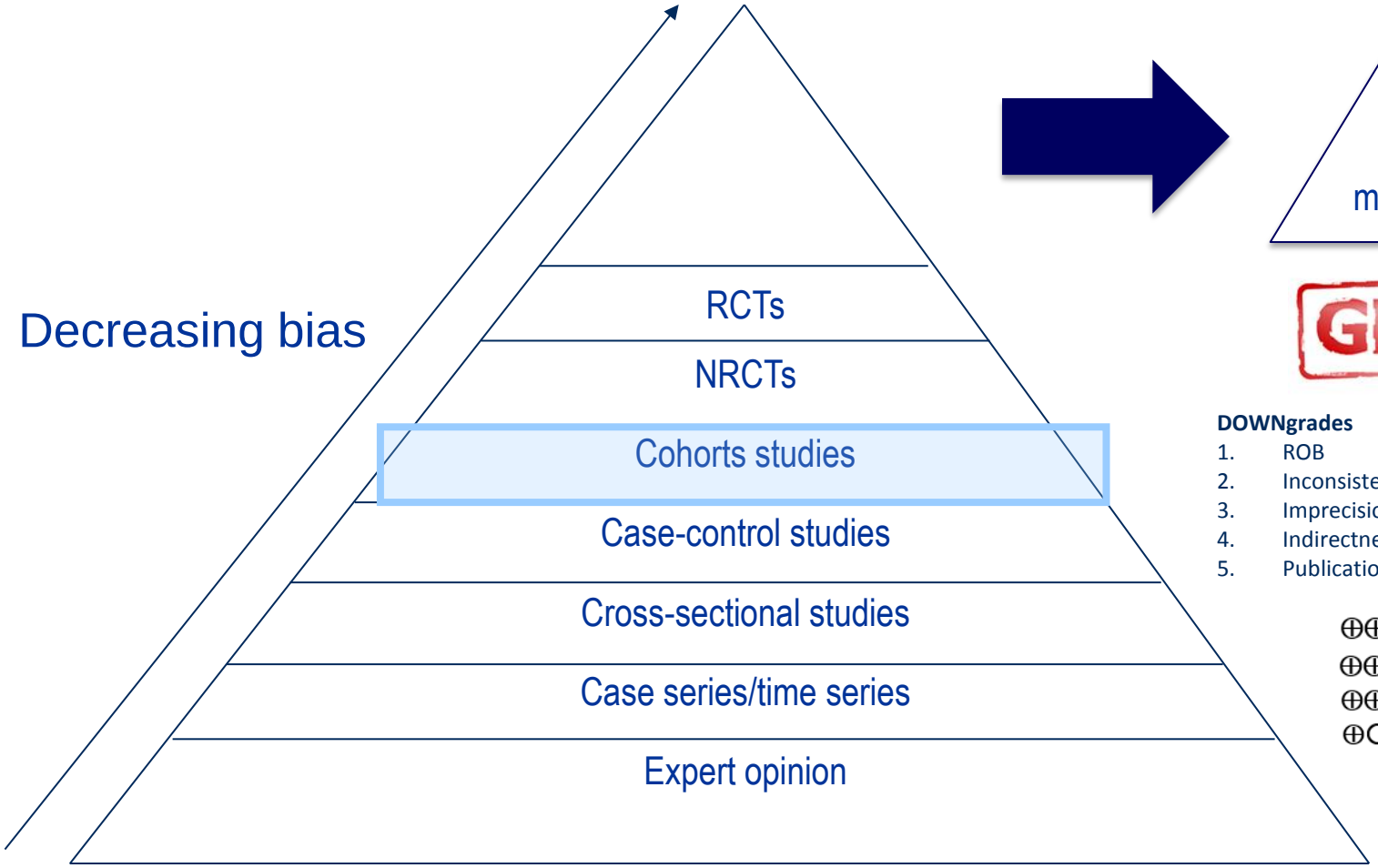
Questions

1. Are **sugars <u>in</u>dependent** of **food form** and **energy** linked with cardiometabolic outcomes?

2. What about **sugar Sweetened Beverages (SSBs)?**

3. What about **<u>other</u> important food sources** of **sugars**?

Hierarchy of evidence in evidence based medicine



Systematic Reviews & meta-analyses

GRADE

DOWNgrades

1. ROB
2. Inconsistency
3. Imprecision
4. Indirectness
5. Publication bias

UPgrades

1. Large magnitude of association
2. Dose-response
3. Attenuation by confounding

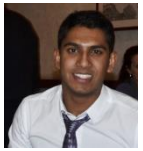
⊕⊕⊕⊕ **High**
⊕⊕⊕◯ **Moderate**
⊕⊕◯◯ **Low**
⊕◯◯◯ **Very low**

Meta-analyses of Fructose-containing Sugars & Incident Cardiometabolic Disease (NCT01608620)

Sugars

- Diabetes
  - Tsilas et al. CMAJ. 2017;189:E711-E720.
- Overweight/obesity
  - Kim et al. unpublished
- Hypertension
  - Jaylath et al. J Am Coll Nutr. 2014;33:328-39
- Gout
  - Jamnik et al. BMJ Open, 2016;6:e013191
- CVD
  - Khan et al. unpublished



CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

ASN EST. 1928

PSI FOUNDATION

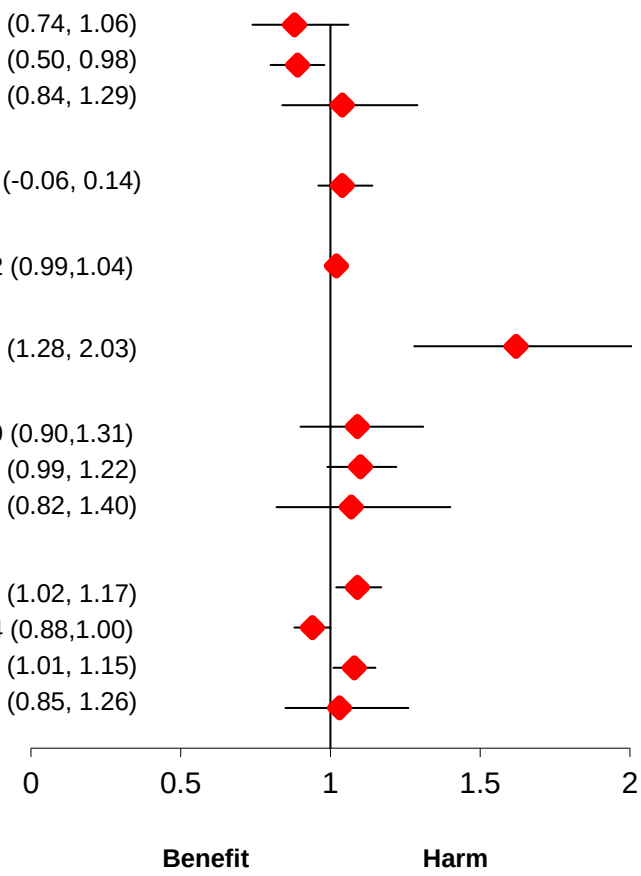
DIABETES CANADA

Calorie Control Council
HEALTHY EATING & EXERCISE FOR LIFE™

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

Relation of sugars with cardiometabolic diseases:
5 SRMAs of >50 cohort comparisons (>2 million participants, >100,000 cases)

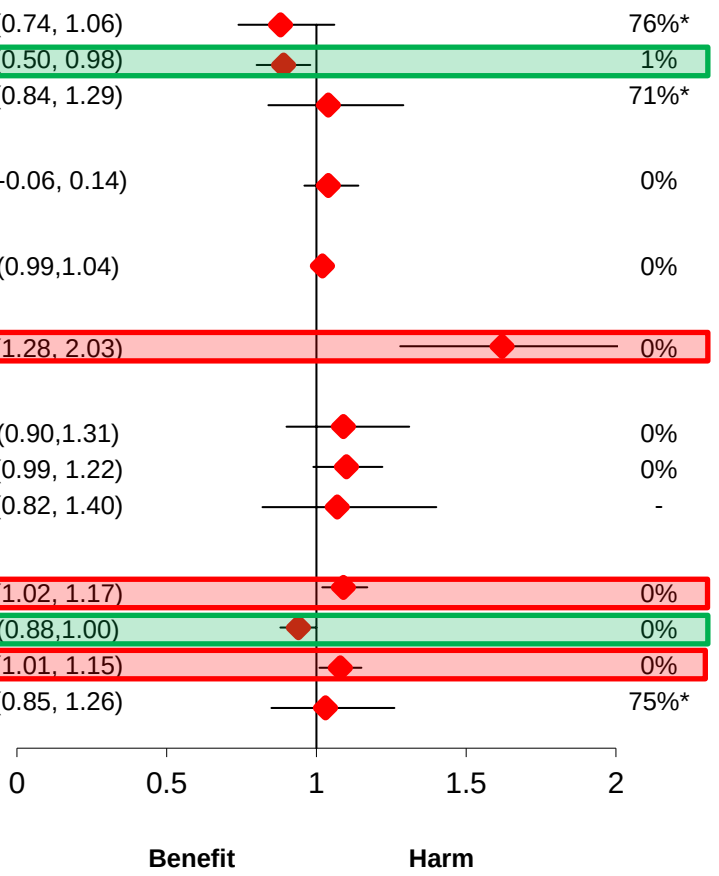
Cardiometabolic outcome	Sugars type	Cohort Comparisons	N	Cases	FU	Risk ratio (RR) with 95% CIs	I^2
Diabetes	Total sugars	13	108,170	14,752	12y	0.88 (0.74, 1.06)	76%*
	Sucrose	8	192,332	4,535	6y	0.89 (0.50, 0.98)	1%
	Fructose	6	107,972	3,833	9y	1.04 (0.84, 1.29)	71%*
Obesity (weight)	Total sugars	2	32,405	-	4y	0.04 (-0.06, 0.14)	0%
Hypertension	Fructose	3	223,230	58,162	18y	1.02 (0.99,1.04)	0%
Gout	Fructose	2	125,299	1,533	17y	1.62 (1.28, 2.03)	0%
Cardiovascular incidence	Total sugars	7	102,679	2,519	10y	1.09 (0.90,1.31)	0%
	Sucrose	3	101,966	3,682	12y	1.10 (0.99, 1.22)	0%
	Fructose	1	75,521	761	10y	1.07 (0.82, 1.40)	-
Cardiovascular mortality	Total sugars	4	362,607	12,024	13y	1.09 (1.02, 1.17)	0%
	Sucrose	2	353,751	10,894	13y	0.94 (0.88,1.00)	0%
	Fructose	2	353,751	10,894	13y	1.08 (1.01, 1.15)	0%
	Added sugars	4	365,484	11,725	14y	1.03 (0.85, 1.26)	75%*



Relation of sugars with cardiometabolic diseases:

5 SRMAs of >50 cohort comparisons (>2 million participants, >100,000 cases)

Cardiometabolic outcome	Sugars type	Cohort Comparisons	N	Cases	FU	Risk ratio (RR) with 95% CIs	I^2
Diabetes	Total sugars	13	108,170	14,752	12y	0.88 (0.74, 1.06)	76%*
	Sucrose	8	192,332	4,535	6y	0.89 (0.50, 0.98)	1%
	Fructose	6	107,972	3,833	9y	1.04 (0.84, 1.29)	71%*
Obesity (weight)	Total sugars	2	32,405	-	4y	0.04 (-0.06, 0.14)	0%
Hypertension	Fructose	3	223,230	58,162	18y	1.02 (0.99,1.04)	0%
Gout	Fructose	2	125,299	1,533	17y	1.62 (1.28, 2.03)	0%
Cardiovascular incidence	Total sugars	7	102,679	2,519	10y	1.09 (0.90,1.31)	0%
	Sucrose	3	101,966	3,682	12y	1.10 (0.99, 1.22)	0%
	Fructose	1	75,521	761	10y	1.07 (0.82, 1.40)	-
Cardiovascular mortality	Total sugars	4	362,607	12,024	13y	1.09 (1.02, 1.17)	0%
	Sucrose	2	353,751	10,894	13y	0.94 (0.88,1.00)	0%
	Fructose	2	353,751	10,894	13y	1.08 (1.01, 1.15)	0%
	Added sugars	4	365,484	11,725	14y	1.03 (0.85, 1.26)	75%*

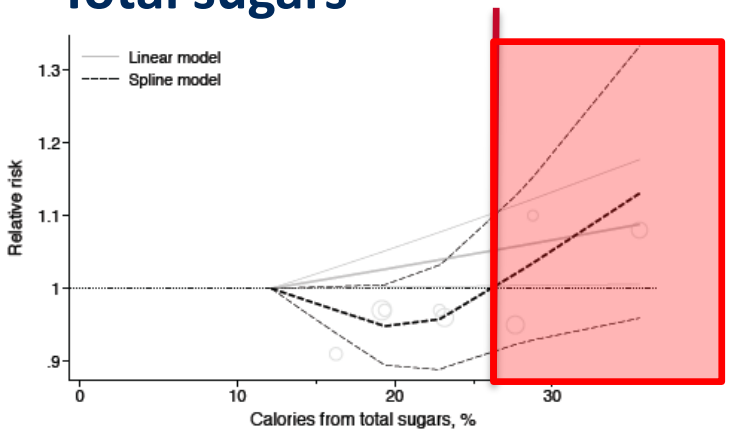


Relation of sugars with cardiometabolic diseases:
5 SRMAs of >50 cohort comparisons (>2 million participants, >100,000 cases)

Cardiometabolic outcome	Sugars type	Cohort Comparisons	N	Cases	FU	
Diabetes	Total sugars	13	108,170	14,752	12y	0.88
	Sucrose	8	192,332	4,535	6y	0.89
	Fructose	6	107,972	3,833	9y	1.04
Obesity (weight)	Total sugars	2	32,405	-	4y	0.04
Hypertension	Fructose	3	223,230	58,162	18y	1.02
Gout	Fructose	2	125,299	1,533	17y	1.62
Cardiovascular incidence	Total sugars	7	102,679	2,519	10y	1.09
	Sucrose	3	101,966	3,682	12y	1.10
	Fructose	1	75,521	761	10y	1.07
Cardiovascular mortality	Total sugars	4	362,607	12,024	13y	1.09
	Sucrose	2	353,751	10,894	13y	0.94
	Fructose	2	353,751	10,894	13y	1.08
	Added sugars	4	365,484	11,725	14y	1.03

