Supplementary Materials: Association Between Food, Beverages and Overweight/Obesity in Children and Adolescents - A Systematic Review and Meta-analysis of Observational Studies

Table S1: Characteristics and ROB assessment of included studies

Author (year published)	Country	Age (yr)	Sex	Study	Dietary instrument	Definition of high intake	Sample size	Adjustments	NOS score
Abreu (2014)[1]	Portugal	15-18y	Both (separate)	Cross-sectional	FFQ	**Ready to eat cereal:** ≥40 g/d (boys), ≥31 g/d (girls). **Vegetables**: ≥114 g/d (boys). **Sweets/pastries:** ≥57 g/d (girls).	1209	Age, maturation, total energy intake (kJ/kcal), low-energy reporters, dietary fiber (g/4184 kJ (1000 kcal)).	10
Ahmed (2013)[2]	Pakistan	9-18y	Both	Cross-sectional	FFQ	**Fruit:** ≥4 times per week	501	Age, sex and socioeconomic status	7
Beck (2014)[3]	US (Mexican/American children)	8-10y	Both	Cross-sectional	YAQ	**Soda, flavored milk, whole milk, 2% milk:** Additional serving of 240 ml	319	Age, gender, the retained beverage variables	7
Bel-Serrat (2019)[4]	Ireland	6-10y	Both	Longitudinal study (FU)	FFQ	**Fruit:** Every day/most days. **Vegetables**: Every day/most days. **Fast food:** Every day. **Savory snacks:** Every day	1262	Measurement round, time follow-up, age, sex, baseline z-BMI, baseline abdominal obesity status, school socioeconomic status, school location, and household ownership (rented vs. owned)	7
Chen (2021)[5]	China	6-12y	Both	Cross-sectional	FFQ	**Vegetables:** highest %. **Red meat:** highest %	12813	Age, gender	6
Choumenkovitch (2013)[6]	US	10y (3rd-6th grade)	Both	Cross-sectional	Block food screener (intake and portions size past 24h)	**Whole grain:** >1.5 servings/day	792	Age, sex, race/ethnicity, physical activity, state of residence	7
Colapinto (2014)[7]	Canada	10-11y (grade 5)	Both	Cross-sectional	The Harward YAQ	**White milk:** ≥ 2 glasses/day. **Chocolate milk:** <1 glass/month	8958	Energy intake, sex, region of residence, household income, parental education	8
Cutler (2012)[8]	US	12-16y	Both (separate)	Longitudinal study (BA)	YAQ	**Vegetables, fruit:** One quintile increase in dietary pattern factor score.	3572	Race/ethnicity, SES, physical activity	7
Denova-Gutiérrez (2008)[9]	Mexico	10-19y	Both	Cross-sectional	FFQ	**SSB:** >3 servings/day	1055	Age, gender, sexual maturation, place of residence, physical activity,	9

								father's education, total caloric intake, alcohol consumption and energy derived from fat intake	
Duan (2020)[10]	China	11-18y	Both	Cross-sectional	Pediatric Sleep QUA-Sleep-Related Breathing Disorder	**Fruit:** >2 times/week	1825	Sex, age, birth history, parental weight, maternal weight, slowness in eating, picky eating	6
Flores (2013)[11]	US	5-6y	Both	Longitudinal study (FU)	Interviews (7 day record)	**SSB:** ≥1 times past 7 days. **Fruit:** ≥1 time past 7 days	6800	Weighted, forward stepwise procedures used	7
Gibson (2007)[12]	UK	7-18y	Both	Cross-sectional	7-days record (weighed)	**SSB:** >0.55 MJ/day	1294	Age, sex, under-reporting, dieting	8
Govindan (2013)[13]	US	10-12y	Girls	Cross-sectional	The School Physical Activity and Nutrition QUA	**Milk:** >2 servings in previous 24 hours	848	Covariates with p>0.10 in the univariate analysis	8
Haboush-Deloye (2021)[14]	US	4-6y	Both	Cross-sectional	7-day record	**Soda**: Any weekly consumption	7814	SES, gender, PA, screen time, feeding practice at 6 months	6
Hadi (2020)[15]	Indonesia	7-12y	Both	Cross-sectional	FFQ	**Junk food:** >1050 kcal/d	488	Calorie intake, demographic, socioeconomic factors	8
Hanley (2000)[16]	US	10-19y	Both	Cross-sectional	FFQ	**Vegetables, Junk food, Bread foods:** Fourth quartile ?	242	Age, sex	7
Hatami (2014)[17]	Iran	10-18y	Both	Cross-sectional	FFQ	**Fruit, vegetables, sweets/candy, soft drinks, SSB, milk, fast food, chips:** 5–7 times/week	1109	Age, sex	7
Heo (2020)[18]	US	Mean age 16y	Both (separate)	Cross-sectional	Youth Risk Behavior Survey	**Soda:** ≥2 times per day	13.571	Age, Hispanic ethnicity	7
Hirschler (2009)[19]	Buenos Aires	6-12y	Both	Cross-sectional	Interviews (Freq. daily)	**SSB:** >1 glass/day. **Milk:** ≥3 glasses/day	330	Fruit and vegetables consumption, milk consumption, maternal educational level, socioeconomic class.	8
Huus (2009)[20]	Sweden	5y	Both	Longitudinal study (FU)	FFQ	**Vegetables, fruit, pastries, cereals (porridge), fast food (fried potatoes/French fries), sweets/candy (candy, chocolate, ice-cream), cream/crème fraiche:** Daily. **Chips:** 3-5 times/week. **Cheese:** 3 times/day. **Milk:** 4 times/day or more. **Meat (sausage):** 1-2 times/week.	5032	Known risk factors (parental BMI, parental education and heredity for diabetes)	7
Hwang (2020)[21]	Korea	10-18y	Both	Cross-sectional	24h recall	**SSB:** ≥ median consumption (boy:≥280.55 g. girl ≥210 g.) **Fruit/vegetable juices:** ≥ median consump-	6121	Age, sex, BMI, household income level