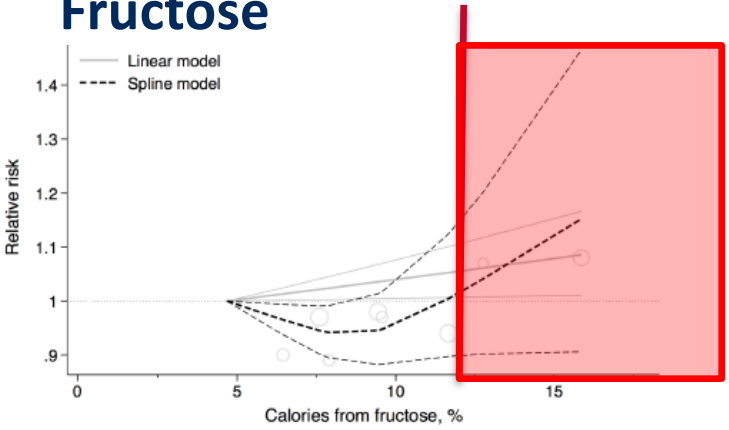
Total sugars

26% energy

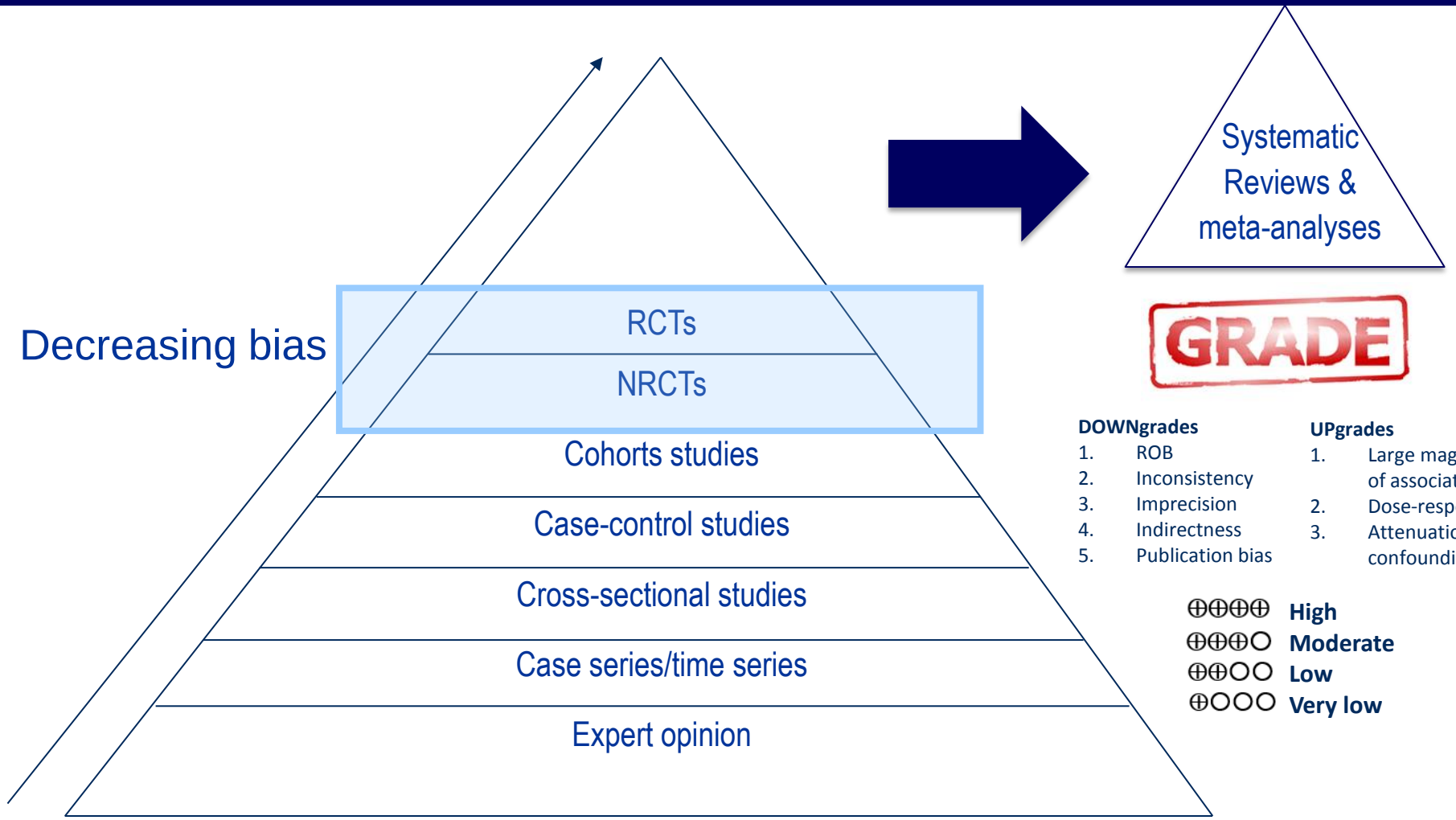


Fructose

12% energy



Hierarchy of evidence in evidence based medicine



Effect of fructose on metabolic control in humans:
A series of systematic reviews & meta-analysis of controlled trials (NCT01363791)

Fructose

- Body weight
  Sievenpiper et al. Ann Intern Med 2012;156:291-304
- Fasting lipids
  Sievenpiper et al. Diabetes Care 2009;32:1930-7
  Chiavaroli et al. JAHA 2015;4:e001700
- Blood pressure
  Ha et al. Hypertension 2012;59:787-95
- Uric acid
  Wang et al. J Nutr 2012;142:916-23)
- Glycemic control
  Cozma et al. Diabetes Care 2012;35:1611-20
- Postprandial lipids
  Wang et al. Atherosclerosis 2014;232:125-133
- NAFLD
  Chiu et al. Eur J Clin Nutr. 2014;68:416-423







'Catalytic' fructose & cardiometabolic risk

Sievenpiper et al. Br J Nutr, 2012;108:418-23

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

PSI FOUNDATION

DIABETES CANADA

Calorie Control Council
HEALTHY EATING & EXERCISE FOR LIFE™

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

2 trial designs:
To interpret results, follow the energy…

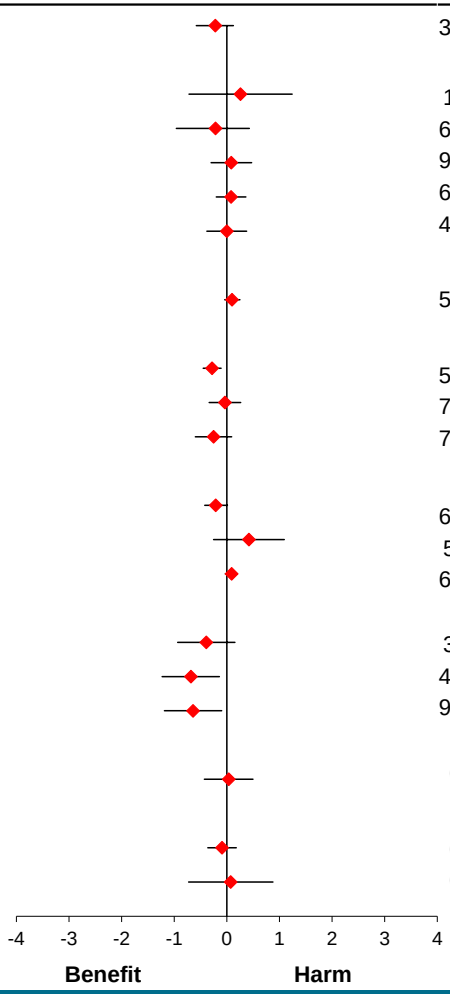
“Substitution trials” = Energy from sugars substituted for other sources of energy in the diet

“Addition trials” = Energy from sugars “added” to the diet

What do the "Substitution trials" tell us?

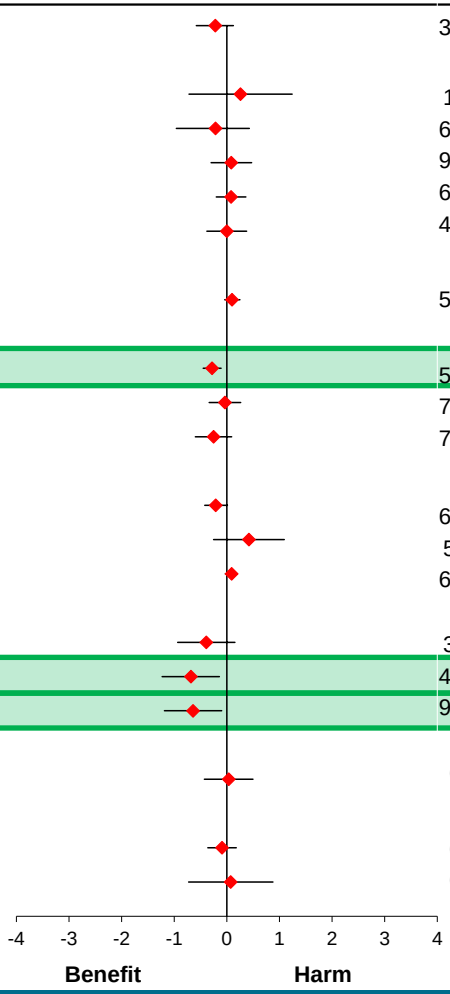
Lack of harm in 'SUBSTITUTION' trials:
>50 trials (N >1000), dose = 22.5-300g/d, FU = 1-52wk

Cardiometabolic endpoint		Comparisons	No.	Standardized Mean Difference (SMD) with 95% CI	I^2
Body weight[4]		31	637	-0.22 (-0.58, 0.13)	37%*
Fasting Lipids[5]	LDL-C	26	327	0.36 (-0.27, 0.50)	11%
	Apo-B	8	176	-0.21(-0.96, 0.43)	62%*
	Non-HDL-C	26	457	0.09 (-0.30, 0.47)	92%*
	TG	49	815	0.08 (-0.20, 0.36)	62%*
	HDL-C	27	525	0.00 (-0.38, 0.38)	49%*
Postprandial TG[6]		14	290	0.14 (-0.02, 0.30)	54%*
Glycemic control[3]	GBP	19	277	-0.28 (-0.45, -0.11)	56%*
	FBG	47	881	-0.04 (-0.34, 0.26)	78%*
	FBI	34	622	-0.25 (-0.60, 0.09)	70%*
Insulin sensitivity[3]	Whole body	16	265	-0.21 (-0.42, 0.01)	66%*
	Hepatic	3	25	0.42 (-0.25, 1.09)	51%
	HOMA-IR	39	806	0.09 (-0.03, 0.20)	66%*
Blood pressure[7]	SBP	13	352	-0.39 (-0.93, 0.16)	31%
	DBP	13	352	-0.68 (-1.23, -0.14)	47%*
	MAP	13	352	-0.64 (-1.19, -0.10)	97%*
Uric acid[8]		18	390	0.04 (-0.43, 0.50)	0%
NAFLD[9]	IHCL	4	95	-0.09 (-0.36, 0.18)	0%
	ALT	6	164	0.07 (-0.73, 0.87)	0%



Lack of harm in 'SUBSTITUTION' trials:
>50 trials (N >1000), dose = 22.5-300g/d, FU = 1-52wk

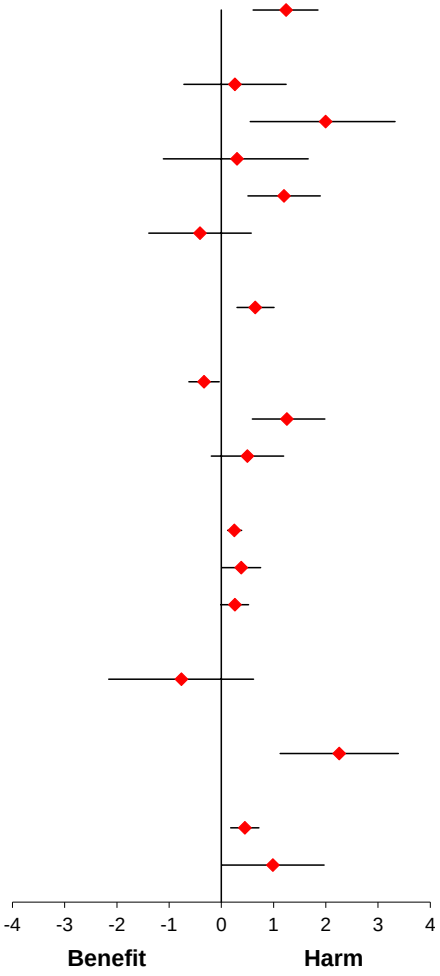
Cardiometabolic endpoint		Comparisons	No.	Standardized Mean Difference (SMD) with 95% CI	I^2
Body weight[4]		31	637	-0.22 (-0.58, 0.13)	37%*
Fasting Lipids[5]	LDL-C	26	327	0.36 (-0.27, 0.50)	11%
	Apo-B	8	176	-0.21(-0.96, 0.43)	62%*
	Non-HDL-C	26	457	0.09 (-0.30, 0.47)	92%*
	TG	49	815	0.08 (-0.20, 0.36)	62%*
	HDL-C	27	525	0.00 (-0.38, 0.38)	49%*
Postprandial TG[6]		14	290	0.14 (-0.02, 0.30)	54%*
Glycemic control[3]	GBP	19	277	-0.28 (-0.45, -0.11)	56%*
	FBG	47	881	-0.04 (-0.34, 0.26)	78%*
	FBI	34	622	-0.25 (-0.60, 0.09)	70%*
Insulin sensitivity[3]	Whole body	16	265	-0.21 (-0.42, 0.01)	66%*
	Hepatic	3	25	0.42 (-0.25, 1.09)	51%
	HOMA-IR	39	806	0.09 (-0.03, 0.20)	66%*
Blood pressure[7]	SBP	13	352	-0.39 (-0.93, 0.16)	31%
	DBP	13	352	-0.68 (-1.23, -0.14)	47%*
	MAP	13	352	-0.64 (-1.19, -0.10)	97%*
Uric acid[8]		18	390	0.04 (-0.43, 0.50)	0%
NAFLD[9]	IHCL	4	95	-0.09 (-0.36, 0.18)	0%
	ALT	6	164	0.07 (-0.73, 0.87)	0%



What do "Addition trials" tell us?

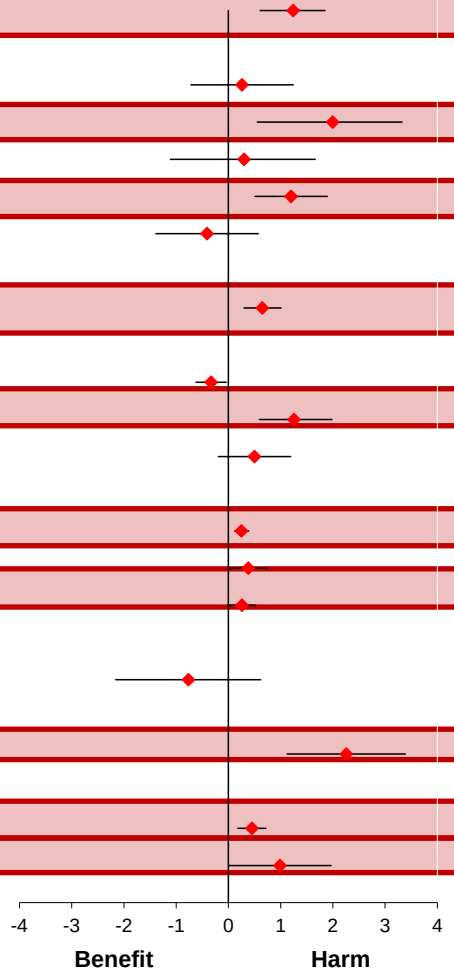
Harm in ‘ADDITION’ trials:
An effect more attributable to energy (up to +250g/d +50% E)

Cardiometabolic end point		Comparisons	No.	Standardized Mean Difference (SMD) with 95% CI	I^2
Body weight[4]		10	119	1.24 (0.61, 1.85)	30%
Fasting lipids[5]	LDL-C	4	79	0.14 (-0.39, 1.57)	77%*
	Apo-B	2	48	2.00 (0.55, 3.33)	0%
	Non-HDL-C	2	43	0.30 (-1.11, 1.66)	93%*
	TG	8	125	1.20 (0.51, 1.89)	66%*
	HDL-C	4	79	-0.41(-1.39,0.57)	0%
Postprandial TG[6]		2	32	0.65 (0.30, 1.01)	22%
Glycemic control[3]	GBP	2	31	-0.33 (-0.62, -0.04)	0%
	FBG	8	98	1.25 (0.59, 1.98)	59%*
	FBI	8	98	0.50 (-0.19, 1.19)	41%
Insulin sensitivity[3]	Whole body	7	74	0.25 (0.12, 0.39)	0%
	Hepatic	3	31	0.38 (0.01, 0.75)	0%
	HOMA-IR	9	113	0.26 (-0.01, 0.52)	77%*
Blood pressure[7]	MAP	2	24	-0.76 (-2.15, 0.62)	24%
Uric acid[8]		3	35	2.26 (1.13, 3.39)	0%
NAFLD[9]	IHCL	5	60	0.45(0.18, 0.72)	51%*
	ALT	4	59	0.99 (0.01, 1.97)	28%



Harm in ‘ADDITION’ trials:
An effect more attributable to energy (up to +250g/d +50% E)

Cardiometabolic end point		Comparisons	No.	Standardized Mean Difference (SMD) with 95% CI	I^2
Body weight[4]		10	119	1.24 (0.61, 1.85)	30%
Fasting lipids[5]	LDL-C	4	79	0.14 (-0.39, 1.57)	77%*
	Apo-B	2	48	2.00 (0.55, 3.33)	0%
	Non-HDL-C	2	43	0.30 (-1.11, 1.66)	93%*
	TG	8	125	1.20 (0.51, 1.89)	66%*
	HDL-C	4	79	-0.41(-1.39,0.57)	0%
Postprandial TG[6]		2	32	0.65 (0.30, 1.01)	22%
Glycemic control[3]	GBP	2	31	-0.33 (-0.62, -0.04)	0%
	FBG	8	98	1.25 (0.59, 1.98)	59%*
	FBI	8	98	0.50 (-0.19, 1.19)	41%
Insulin sensitivity[3]	Whole body	7	74	0.25 (0.12, 0.39)	0%
	Hepatic	3	31	0.38 (0.01, 0.75)	0%
	HOMA-IR	9	113	0.26 (-0.01, 0.52)	77%*
Blood pressure[7]	MAP	2	24	-0.76 (-2.15, 0.62)	24%
Uric acid[8]		3	35	2.26 (1.13, 3.39)	0%
NAFLD[9]	IHCL	5	60	0.45(0.18, 0.72)	51%*
	ALT	4	59	0.99 (0.01, 1.97)	28%



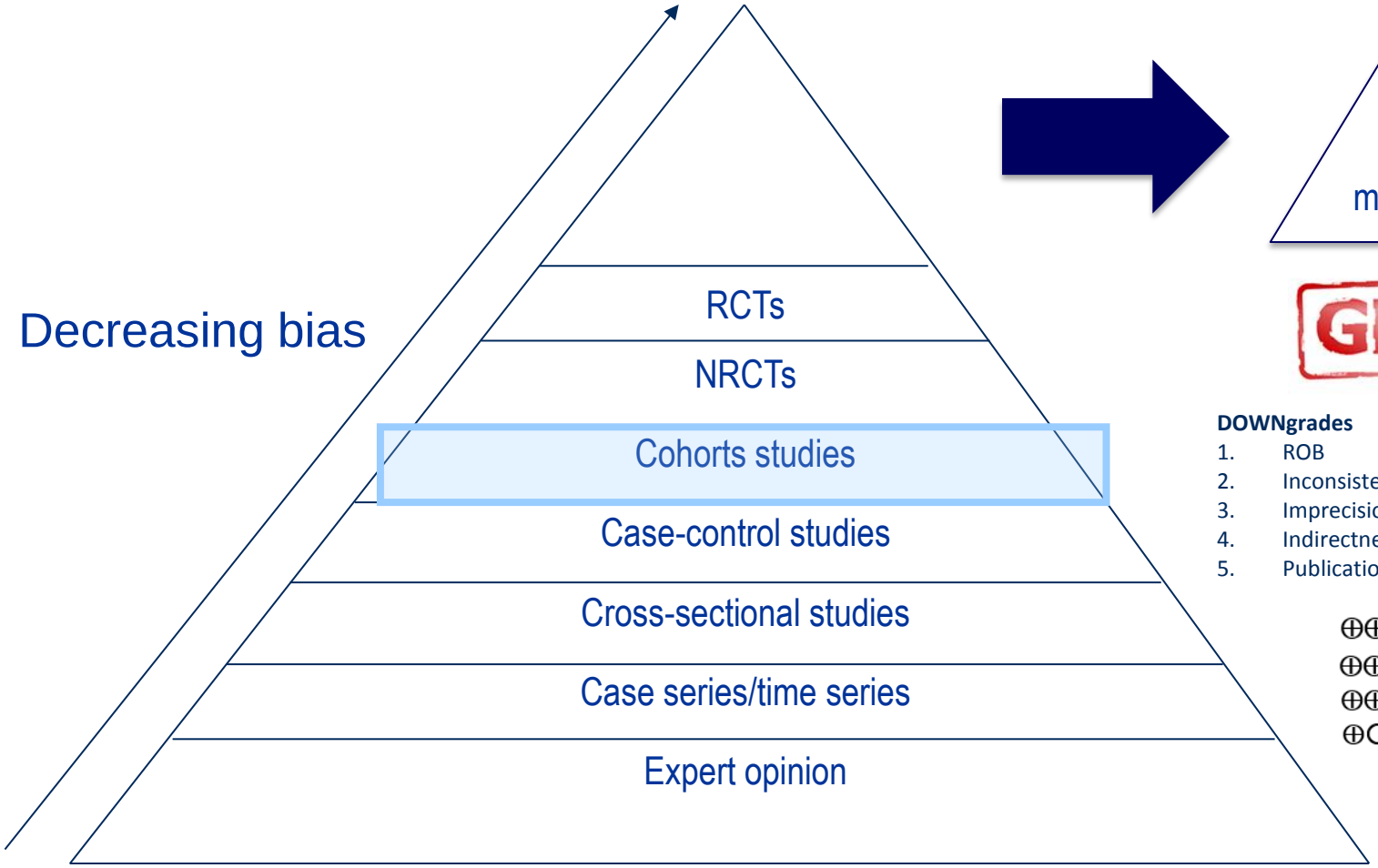
Questions

1. Are **sugars** **in**dependent of **food form** and **energy** linked with cardiometabolic outcomes?

2. What about **sugar Sweetened Beverages (SSBs)?**

3. What about **other** **important food sources** of **sugars**?

Hierarchy of evidence in evidence based medicine



Systematic Reviews & meta-analyses

GRADE

DOWNgrades

1. ROB
2. Inconsistency
3. Imprecision
4. Indirectness
5. Publication bias

UPgrades

1. Large magnitude of association
2. Dose-response
3. Attenuation by confounding

⊕⊕⊕⊕ **High**
⊕⊕⊕◯ **Moderate**
⊕⊕◯◯ **Low**
⊕◯◯◯ **Very low**

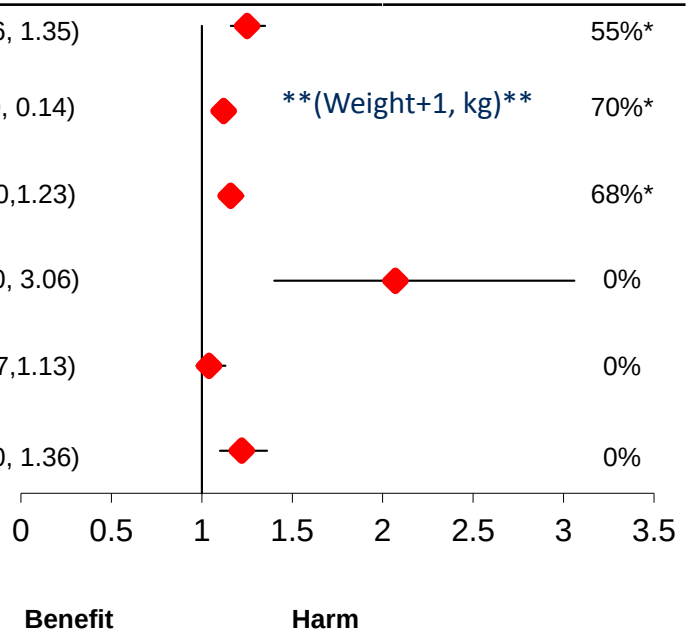
Sugar-sweetened beverages (SSBs) & Incident Cardiometabolic Disease

SSBs

- Diabetes/MetS
  - Imamura et al. BMJ. 2015;351:h3576
- Overweight/obesity
  - Malik et al. Am J Clin Nutr. 2013;98:1084-1020
- Hypertension
  - Jaylath et al. Am J Clin Nutr. 2015;102:914-21
- Gout
  - Choi et al. JAMA. 2010;304:2270-8
- CVD
  - Xi et al. Br J Nutr. 2015;113:709-17

Relation of SSBs with cardiometabolic diseases:
5 SRMAs of >50 cohort comparisons (>2 million participants, >100,000 cases)

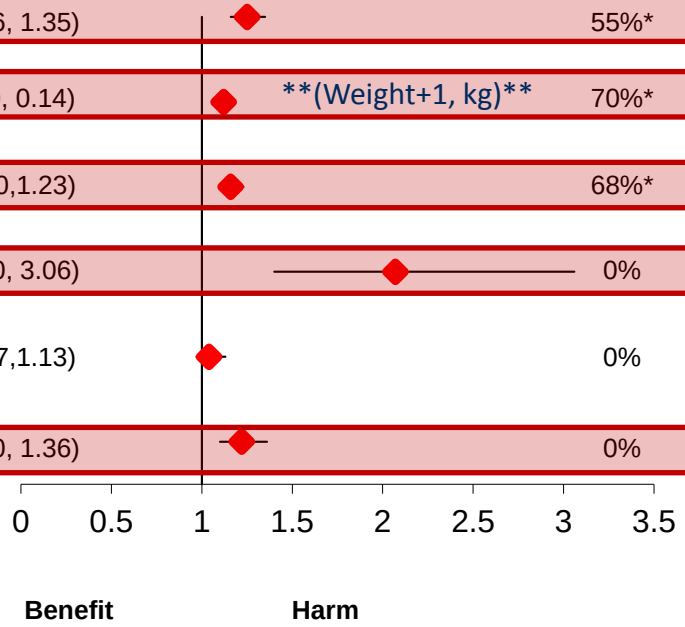
Cardiometabolic outcome	Sugars type	Cohort Comparisons	N	Cases	FU	Risk ratio (RR) with 95% CIs	I^2
Diabetes	SSBs	16	411,739	26,884	11y	1.25 (1.16, 1.35)	55%*
Obesity (weight)	SSBs	8	174,252	-	5y	0.12 0.10, 0.14)	70%*
Hypertension	SSBs	10	407,351	115,169	12y	1.16 (1.10,1.23)	68%*
Gout	SSBs	3	154,289	1,761	17y	2.07 (1.40, 3.06)	0%
CV incidence	SSBs	6	94,784	4,856	10y	1.04 (0.97,1.13)	0%
CV mortality	SSBs	4	188,177	10,910	16y	1.22 (1.10, 1.36)	0%



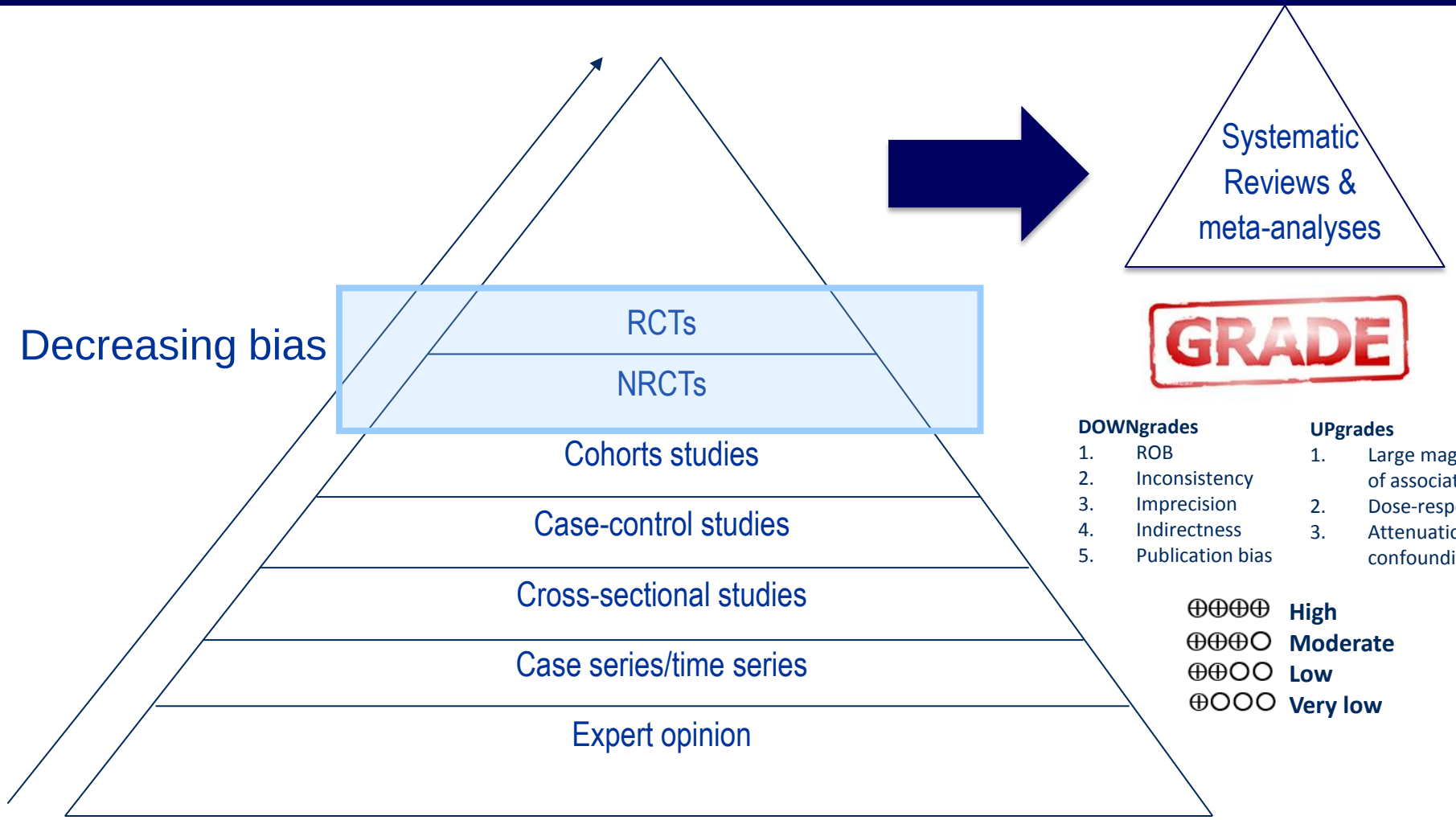
Relation of SSBs with cardiometabolic diseases:

5 SRMAs of >50 cohort comparisons (>2 million participants, >100,000 cases)

Cardiometabolic outcome	Sugars type	Cohort Comparisons	N	Cases	FU	Risk ratio (RR) with 95% CIs	I^2
Diabetes	SSBs	16	411,739	26,884	11y	1.25 (1.16, 1.35)	55%*
Obesity (weight)	SSBs	8	174,252	-	5y	0.12 0.10, 0.14)	70%*
Hypertension	SSBs	10	407,351	115,169	12y	1.16 (1.10,1.23)	68%*
Gout	SSBs	3	154,289	1,761	17y	2.07 (1.40, 3.06)	0%
CV incidence	SSBs	6	94,784	4,856	10y	1.04 (0.97,1.13)	0%
CV mortality	SSBs	4	188,177	10,910	16y	1.22 (1.10, 1.36)	0%



Hierarchy of evidence in evidence based medicine



Effect of fructose on metabolic control in humans:
A series of systematic reviews & meta-analysis of controlled trials (NCT01363791)

Fructose

- Body weight
  Sievenpiper et al. Ann Intern Med 2012;156:291-304
- Fasting lipids
  Sievenpiper et al. Diabetes Care 2009;32:1930-7
  Chiavaroli et al. JAHA 2015;4:e001700
- Blood pressure
  Ha et al. Hypertension 2012;59:787-95
- Uric acid
  Wang et al. J Nutr 2012;142:916-23)
- Glycemic control
  Cozma et al. Diabetes Care 2012;35:1611-20
- Postprandial lipids
  Wang et al. Atherosclerosis 2014;232:125-133
- NAFLD
  Chiu et al. Eur J Clin Nutr. 2014;68:416-423







'Catalytic' fructose & cardiometabolic risk

Sievenpiper et al. Br J Nutr, 2012;108:418-23

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

PSI FOUNDATION

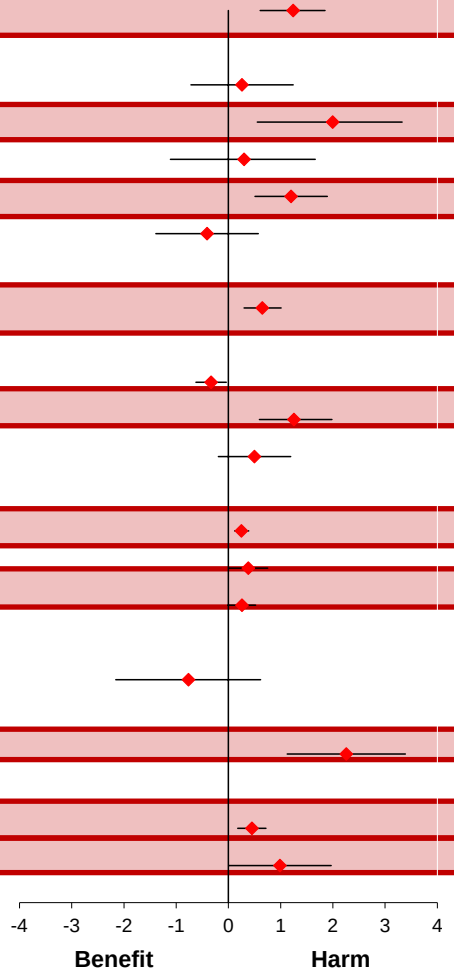
DIABETES CANADA

Calorie Control Council
HEALTHY EATING & EXERCISE FOR LIFE™

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

Harm in ‘ADDITION’ trials:
An effect more attributable to energy (up to +250g/d +50% E)

Cardiometabolic end point		Comparisons	No.	Standardized Mean Difference (SMD) with 95% CI	I^2
Body weight[4]		10	119	1.24 (0.61, 1.85)	30%
Fasting lipids[5]	LDL-C	4	79	0.14 (-0.39, 1.57)	77%*
	Apo-B	2	48	2.00 (0.55, 3.33)	0%
	Non-HDL-C	2	43	0.30 (-1.11, 1.66)	93%*
	TG	8	125	1.20 (0.51, 1.89)	66%*
	HDL-C	4	79	-0.41(-1.39,0.57)	0%
Postprandial TG[6]		2	32	0.65 (0.30, 1.01)	22%
Glycemic control[3]	GBP	2	31	-0.33 (-0.62, -0.04)	0%
	FBG	8	98	1.25 (0.59, 1.98)	59%*
	FBI	8	98	0.50 (-0.19, 1.19)	41%
Insulin sensitivity[3]	Whole body	7	74	0.25 (0.12, 0.39)	0%
	Hepatic	3	31	0.38 (0.01, 0.75)	0%
	HOMA-IR	9	113	0.26 (-0.01, 0.52)	77%*
Blood pressure[7]	MAP	2	24	-0.76 (-2.15, 0.62)	24%
Uric acid[8]		3	35	2.26 (1.13, 3.39)	0%
NAFLD[9]	IHCL	5	60	0.45(0.18, 0.72)	51%*
	ALT	4	59	0.99 (0.01, 1.97)	28%



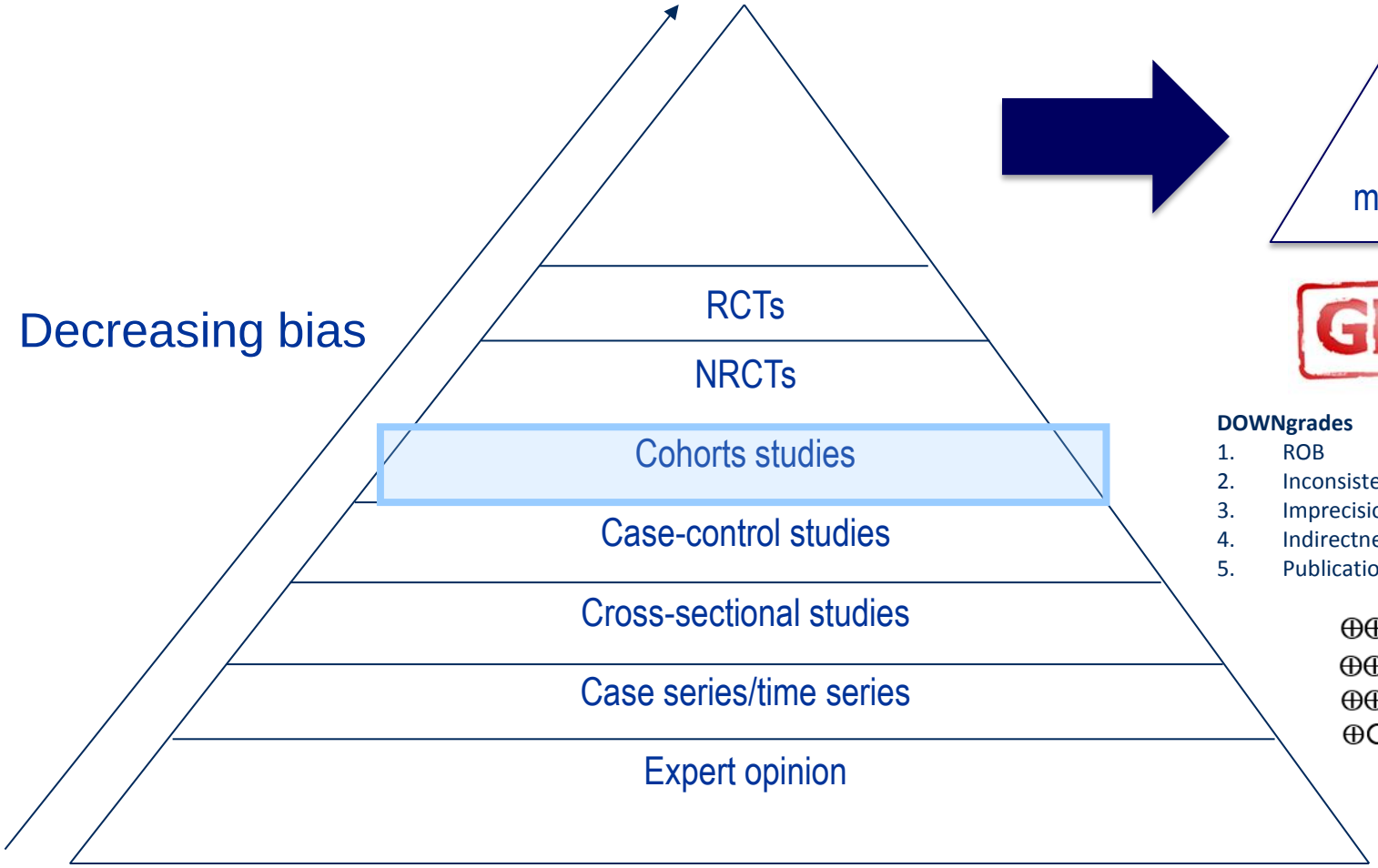
Questions

1. Are **sugars** **in**dependent of **food form** and **energy** linked with cardiometabolic outcomes?

2. What about **sugar Sweetened Beverages (SSBs)?**

3. What about **other important food sources** of **sugars**?

Hierarchy of evidence in evidence based medicine



Systematic Reviews & meta-analyses

GRADE

DOWNgrades

1. ROB
2. Inconsistency
3. Imprecision
4. Indirectness
5. Publication bias

UPgrades

1. Large magnitude of association
2. Dose-response
3. Attenuation by confounding

⊕⊕⊕⊕ **High**
⊕⊕⊕◯ **Moderate**
⊕⊕◯◯ **Low**
⊕◯◯◯ **Very low**

Meta-analyses of important food sources of fructose-containing Sugars & Incident Cardiometabolic Disease (NCT02702375)

Sugars (food)

- Diabetes risk
  - Tsilas et al. CMAJ. 2017;189:E711-E720.
  - Khan et al., unpublished.
- Weight change
  - Blanco Mejia et al., unpublished.
- Hypertension risk
  - Liu et al., submitted
- Gout risk
  - Ayoub Charette et al., submitted
- CVD
  - Au Yeung et al., unpublished.





CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

ASN EST. 1928

PSI FOUNDATION

DIABETES CANADA

UNIVERSITY OF TORONTO FACULTY OF MEDICINE

Meta-analyses of important food sources of fructose-containing Sugars & Incident Cardiometabolic Disease (NCT02702375)

Sugars (food) → Diabetes risk

Tsilas et al. CMAJ. 2017;189:E711-E720.

Khan et al., unpublished.

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

ASN EST. 1928

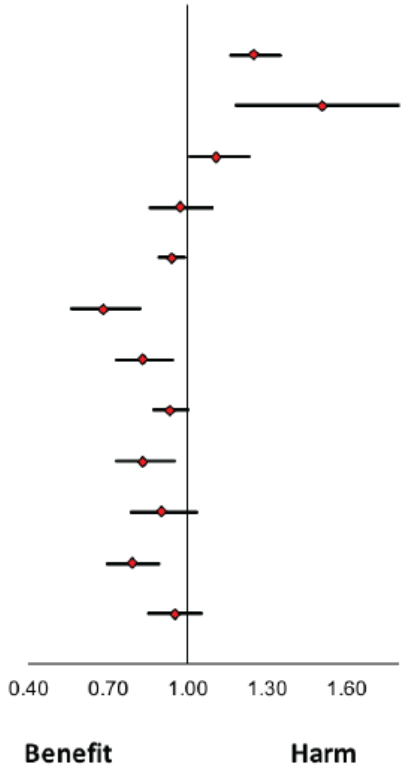
PSI FOUNDATION

DIABETES CANADA

UNIVERSITY OF TORONTO FACULTY OF MEDICINE

Relation of food sources of sugars with diabetes incidence: 84 cohort comparisons, n=3,899,203 (99,668 cases), FU=14y

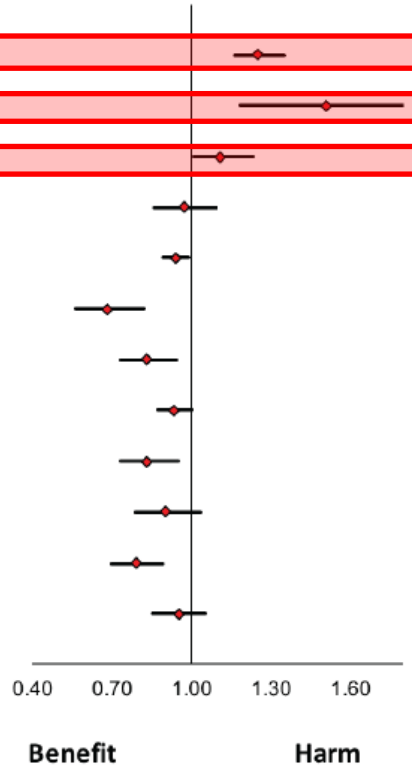
Food source	Cohort comparisons	Cases	Subjects	Risk ratio [95% CIs]	P (Association)	I^2	P (Heterogeneity)
Sugar-sweetened beverages	16	26,884	411,739	1.25 [1.16, 1.35]	<0.0001	55%	0.005
Fruit drinks	3	2,898	67,906	1.51 [1.18, 1.92]	0.001	50%	0.14
Mixed fruit drinks	7	18,959	364,321	1.11 [1.01, 1.23]	0.033	75%	0.001
100% fruit juice	5	13,739	206,899	0.97 [0.86, 1.09]	0.62	0%	0.59
Fruit	21	65,989	1,847,583	0.94 [0.89, 0.99]	0.04	41%	0.038
Whole grain breakfast cereal	4	3,779	237,694	0.68 [0.56, 0.82]	0.016	71%	0.016
Yoghurt	10	6,152	366,208	0.83 [0.73, 0.94]	0.008	58%	0.008
Jams, syrups, honey	4	993	27,847	0.93 [0.87, 1.0]	0.39	0%	0.39
Ice cream	2	1,499	150,477	0.83 [0.73, 0.95]	0.007	0%	0.37
Sherbert	2	1,548	172,015	0.90 [0.79, 1.03]	0.12	0%	0.6
Chocolate	5	1,630	26,737	0.79 [0.70, 0.89]	<0.0001	0%	0.83
Confectionary (biscuits, cakes, desserts)	3	837	23,531	0.95 [0.85, 1.05]	0.62	0%	0.95



Khan et al. Unpublished

Relation of food sources of sugars with diabetes incidence: 84 cohort comparisons, n=3,899,203 (99,668 cases), FU=14y

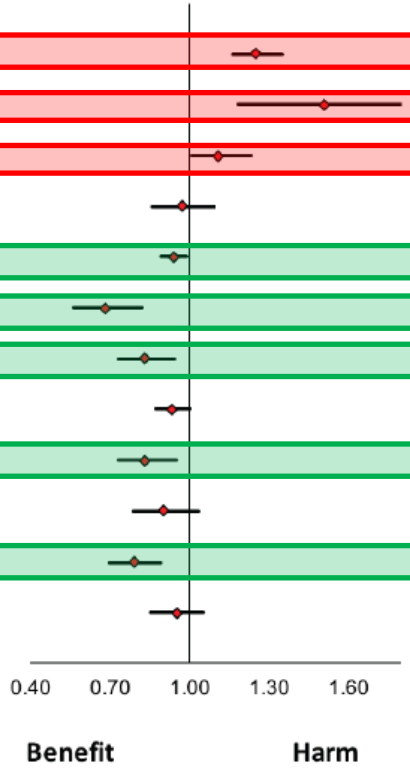
Food source	Cohort comparisons	Cases	Subjects	Risk ratio [95% CIs]	P (Association)	I^2	P (Heterogeneity)
Sugar-sweetened beverages	16	26,884	411,739	1.25 [1.16, 1.35]	<0.0001	55%	0.005
Fruit drinks	3	2,898	67,906	1.51 [1.18, 1.92]	0.001	50%	0.14
Mixed fruit drinks	7	18,959	364,321	1.11 [1.01, 1.23]	0.033	75%	0.001
100% fruit juice	5	13,739	206,899	0.97 [0.86, 1.09]	0.62	0%	0.59
Fruit	21	65,989	1,847,583	0.94 [0.89, 0.99]	0.04	41%	0.038
Whole grain breakfast cereal	4	3,779	237,694	0.68 [0.56, 0.82]	0.016	71%	0.016
Yoghurt	10	6,152	366,208	0.83 [0.73, 0.94]	0.008	58%	0.008
Jams, syrups, honey	4	993	27,847	0.93 [0.87, 1.0]	0.39	0%	0.39
Ice cream	2	1,499	150,477	0.83 [0.73, 0.95]	0.007	0%	0.37
Sherbert	2	1,548	172,015	0.90 [0.79, 1.03]	0.12	0%	0.6
Chocolate	5	1,630	26,737	0.79 [0.70, 0.89]	<0.0001	0%	0.83
Confectionary (biscuits, cakes, desserts)	3	837	23,531	0.95 [0.85, 1.05]	0.62	0%	0.95



Khan et al. Unpublished

Relation of food sources of sugars with diabetes incidence: 84 cohort comparisons, n=3,899,203 (99,668 cases), FU=14y

Food source	Cohort comparisons	Cases	Subjects	Risk ratio [95% CIs]	P (Association)	I^2	P (Heterogeneity)
Sugar-sweetened beverages	16	26,884	411,739	1.25 [1.16, 1.35]	<0.0001	55%	0.005
Fruit drinks	3	2,898	67,906	1.51 [1.18, 1.92]	0.001	50%	0.14
Mixed fruit drinks	7	18,959	364,321	1.11 [1.01, 1.23]	0.033	75%	0.001
100% fruit juice	5	13,739	206,899	0.97 [0.86, 1.09]	0.62	0%	0.59
Fruit	21	65,989	1,847,583	0.94 [0.89, 0.99]	0.04	41%	0.038
Whole grain breakfast cereal	4	3,779	237,694	0.68 [0.56, 0.82]	0.016	71%	0.016
Yoghurt	10	6,152	366,208	0.83 [0.73, 0.94]	0.008	58%	0.008
Jams, syrups, honey	4	993	27,847	0.93 [0.87, 1.0]	0.39	0%	0.39
Ice cream	2	1,499	150,477	0.83 [0.73, 0.95]	0.007	0%	0.37
Sherbert	2	1,548	172,015	0.90 [0.79, 1.03]	0.12	0%	0.6
Chocolate	5	1,630	26,737	0.79 [0.70, 0.89]	<0.0001	0%	0.83
Confectionary (biscuits, cakes, desserts)	3	837	23,531	0.95 [0.85, 1.05]	0.62	0%	0.95



Khan et al. Unpublished

Meta-analyses of important food sources of fructose-containing Sugars & Incident Cardiometabolic Disease (NCT02702375)

Sugars (food)

- Diabetes risk
  - Tsilas et al. CMAJ. 2017;189:E711-E720.
  - Khan et al., unpublished.
- Weight change
  - Blanco Mejia et al., unpublished.
- Hypertension risk
  - Liu et al., submitted
- Gout risk
  - Ayoub Charette et al., submitted
- CVD
  - Au Yeung et al., unpublished.





CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

ASN EST. 1928

PSI FOUNDATION

DIABETES CANADA

UNIVERSITY OF TORONTO FACULTY OF MEDICINE

Meta-analyses of important food sources of fructose-containing Sugars & Incident Cardiometabolic Disease (NCT02702375)

Sugars (food)

CVD

Au Yeung et al., unpublished.

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

ASN EST. 1928

PSI FOUNDATION

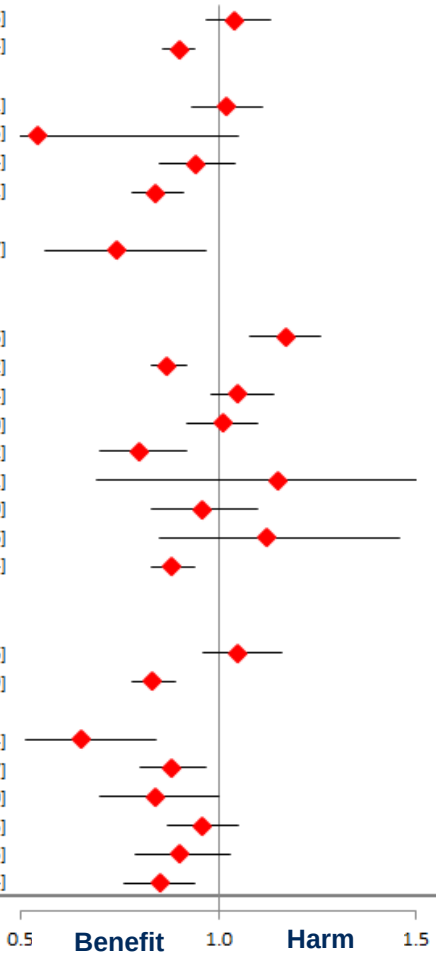
DIABETES CANADA

UNIVERSITY OF TORONTO FACULTY OF MEDICINE

CV Incidence

Relation of food sources of sugars with CV incidence : 134 cohort comparisons, n=5,311,852 (181,925 cases), FU=14y

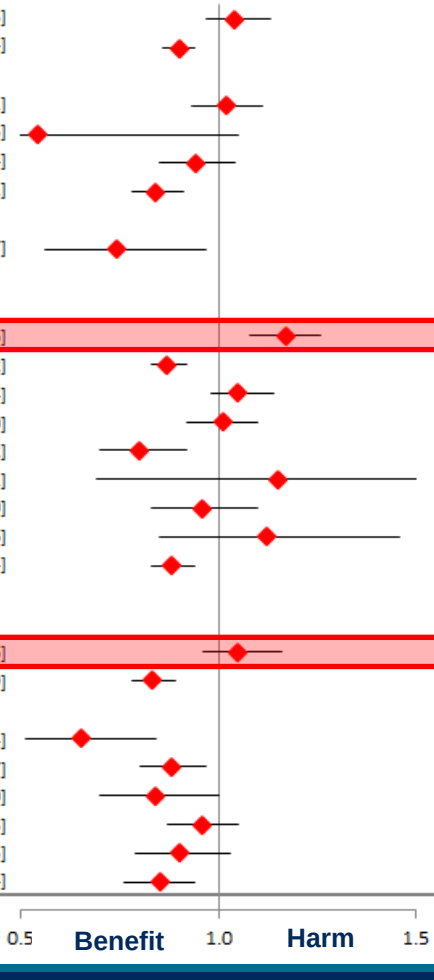
Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	Relative Risk (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD incidence								
Sugar-Sweetened Beverage	6	10.0	4,856	94,784	1.04 [0.97, 1.13]	0%	0.58	●○○○ Very Low
Fruit	14	10.0	22,438	524,940	0.90 [0.86, 0.94]	0%	0.57	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	17.5	4,255	133,319	1.02 [0.93, 1.11]	0%	0.98	●○○○ Very Low
Breakfast Cereal	1	8.0	363	23,531	0.54 [0.28, 1.05]	n/a	-	●○○○ Very Low
Cookies and Cakes	3	12.0	2,883	49,946	0.94 [0.85, 1.04]	7%	0.34	●○○○ Very Low
Yogurt/Sweetened Dairy	3	24.0	7,605	100,575	0.84 [0.78, 0.91]	0%	0.62	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	10.0	2,509	40,308	0.74 [0.56, 0.97]	59%	0.12	●○○○ Very Low
CHD incidence								
Sugar-Sweetened Beverage	6	18.0	9,889	199,942	1.17 [1.08, 1.26]	0%	0.73	●●●○ Moderate
Fruit	20	8.8	19,214	1,147,139	0.87 [0.83, 0.92]	0%	0.53	●●●○ Moderate
Fruit Drink	3	22.0	11,167	153,358	1.05 [0.98, 1.14]	86%	<0.01	●○○○ Very Low
Fruit Juice	5	11.0	10,137	227,927	1.01 [0.92, 1.10]	0%	0.79	●○○○ Very Low
Breakfast Cereal	3	8.6	1,933	153,770	0.80 [0.70, 0.92]	0%	0.84	●○○○ Very Low
Cookies and Cakes	2	12.5	2,924	111,285	1.15 [0.69, 1.91]	81%	0.02	●○○○ Very Low
Yogurt/Sweetened Dairy	8	14.8	6,973	144,731	0.96 [0.83, 1.10]	76%	<0.01	●○○○ Very Low
Ice Cream/Sherbert	2	16.2	451	1,759	1.12 [0.85, 1.46]	0%	0.34	●○○○ Very Low
Chocolate	6	10.7	12,843	283,819	0.88 [0.83, 0.94]	0%	0.46	●●○○ Low
Stroke incidence								
Sugar-Sweetened Beverage	10	14.0	11,026	267,669	1.05 [0.96, 1.16]	25%	0.22	●●○○ Low
Fruit	18	12.8	28,368	958,203	0.83 [0.78, 0.89]	28%	0.13	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	11.0	570	114,279	0.65 [0.51, 0.84]	0%	0.47	●○○○ Very Low
Breakfast Cereal	2	25.0	2,458	114,573	0.88 [0.80, 0.97]	0%	0.57	●○○○ Very Low
Cookies and Cakes	2	14.0	1,176	26,415	0.84 [0.70, 1.00]	0%	0.44	●○○○ Very Low
Yogurt/Sweetened Dairy	7	13.6	10,263	292,091	0.96 [0.87, 1.05]	57%	0.03	●○○○ Very Low
Ice Cream/Sherbert	2	13.8	2,627	112,320	0.90 [0.79, 1.03]	4%	0.31	●○○○ Very Low
Chocolate	5	11.9	6,337	157,219	0.85 [0.76, 0.94]	19%	0.29	●●●○ Moderate



Au Yeung et al. Unpublished

Relation of food sources of sugars with CV incidence : 134 cohort comparisons, n=5,311,852 (181,925 cases), FU=14y

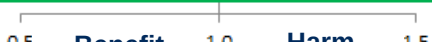
Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	Relative Risk (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD incidence								
Sugar-Sweetened Beverage	6	10.0	4,856	94,784	1.04 [0.97, 1.13]	0%	0.58	●○○○ Very Low
Fruit	14	10.0	22,438	524,940	0.90 [0.86, 0.94]	0%	0.57	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	17.5	4,255	133,319	1.02 [0.93, 1.11]	0%	0.98	●○○○ Very Low
Breakfast Cereal	1	8.0	363	23,531	0.54 [0.28, 1.05]	n/a	-	●○○○ Very Low
Cookies and Cakes	3	12.0	2,883	49,946	0.94 [0.85, 1.04]	7%	0.34	●○○○ Very Low
Yogurt/Sweetened Dairy	3	24.0	7,605	100,575	0.84 [0.78, 0.91]	0%	0.62	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	10.0	2,509	40,308	0.74 [0.56, 0.97]	59%	0.12	●○○○ Very Low
CHD incidence								
Sugar-Sweetened Beverage	6	18.0	9,889	199,942	1.17 [1.08, 1.26]	0%	0.73	●●●○ Moderate
Fruit	20	8.8	19,214	1,147,139	0.87 [0.83, 0.92]	0%	0.53	●●●○ Moderate
Fruit Drink	3	22.0	11,167	153,358	1.05 [0.98, 1.14]	86%	<0.01	●○○○ Very Low
Fruit Juice	5	11.0	10,137	227,927	1.01 [0.92, 1.10]	0%	0.79	●○○○ Very Low
Breakfast Cereal	3	8.6	1,933	153,770	0.80 [0.70, 0.92]	0%	0.84	●○○○ Very Low
Cookies and Cakes	2	12.5	2,924	111,285	1.15 [0.69, 1.91]	81%	0.02	●○○○ Very Low
Yogurt/Sweetened Dairy	8	14.8	6,973	144,731	0.96 [0.83, 1.10]	76%	<0.01	●○○○ Very Low
Ice Cream/Sherbert	2	16.2	451	1,759	1.12 [0.85, 1.46]	0%	0.34	●○○○ Very Low
Chocolate	6	10.7	12,843	283,819	0.88 [0.83, 0.94]	0%	0.46	●●○○ Low
Stroke incidence								
Sugar-Sweetened Beverage	10	14.0	11,026	267,669	1.05 [0.96, 1.16]	25%	0.22	●●○○ Low
Fruit	18	12.8	28,368	958,203	0.83 [0.78, 0.89]	28%	0.13	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	11.0	570	114,279	0.65 [0.51, 0.84]	0%	0.47	●○○○ Very Low
Breakfast Cereal	2	25.0	2,458	114,573	0.88 [0.80, 0.97]	0%	0.57	●○○○ Very Low
Cookies and Cakes	2	14.0	1,176	26,415	0.84 [0.70, 1.00]	0%	0.44	●○○○ Very Low
Yogurt/Sweetened Dairy	7	13.6	10,263	292,091	0.96 [0.87, 1.05]	57%	0.03	●○○○ Very Low
Ice Cream/Sherbert	2	13.8	2,627	112,320	0.90 [0.79, 1.03]	4%	0.31	●○○○ Very Low
Chocolate	5	11.9	6,337	157,219	0.85 [0.76, 0.94]	19%	0.29	●●●○ Moderate



Au Yeung et al. Unpublished

Relation of food sources of sugars with CV incidence : 134 cohort comparisons, n=5,311,852 (181,925 cases), FU=14y

Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	Relative Risk (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD incidence								
Sugar-Sweetened Beverage	6	10.0	4,856	94,784	1.04 [0.97, 1.13]	0%	0.58	●○○○ Very Low
Fruit	14	10.0	22,438	524,940	0.90 [0.86, 0.94]	0%	0.57	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	17.5	4,255	133,319	1.02 [0.93, 1.11]	0%	0.98	●○○○ Very Low
Breakfast Cereal	1	8.0	363	23,531	0.54 [0.28, 1.05]	n/a	-	●○○○ Very Low
Cookies and Cakes	3	12.0	2,883	49,946	0.94 [0.85, 1.04]	7%	0.34	●○○○ Very Low
Yogurt/Sweetened Dairy	3	24.0	7,605	100,575	0.84 [0.78, 0.91]	0%	0.62	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	10.0	2,509	40,308	0.74 [0.56, 0.97]	59%	0.12	●○○○ Very Low
CHD incidence								
Sugar-Sweetened Beverage	6	18.0	9,889	199,942	1.17 [1.08, 1.26]	0%	0.73	●●●○ Moderate
Fruit	20	8.8	19,214	1,147,139	0.87 [0.83, 0.92]	0%	0.53	●●●○ Moderate
Fruit Drink	3	22.0	11,167	153,358	1.05 [0.98, 1.14]	86%	<0.01	●○○○ Very Low
Fruit Juice	5	11.0	10,137	227,927	1.01 [0.92, 1.10]	0%	0.79	●○○○ Very Low
Breakfast Cereal	3	8.6	1,933	153,770	0.80 [0.70, 0.92]	0%	0.84	●○○○ Very Low
Cookies and Cakes	2	12.5	2,924	111,285	1.15 [0.69, 1.91]	81%	0.02	●○○○ Very Low
Yogurt/Sweetened Dairy	8	14.8	6,973	144,731	0.96 [0.83, 1.10]	76%	<0.01	●○○○ Very Low
Ice Cream/Sherbert	2	16.2	451	1,759	1.12 [0.85, 1.46]	0%	0.34	●○○○ Very Low
Chocolate	6	10.7	12,843	283,819	0.88 [0.83, 0.94]	0%	0.46	●●○○ Low
Stroke incidence								
Sugar-Sweetened Beverage	10	14.0	11,026	267,669	1.05 [0.96, 1.16]	25%	0.22	●●○○ Low
Fruit	18	12.8	28,368	958,203	0.83 [0.78, 0.89]	28%	0.13	●●●○ Moderate
Fruit Drink	-				-	-	-	-
Fruit Juice	2	11.0	570	114,279	0.65 [0.51, 0.84]	0%	0.47	●○○○ Very Low
Breakfast Cereal	2	25.0	2,458	114,573	0.88 [0.80, 0.97]	0%	0.57	●○○○ Very Low
Cookies and Cakes	2	14.0	1,176	26,415	0.84 [0.70, 1.00]	0%	0.44	●○○○ Very Low
Yogurt/Sweetened Dairy	7	13.6	10,263	292,091	0.96 [0.87, 1.05]	57%	0.03	●○○○ Very Low
Ice Cream/Sherbert	2	13.8	2,627	112,320	0.90 [0.79, 1.03]	4%	0.31	●○○○ Very Low
Chocolate	5	11.9	6,337	157,219	0.85 [0.76, 0.94]	19%	0.29	●●●○ Moderate

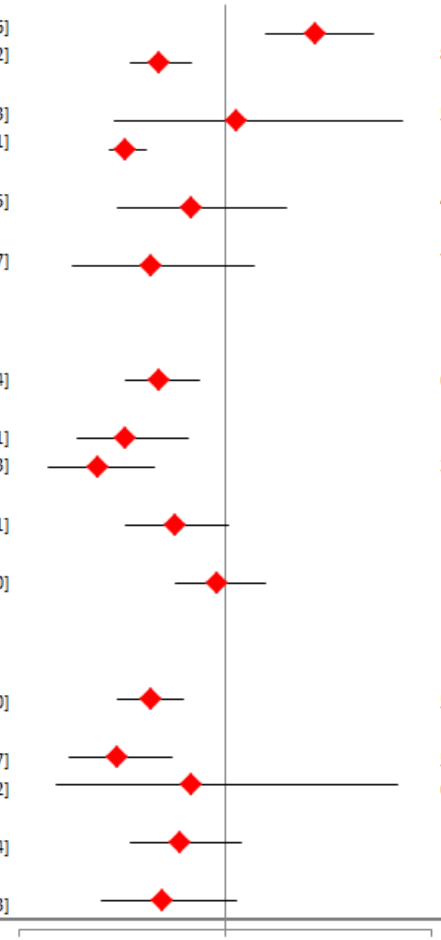


Au Yeung et al. Unpublished

CV mortality

Relation of food sources of sugars with CV mortality: 100 cohort comparisons, n=6,019,085 (93,261 cases), FU=14y

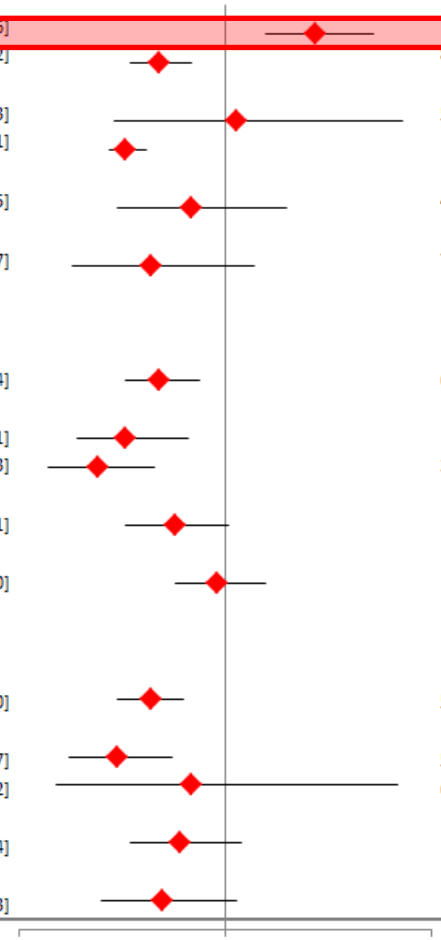
Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	RR (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD mortality								
Sugar-Sweetened Beverages	4	15.5	10,910	188,177	1.22 [1.10, 1.36]	0%	0.42	●●●○ Moderate
Fruit	22	11.2	25,965	1,435,451	0.84 [0.77, 0.92]	80%	<0.001	●●○○ Low
Fruit Drinks	-				-	-	-	-
Fruit Juices	2	16.5	3,391	83,042	1.03 [0.73, 1.43]	51%	0.15	●○○○ Very Low
Breakfast Cereals	2	9.8	12,664	453,632	0.76 [0.72, 0.81]	0%	0.62	●●○○ Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	3	14.4	2,254	78,341	0.92 [0.74, 1.15]	46%	0.16	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	14.0	3,121	55,443	0.82 [0.63, 1.07]	77%	0.04	●○○○ Very Low
CHD mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	23	14.0	14,160	1,338,743	0.84 [0.76, 0.94]	68%	<0.001	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	3	12.8	1,085	128,270	0.76 [0.64, 0.91]	0%	0.11	●●○○ Low
Breakfast Cereals	3	12.4	1,633	205,708	0.69 [0.57, 0.83]	25%	0.26	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,248	175,613	0.88 [0.76, 1.01]	0%	0.46	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	1,329	34,492	0.98 [0.88, 1.10]	n/a	-	●○○○ Very Low
Stroke mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	17	16.0	8,109	1,263,598	0.82 [0.74, 0.90]	51%	0.008	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	4	14.4	2,705	162,762	0.74 [0.62, 0.87]	53%	0.09	●●○○ Low
Breakfast Cereals	3	12.4	426	205,708	0.92 [0.59, 1.42]	60%	0.08	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,792	175,613	0.89 [0.77, 1.04]	0%	0.89	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	469	34,492	0.85 [0.70, 1.03]	n/a	-	●○○○ Very Low



Au Yeung et al. Unpublished

Relation of food sources of sugars with CV mortality: 100 cohort comparisons, n=6,019,085 (93,261 cases), FU=14y

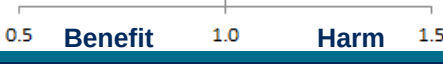
Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	RR (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD mortality								
Sugar-Sweetened Beverages	4	15.5	10,910	188,177	1.22 [1.10, 1.36]	0%	0.42	●●●○ Moderate
Fruit	22	11.2	25,965	1,435,451	0.84 [0.77, 0.92]	80%	<0.001	●●○○ Low
Fruit Drinks	-				-	-	-	-
Fruit Juices	2	16.5	3,391	83,042	1.03 [0.73, 1.43]	51%	0.15	●○○○ Very Low
Breakfast Cereals	2	9.8	12,664	453,632	0.76 [0.72, 0.81]	0%	0.62	●●○○ Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	3	14.4	2,254	78,341	0.92 [0.74, 1.15]	46%	0.16	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	14.0	3,121	55,443	0.82 [0.63, 1.07]	77%	0.04	●○○○ Very Low
CHD mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	23	14.0	14,160	1,338,743	0.84 [0.76, 0.94]	68%	<0.001	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	3	12.8	1,085	128,270	0.76 [0.64, 0.91]	0%	0.11	●●○○ Low
Breakfast Cereals	3	12.4	1,633	205,708	0.69 [0.57, 0.83]	25%	0.26	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,248	175,613	0.88 [0.76, 1.01]	0%	0.46	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	1,329	34,492	0.98 [0.88, 1.10]	n/a	-	●○○○ Very Low
Stroke mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	17	16.0	8,109	1,263,598	0.82 [0.74, 0.90]	51%	0.008	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	4	14.4	2,705	162,762	0.74 [0.62, 0.87]	53%	0.09	●●○○ Low
Breakfast Cereals	3	12.4	426	205,708	0.92 [0.59, 1.42]	60%	0.08	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,792	175,613	0.89 [0.77, 1.04]	0%	0.89	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	469	34,492	0.85 [0.70, 1.03]	n/a	-	●○○○ Very Low



Au Yeung et al. Unpublished

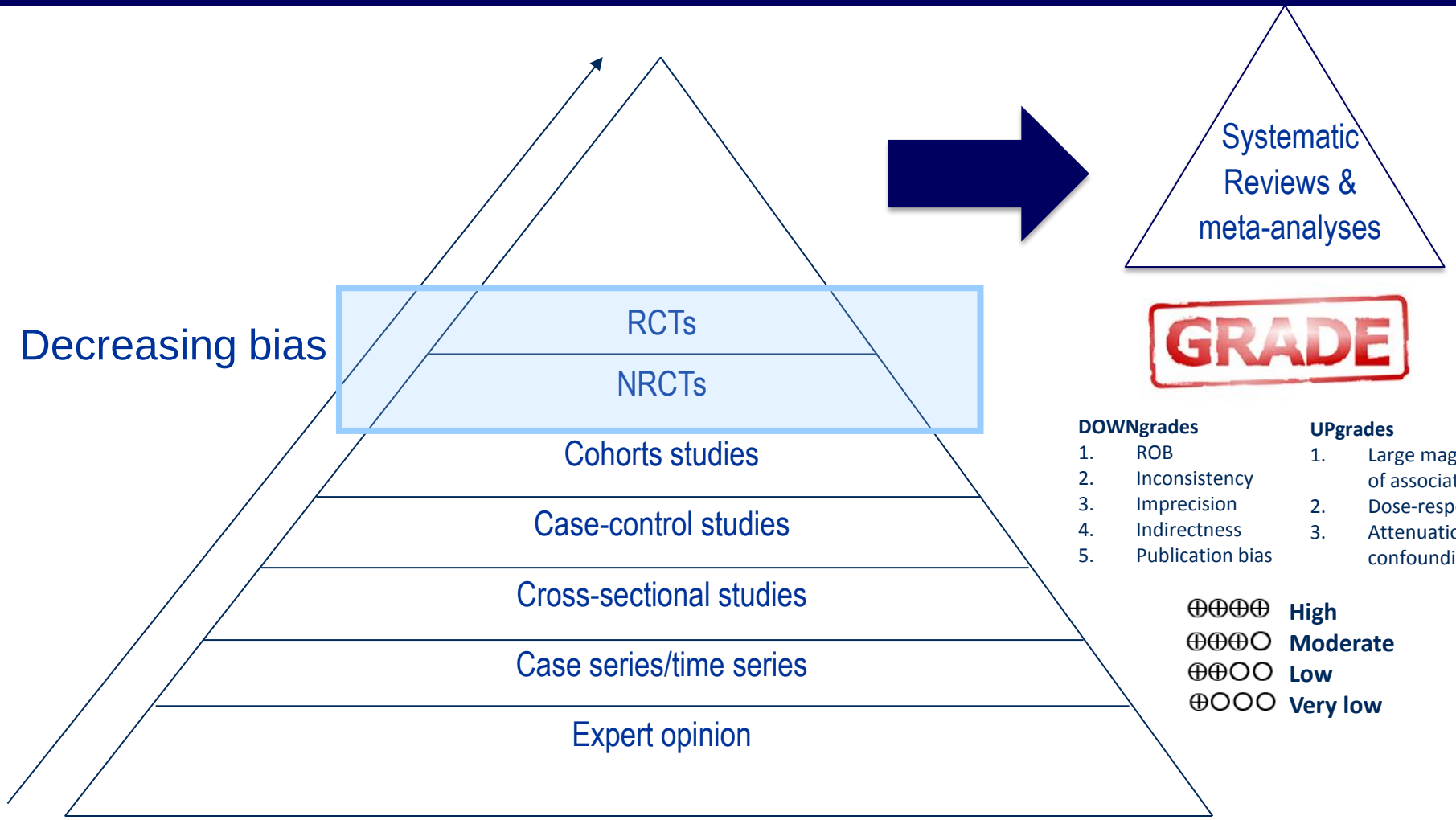
Relation of food sources of sugars with CV mortality: 100 cohort comparisons, n=6,019,085 (93,261 cases), FU=14y

Outcome and Food Source	Cohort Comparisons	Follow up (yrs)	Events	N	RR (95% CIs)	I^2	P-value I^2	GRADE Assessment
CVD mortality								
Sugar-Sweetened Beverages	4	15.5	10,910	188,177	1.22 [1.10, 1.36]	0%	0.42	●●●○ Moderate
Fruit	22	11.2	25,965	1,435,451	0.84 [0.77, 0.92]	80%	<0.001	●●○○ Low
Fruit Drinks	-				-	-	-	-
Fruit Juices	2	16.5	3,391	83,042	1.03 [0.73, 1.43]	51%	0.15	●○○○ Very Low
Breakfast Cereals	2	9.8	12,664	453,632	0.76 [0.72, 0.81]	0%	0.62	●●○○ Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	3	14.4	2,254	78,341	0.92 [0.74, 1.15]	46%	0.16	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	2	14.0	3,121	55,443	0.82 [0.63, 1.07]	77%	0.04	●○○○ Very Low
CHD mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	23	14.0	14,160	1,338,743	0.84 [0.76, 0.94]	68%	<0.001	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	3	12.8	1,085	128,270	0.76 [0.64, 0.91]	0%	0.11	●●○○ Low
Breakfast Cereals	3	12.4	1,633	205,708	0.69 [0.57, 0.83]	25%	0.26	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,248	175,613	0.88 [0.76, 1.01]	0%	0.46	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	1,329	34,492	0.98 [0.88, 1.10]	n/a	-	●○○○ Very Low
Stroke mortality								
Sugar-Sweetened Beverages	-				-	-	-	-
Fruit	17	16.0	8,109	1,263,598	0.82 [0.74, 0.90]	51%	0.008	●●●○ Moderate
Fruit Drinks	-				-	-	-	-
Fruit Juices	4	14.4	2,705	162,762	0.74 [0.62, 0.87]	53%	0.09	●●○○ Low
Breakfast Cereals	3	12.4	426	205,708	0.92 [0.59, 1.42]	60%	0.08	●○○○ Very Low
Cookies and Cakes	-				-	-	-	-
Yogurts/Sweetened Dairy	5	12.8	2,792	175,613	0.89 [0.77, 1.04]	0%	0.89	●○○○ Very Low
Ice Cream/Sherbert	-				-	-	-	-
Chocolate	1	16.0	469	34,492	0.85 [0.70, 1.03]	n/a	-	●○○○ Very Low



Au Yeung et al. Unpublished

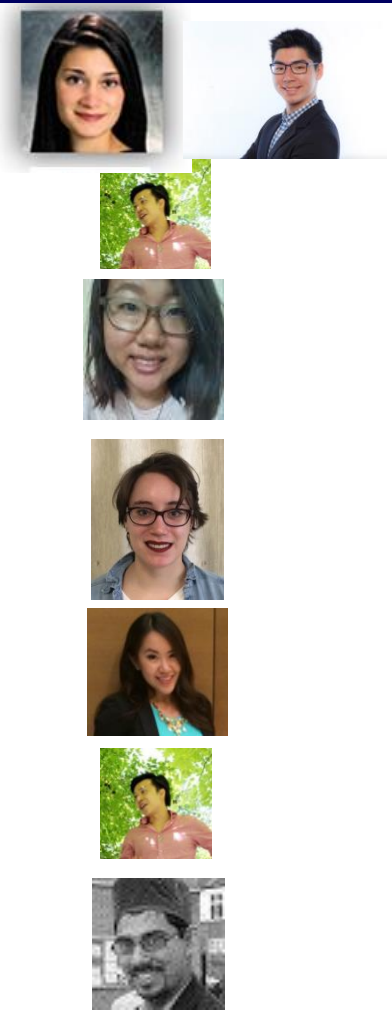
Hierarchy of evidence in evidence based medicine



Food sources of sugars & cardiometabolic risk factors:
A series of systematic reviews & meta-analyses of controlled trials (NCT02716870)

Sugars (food)

- **Body weight** — Chiavaoli et al., unpublished.
- **Fasting lipids** — Au Yeung et al., unpublished.
- **Blood pressure** — Liu et al., unpublished
- **Uric acid** — Ayoub Charette et al., unpublished
- **Glycemic control** — Choo et al., submitted
- **Postprandial lipids** — Au Yeung et al., unpublished.
- **NAFLD** — Au Yeung et al., unpublished.



DIABETES CANADA

PSI FOUNDATION

ASN EST. 1928

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

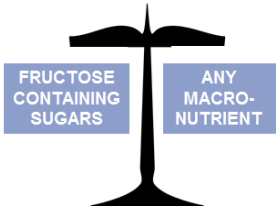
4 trial designs:
To interpret results, follow the energy…

"Substitution trials" = Energy from sugars substituted for other sources of energy in the diet

"Addition trials" = Energy from sugars "added" to the diet

"Subtraction trials" = Energy from sugars "subtracted" from the diet

***"Ad libitum* trials"** = Energy from sugars is freely replaced with other macronutrients



Food sources of sugars & cardiometabolic risk factors:

Summary of 7 SRMAs of >500 trial comparisons, (n>10,000), FU=1-52wk

Cardiometabolic outcome	Substitution 	Addition 	Subtraction 	*Ad libitum* 
Body weight	Fruit↓	SSBs↑ Fruit juice↑ Mixed↑ Fruit ↓	Candy↓	
Fasting lipids		SSBs↑		
Postprandial lipids		SSBs↑		
Blood pressure	Dried fruit↓		SSBs↓	
Glycemic control	Fruit↓ Fruit juice ↓ Sweetened-milk↑	SSBs↑ Fruit juice↑ Mixed↑		Mixed↑
Uric acid	SSBs↑	SSBs↑ Fruit ↓ Fruit drink↓	Mixed↓	
NAFLD		SSBs↑		

Unintended Consequences

Low fat paradigm revisited:
Low fat does not necessarily equal low calories

Low fat paradigm revisited: Can one select a healthy diet by sugar alone?

Serving size: 28g
Calories: 110kcal
Sugars: 3g
Fibre: 1g
GI: 95

Kellogg's
Corn Flakes®

Nutrition Facts
Serving Size 1 Cup (28g)

Amount Per Serving	Cereal	with ½ cup skim milk
Calories	100	140
Calories from Fat	0	0
	% Daily Value**	
Total Fat 0g*	**0%**	**0%**
Saturated Fat 0g	**0%**	**0%**
Trans Fat 0g		
Polyunsaturated Fat 0g		
Monounsaturated Fat 0g		
Cholesterol 0mg	**0%**	**0%**
Sodium 200mg	**8%**	**11%**
Potassium 45mg	**1%**	**7%**
Total Carbohydrate 24g	**8%**	**10%**
Dietary Fiber 1g	**4%**	**4%**
Sugars 3g		
Protein 2g		
Vitamin A	10%	15%
Vitamin C	10%	10%
Calcium	0%	15%
Iron	45%	45%
Vitamin D	10%	25%
Thiamin	25%	30%
Riboflavin	25%	35%
Niacin	25%	25%
Vitamin B_6	25%	25%
Folic Acid	25%	25%
Vitamin B_{12}	25%	35%

* Amount in cereal. One half cup of skim milk contributes an additional 40 calories, 65mg sodium, 6g total carbohydrates (6g sugars), and 4g protein.

** Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat. Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Serving size: 30g
Calories: 80kcal
Sugars: 8g
Fibre: 13g
GI: 47

Kellogg's®
All-Bran®
Bran Buds®

Nutrition Facts
Serving Size 1/3 Cup (30g)

Amount Per Serving	Cereal	with ½ cup skim milk
Calories	80	120
Calories from Fat	10	10
	% Daily Value**	
Total Fat 1g*	**2%**	**2%**
Saturated Fat 0g	**0%**	**0%**
Trans Fat 0g		
Polyunsaturated Fat 0g		
Monounsaturated Fat 0g		
Cholesterol 0mg	**0%**	**0%**
Sodium 210mg	**9%**	**11%**
Total Carbohydrate 24g	**8%**	**10%**
Dietary Fiber 13g	**51%**	**51%**
Soluble Fiber 3g		
Insoluble Fiber 9g		
Sugars 8g		
Protein 3g		
Vitamin A	10%	15%
Vitamin C	10%	10%
Calcium	0%	15%
Iron	25%	25%
Vitamin D	10%	25%
Thiamin	25%	30%
Riboflavin	25%	35%
Niacin	25%	25%
Vitamin B_6	100%	100%
Folic Acid	100%	100%
Vitamin B_{12}	100%	110%
Phosphorus	15%	25%
Magnesium	15%	20%
Zinc	10%	15%

* Amount in cereal. One half cup of skim milk contributes an additional 40 calories, 65mg sodium, 6g total carbohydrates (6g sugars), and 4g protein.

** Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat. Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Atkinson FS et al. International Tables of Glycemic Index and Glycemic Load Values: 2008. Diabetes Care 2008 Dec; 31(12): 2281-2283.

Global burden of disease attributable to 79 risk factors: *Global Burden of Disease Study* 2015

In North America and **Canada**, only 1 of 14 dietary risk factors is in the top 10 leading risk factors for disability-adjusted-life-years (DALYs): **Whole grains**

	1	2	3	4	5	6	7	8	9	10
Global	Blood pressure	Smoking	Fasting plasma glucose	Body-mass index	Childhood U	Particulate matter	Total cholesterol	Household air pollution	Alcohol use	Sodium
High-income North America	Smoking	Body-mass index	Fasting plasma glucose	Blood pressure	Total cholesterol	Drug use	Alcohol use	Glomerular filtration	Physical activity	Whole grains
Canada	Smoking	Body-mass index	Blood pressure	Fasting plasma glucose	Total cholesterol	Drug use	Alcohol use	Glomerular filtration	Physical activity	Whole grains

Table. % DALYs attributable to 14 dietary risk factors in Canada

Dietary Risk Factors	% DALYs
1. Low whole Grains	2.1%
2. Low Fruit	2.0%
3. Low Nuts & Seeds	1.9%
4. Low Vegetables	1.6%
5. High Sodium	1.6%
6. High Processed Meat	1.0%
7. Low omega-3	0.9%
8. Low Fibre	0.5%
9. Low PUFA	0.5%
10. High TFA	0.5%
11. Low Milk	0.3%
12. High Red Meat	0.3%
13. Low Calcium	0.3%
14. High SSBs	0.2%

*"Much of the diet **policy debate** has focused on the importance of reductions of **sodium, sugar, and fat**.85,86. Our assessment of the burden from diseases attributable to **14 dietary factors** showed that, at the global scale, six factors each accounted for **more than 1%** of global DALYs, in order of importance: **diets high in sodium, low in vegetables, low in fruit, low in whole grains, low in nuts and seeds**.... If our findings are correct, **a policy focus on the sugar and fat components of diets** might have a **comparatively smaller effect than that of promotion of increased uptake of vegetables, fruit, whole grains, nuts and seeds**...."*

GBD 2015 Risk Factors Collaborators. Lancet 2016; 388: 1659–724

The path forward

Paradigm shift:
"Macronutrient-based" to "food- and dietary pattern-based" recommendations

Can J Diabetes 37 (2013) 51–57

Contents lists available at SciVerse ScienceDirect

Canadian Journal of Diabetes

journal homepage: www.canadianjournalofdiabetes.com

Review

Food and Dietary Pattern-Based Recommendations: An Emerging Approach to Clinical Practice Guidelines for Nutrition Therapy in Diabetes

John L. Sievenpiper MD, PhD[a,b,*], Paula DN. Dworatzek PhD, RD[c]

[a] Department of Pathology and Molecular Medicine, Faculty of Health Sciences, McMaster University, Hamilton, Ontario, Canada
[b] Toronto 3D Knowledge Synthesis and Clinical Trials Unit, Clinical Nutrition and Risk Factor Modification Centre, St. Michael's Hospital, Toronto, Ontario, Canada
[c] Division of Food and Nutritional Sciences, Brescia University College at Western University, London, Ontario, Canada

ARTICLE INFO

Article history:
Received 19 August 2012
Received in revised form
16 November 2012
Accepted 30 November 2012

Keywords:
clinical practice guidelines
diabetes
dietary patterns
food
medical nutrition therapy

ABSTRACT

Clinical practice guidelines (CPGs) for the nutritional management of diabetes mellitus have evolved considerably over the last 25 years. As major diabetes associations have focussed on the individualization of nutrition therapy, there has been a move toward a broader more flexible macronutrient distribution that emphasizes macronutrient quality over quantity. There is now a call for the integration of food- and dietary pattern-based approaches into diabetes association CPGs. The main argument has been that an approach that focuses on nutrients alone misses important nutrient interactions oversimplifying the complexity of foods and dietary patterns, both of which have been shown to have a stronger influence on disease risk than nutrients alone. Although cancer and heart associations have begun to integrate this approach into their dietary guidelines, diabetes associations have not yet adopted this approach. We provide a rationale for the adoption of this approach for The Canadian Diabetes Association (CDA) 2013 CPGs for nutrition therapy. The systematic review for the development of these guidelines revealed emerging evidence to support the use of vegetarian, Mediterranean, and Dietary Approaches to Stop Hypertension (DASH) dietary patterns as well as specific foods such as dietary pulses and nuts in people with diabetes. Popular and conventional weight loss diets were also found to have similar advantages in people with diabetes, although poor dietary adherence remains an issue with these diets. The CDA 2013 CPGs will support an even greater individualization of nutrition therapy for people with diabetes and appeal to a broader range of practice styles of health professionals.

© 2013 Canadian Diabetes Association

RÉSUMÉ

Mots clés:
lignes directrices de pratique clinique
diabète
régimes alimentaires
aliment
thérapie nutritionnelle médicale

Les lignes directrices de pratique clinique (LDPC) pour la prise en charge nutritionnelle du diabète sucré ont considérablement évolué au cours des 25 dernières années. Alors que les principales associations de diabète ont mis l'accent sur l'individualisation de la thérapie nutritionnelle, on a assisté à une tendance vers une plus grande et plus souple distribution des macronutriments qui met en évidence la qualité macronutritionnelle par rapport à la quantité. Un appel à l'intégration des approches fondées sur les types d'alimentation et les régimes alimentaires aux LDPC de l'association de diabète est maintenant lancé. Le principal argument a été qu'une approche qui met l'accent sur les nutriments seuls omet les importantes interactions nutritionnelles en simplifiant trop la complexité des types d'alimentation et des régimes alimentaires, qui ont tous deux démontré une plus forte influence sur le risque de maladie que les nutriments seuls. Bien que les associations du cancer et des maladies du cœur aient commencé à intégrer cette approche à leurs lignes directrices sur l'alimentation, les associations de diabète n'ont pas encore adopté cette approche. Nous justifions l'adoption de cette approche sur la thérapie nutritionnelle lors de la mise à jour des LDPC 2013 de l'Association canadienne de diabète (ACD). La revue systématique de l'élaboration de ces lignes directrices a révélé des données scientifiques émergentes en mesure d'appuyer l'utilisation des régimes alimentaires végétarien, méditerranéen et DASH aussi bien que des aliments spécifiques comme les légumineuses et les noix chez les personnes ayant le diabète. Les régimes amaigrissants populaires et courants ont également présenté des avantages similaires chez les personnes

* Address for correspondence: John L. Sievenpiper, Toronto 3D Knowledge Synthesis and Clinical Trials Unit, Clinical Nutrition and Risk Factor Modification Centre, St. Michael's Hospital, 6137-61 Queen Street East, Toronto, Ontario, Canada, M5C 2T2.
E-mail address: john.sievenpiper@utoronto.ca (J.L. Sievenpiper).

1499-2671/$ – see front matter © 2013 Canadian Diabetes Association
http://dx.doi.org/10.1016/j.jcjd.2012.11.001

Sievenpiper, Dworatzek. Can J Diabetes 2013;37:S1-S7

Can J Diabetes 37 (2013) S45–S55

Contents lists available at SciVerse ScienceDirect

Canadian Journal of Diabetes

journal homepage: www.canadianjournalofdiabetes.com

Clinical Practice Guidelines

Nutrition Therapy

Canadian Diabetes Association Clinical Practice Guidelines Expert Committee

The initial draft of this chapter was prepared by Paula D. Dworatzek PhD, RD, Kathryn Arcudi PDt, CDE, Réjeanne Gougeon PhD, Nadira Husein MD, FRCPC, John L. Sievenpiper MD, PhD, Sandra L. Williams MEd, RD, CDE

KEY MESSAGES

- People with diabetes should receive nutrition counselling by a registered dietitian.
- Nutrition therapy can reduce glycated hemoglobin (A1C) by 1.0% to 2.0% and, when used with other components of diabetes care, can further improve clinical and metabolic outcomes.
- Reduced caloric intake to achieve and maintain a healthier body weight should be a treatment goal for people with diabetes who are overweight or obese.
- The macronutrient distribution is flexible within recommended ranges and will depend on individual treatment goals and preferences.
- Replacing high glycemic index carbohydrates with low glycemic index carbohydrates in mixed meals has a clinically significant benefit for glycemic control in people with type 1 and type 2 diabetes.
- Intensive lifestyle interventions in people with type 2 diabetes can produce improvements in weight management, fitness, glycemic control and cardiovascular risk factors.
- A variety of dietary patterns and specific foods have been shown to be of benefit in people with type 2 diabetes.
- Consistency in carbohydrate intake and in spacing and regularity in meal consumption may help control blood glucose and weight.

Introduction

Nutrition therapy and counselling are an integral part of the treatment and self-management of diabetes. The goals of nutrition therapy are to maintain or improve quality of life and nutritional and physiological health; and to prevent and treat acute and long-term complications of diabetes, associated comorbid conditions and concomitant disorders.

It is well documented that nutrition therapy can improve glycemic control (1) by reducing glycated hemoglobin (A1C) by 1.0% to 2.0% (2–5) and, when used with other components of diabetes care, can further improve clinical and metabolic outcomes (3,4,6,7), resulting in reduced hospitalization rates (8). Furthermore, frequent follow-up (i.e. every 3 months) with a registered dietitian (RD) has been associated with better dietary adherence in type 2 diabetes (7).

Nutrition therapy provided by an RD with expertise in diabetes management (9,10), delivered in either a small group and/or an individual setting (11–13), has demonstrated benefits for those with, or at risk for, diabetes. Individual counselling may be preferable for people of lower socioeconomic status (8), while group education has been shown to be more effective than individual counselling when it incorporates principles of adult education, including hands-on activities, problem solving, role playing and group discussions (14). Additionally, in people with type 2 diabetes, culturally sensitive peer education has been shown to improve A1C, nutrition knowledge and diabetes self-management (15), and web-based care management has been shown to improve glycemic control (16). Diabetes education programs serving vulnerable populations should evaluate the presence of barriers to healthy eating (e.g. cost of healthy food, stress-related overeating) (17) and work toward solutions to facilitate behaviour change.

In general, people with diabetes should follow the healthy diet recommended for the general population in *Eating Well with Canada's Food Guide* (18). This involves consuming a variety of foods from the 4 food groups (vegetables and fruits; grain products; milk and alternatives; meat and alternatives), with an emphasis on foods that are low in energy density and high in volume to optimize satiety and discourage overconsumption. This diet may help a person attain and maintain a healthy body weight while ensuring an adequate intake of carbohydrate (CHO), fibre, fat and essential fatty acids, protein, vitamins and minerals.

Overall, nutrition counselling should be individualized, regularly evaluated and reinforced in an intensive manner (19–21), and incorporate self-management education (22). As evidence is limited for the rigid adherence to any single dietary prescription (23,24), nutrition therapy and meal planning should be individualized to accommodate the individual's age, type and duration of diabetes, concurrent medical therapies, treatment goals, values, preferences, needs, culture, lifestyle, economic status (25), activity level, readiness to change and abilities. Applying the evidence from the sections that follow, Figure 1 and Table 1 present an algorithm which allows for this level of individualization of therapy in an evidence-based framework.

Energy

As an estimated 80% to 90% of people with type 2 diabetes are overweight or obese, strategies that include energy restriction to achieve weight loss are a primary consideration (26). A modest weight loss of 5% to 10% of initial body weight can substantially improve insulin sensitivity, glycemic control, hypertension and

1499-2671/$ – see front matter © 2013 Canadian Diabetes Association
http://dx.doi.org/10.1016/j.jcjd.2013.01.010

Dworatzek et al. Can J Diabetes 2013;37:S45eS5

Can J Diabetes 42 (2018) S64–S79

Contents lists available at ScienceDirect

Canadian Journal of Diabetes

journal homepage: www.canadianjournalofdiabetes.com

DIABETES CANADA

2018 Clinical Practice Guidelines

Nutrition Therapy

Diabetes Canada Clinical Practice Guidelines Expert Committee

John L. Sievenpiper MD, PhD, FRCPC, Catherine B. Chan PhD, Paula D. Dworatzek PhD, RD, Catherine Freeze MEd, RD, CDE, Sandra L. Williams MEd, RD, CDE

KEY MESSAGES

- People with diabetes should receive nutrition counselling by a registered dietitian.
- Nutrition therapy can reduce glycated hemoglobin (A1C) by 1.0% to 2.0% and, when used with other components of diabetes care, can further improve clinical and metabolic outcomes.
- Reduced caloric intake to achieve and maintain a healthier body weight should be a treatment goal for people with diabetes with overweight or obesity.
- The macronutrient distribution is flexible within recommended ranges and will depend on individual treatment goals and preferences.
- Replacing high-glycemic-index carbohydrates with low-glycemic-index carbohydrates in mixed meals has a clinically significant benefit for glycemic control in people with type 1 and type 2 diabetes.
- Consistency in spacing and intake of carbohydrate intake and in spacing and regularity in meal consumption may help control blood glucose and weight.
- Intensive healthy behaviour interventions in people with type 2 diabetes can produce improvements in weight management, fitness, glycemic control and cardiovascular risk factors.
- A variety of dietary patterns and specific foods have been shown to be of benefit in people with type 1 and type 2 diabetes.
- People with diabetes should be encouraged to choose the dietary pattern that best aligns with their values, preferences and treatment goals, allowing them to achieve the greatest adherence over the long term.

KEY MESSAGES FOR PEOPLE WITH DIABETES

- It is natural to have questions about what food to eat. A registered dietitian can help you develop a personalized meal plan that considers your culture and nutritional preferences to help you achieve your blood glucose and weight management goals.
- Food is key in the management of diabetes and reducing the risk of heart attack and stroke.
- Try to prepare more of your meals at home and use fresh unprocessed ingredients.
- Try to prepare meals and eat together as a family. This is a good way to model healthy food behaviours to children and teenagers, which could help reduce their risk of becoming overweight or developing diabetes.
- With prediabetes and recently diagnosed type 2 diabetes, weight loss is the most important and effective dietary strategy if you have overweight or obesity. A weight loss of 5% to 10% of your body weight may help normalize blood glucose levels.
- There are many strategies that can help with weight loss. The best strategy is one that you are able to maintain long term.
- Adoption of diabetes-friendly eating habits can help manage your blood glucose levels as well as reduce your risk for developing heart and blood vessel disease for those with either type 1 or type 2 diabetes.
  - Select whole and less refined foods instead of processed foods, such as sugar-sweetened beverages, fast foods and refined grain products.
  - Pay attention to both carbohydrate quality and quantity.
  - Include low-glycemic-index foods, such as legumes, whole grains, and fruit and vegetables. These foods can help control blood glucose and cholesterol levels.
  - Consider learning how to count carbohydrates as the quantity of carbohydrate eaten at one time is usually important in managing diabetes.
  - Select unsaturated oils and nuts as the preferred dietary fats.
  - Choose lean animal proteins. Select more vegetable proteins.
  - The style of eating that works well for diabetes may be described as a Mediterranean style diet, Nordic style diet, DASH diet or vegetarian style diet. All of these diets are rich in protective foods and have been shown to help manage diabetes and cardiovascular disease. They all contain the key elements of a diabetes-friendly diet.

Introduction

Nutrition therapy and counselling are an integral part of the treatment and self-management of diabetes. The goals of nutrition therapy are to maintain or improve quality of life and nutritional and physiological health; and to prevent and treat acute- and long-term complications of diabetes, associated comorbid conditions and concomitant disorders. It is well documented that nutrition therapy can improve glycemic control (1) by reducing glycated hemoglobin (A1C) by 1.0% to 2.0% (2–5) and, when used with other components of diabetes care, can further improve clinical and metabolic outcomes (3,4,6,7), resulting in reduced hospitalization rates (8).

Ethnocultural Diversity

Canada is a country rich in ethnocultural diversity. More than 200 ethnic origins were reported in Canada in the 2011 census. The most common ethnic origins with populations in excess of 1 million from highest to lowest include Canadian, English, French, Scottish, Irish, German, Italian, Chinese, Aboriginal, Ukrainian, East Indian, Dutch and Polish. The largest visible minorities include South Asians, Chinese and Blacks, followed by Filipinos, Latin Americans, Arabs, Southeast Asians, West Asians, Koreans and Japanese (9). These different ethnocultural groups have distinct and shared foods, food preparation techniques, dining habits, dietary patterns, and lifestyles that directly impact the delivery of nutrition therapy. A

Conflict of interest statements can be found on page S74.

1499-2671 © 2018 Canadian Diabetes Association.
The Canadian Diabetes Association is the registered owner of the name Diabetes Canada.
https://doi.org/10.1016/j.jcjd.2017.10.006

Sievenpiper et al. Can J Diabetes 2018;42:s64-s79

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

DIABETES CANADA
CLINICAL PRACTICE GUIDELINES

Diabetes Canada:

2018 Clinical Practice Guidelines for Nutrition Therapy

2018 Clinical Practice Guidelines

Nutrition Therapy

Diabetes Canada Clinical Practice Guidelines Expert Committee

John L. Sievenpiper MD, PhD, FRCPC, Catherine B. Chan PhD, Paula D. Dworatzek PhD, RD, Catherine Freeze MEd, RD, CDE, Sandra L. Williams MEd, RD, CDE

Clinical assessment
Healthy behaviour interventions by Registered Dietitian

↓

Initiate intensive healthy behaviour interventions or energy restriction and increased physical activity to achieve/maintain a healthy body weight

↓

Provide counseling on a diet best suited to the individual based on values, preferences, and treatment goals using the advantages/disadvantages in Table 1

↓

If not at target

↓

Continue healthy behaviour interventions and add pharmacotherapy

↓

Timely adjustments to healthy behaviour interventions and/or pharmacotherapy should be made to attain target A1C within 2 to 3 months for healthy behaviour interventions alone or 3 to 6 months for any combination with pharmacotherapy

Table 1
Properties of dietary interventions*†‡

Properties of dietary interventions (listed in the order they are presented in the text)

Dietary interventions	A1C	CV benefit	Other advantages	Disadvantages
Macronutrient-based approaches				
Low-glycemic-index diets	↓ (32,44,46,47)	↓CVD (52)	↓LDL-C, ↓CRP, ↓hypoglycemia, ↓diabetes Rx	None
High-fibre diets	↓ (viscous fibre) (57)	↓CVD (69)	↓LDL-C, ↓non-HDL-C, ↓apo B (viscous fibre) (54,57,59)	GI side effects (transient)
High-MUFA diets	↔	↓CVD	↓Weight, ↓TG, ↓BP	None
Low-carbohydrate diets	↔	-	↓TG	↓Micronutrients, ↑renal load
High-protein diets	↓	-	↓TG, ↓BP, preserve lean mass	↓Micronutrients, ↑renal load
Mediterranean dietary pattern	↓ (50,139)	↓CVD (143)	↓retinopathy (144), ↓BP, ↓CRP, ↑HDL-C (139,140)	None
Alternate dietary patterns				
Vegetarian	↓ (145,251)	↓CHD (152)	↓Weight (148), ↓LDL-C (149)	↓vitamin B12
DASH	↓ (159)	↓CHD (161)	↓Weight (159), ↓LDL-C (159), ↓BP (159), ↓CRP (160)	None
Portfolio	-	↓CVD (162,163)	↓LDL-C (162,163), ↓CRP (162), ↓BP (163)	None
Nordic	-	-	↓LDL-C+, ↓non-HDL-C (169–171)	None
Popular weight loss diets				
Atkins	↔	-	↓Weight, ↓TG, ↑HDL-C, ↓CRP	↑LDL-C, ↓micronutrients, ↓adherence
Protein Power Plan	↓	-	↓Weight, ↓TG, ↑HDL-C	↓Micronutrients, ↓adherence, ↑renal load
Ornish	-	-	↓Weight, ↓LDL-C, ↓CRP	↔ FPG, ↓adherence
Weight Watchers	-	-	↓Weight, ↓LDL-C, ↑HDL-C, ↓CRP	↔ FPG, ↓adherence
Zone	-	-	↓Weight, ↓LDL-C, ↓TG, ↑HDL-C	↔ FPG, ↓adherence
Dietary patterns of specific foods				
Dietary pulses/legumes	↓ (176)	↓CVD (181)	↓Weight (179), ↓LDL-C (177), ↓BP (178)	GI side effects (transient)
Fruit and vegetables	↓ (183,184)	↓CVD (79)	↓BP (186,187)	None
Nuts	↓ (188)	↓CVD (143,181)	↓LDL-C (190), ↓TG, ↓FPG (189)	Nut allergies (some individuals)
Whole grains	↓ (oats) (194)	↓CHD (99)	↓LDL-C, FPG (oats, barley) (57,193)	GI side effects (transient)
Dairy	↔	↓CVD (199,200)	↓BP, ↓TG (when replacing SSBs) (197)	Lactose intolerance (some individuals)
Meal replacements	↓	-	↓Weight	Temporary intervention

Dworatzek et al. Can J Diabetes 2013;37:S45eS55

Take away messages

Conclusions

1. Any effect **of sugars** appears to be highly dependent on the **food source** and **comparator/energy control**.
2. Whereas **SSBs** show **adverse associations** with **cardiometabolic disease outcomes**, the same does **not** hold for other **important food sources** of fructose-containing sugars with **protective associations** even seen for **some foods: yogurt, fruit, 100% fruit juice, whole grain cereals.**
3. To address the limitations in the evidence, **Clinical practice guidelines (CPGs)** are shifting away from "one-size-fits-all" nutrient-centric recommendations ("low-fat", "low-sugars", "low-carb", "low-salt", etc.) to **dietary patterns-**based recommendations.
4. Targeting **sugars** as a source of **excess** calories remains a **prudent strategy** because foods and beverages high in sugars often contribute **little nutritional value**. But one **cannot** choose a healthful diet by sugars alone! **A little sugars help the low-fat dairy, wholegrains, dietary fibre, and fruit go down**

Acknowledgements

Acknowledgements

St. Michael's
Inspired Care.
Inspiring Science.

Arash Mirrahimi, HBSc, MSc (Coordinator, Co-I)
Amanda J Carleton, MSc (MD student, Co-P)
Dr. Sonia Blanco MD, MSc (Coordinator)
Laura Chiavaroli, MSc (PhD Candidate)
Adrian I Cozma, HBSc (Research Assistant)
Vanessa Ha, HBSc (MSc Candidate)
David Wang, HBSc (Project Student)
Simon Chiu (Project Student)
Matt E Yu, HBSc (Project Student)
Viranda (Jay) Jayalath (Project Student)
Christine Tsilias (Project Student)
Reem Tawfik (Project Student)
Sara Rehman (Project Student)
Vivian Choo (Project Student)

Prof. David JA Jenkins MD, PhD, DSc (PI)

Prof. Cyril WC Kendall, PhD (Co-I)

McMaster University
Inspiring Innovation and Discovery

Dr. Russell J de Souza, ScD, RD (PDF, Co-I)

McMaster University

SickKids

Prof. Joseph Beyene, PhD (Co-I)

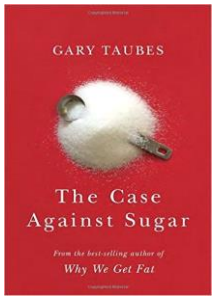
Dr. Alexandra L Jenkins, PhD, RD (Decision Maker)
Prof. Lawrence A Leiter, MD (Decision Maker)
Prof. Thomas MS Wolever, MD, PhD (Decision Maker)

American Heart Association
Learn and Live

Dr. Marco DiBuono, PhD (Decision Maker)

Extra

What about fruit?



*"…even an **apple** may <u>not</u> be a good thing… it may very well not be for people predisposed to gain weight easily or who are already obese and/or diabetic"*

http://www.vox.com/science-and-health/2017/1/6/14167092/gary-taubes-case-against-sugar-book


0/12/28/health/28zuger.html

EARCH

The New York Times

Romaine Riddle: Why the E. Coli Outbreak Eludes Food Investigators

Valeant, Distancing Itself From Its Past, Will Change Its Name to Bausch Health

PERSONAL HEALTH
How to Avoid Burnout in Youth Sports

HEALTH | BOOKS

A Diet Manifesto: Drop the Apple and Walk Away

By ABIGAIL ZUGER, M.D. DEC. 27, 2010

https://www.nytimes.com/2010/12/28/health/28zuger.html

International Diabetes Federation

"IDF therefore advocates the following specific measures:

*3. Revision of healthy eating guidelines to reduce consumption of foods with naturally high sugar content (eg certain **fruits** and **fruit juices**)."*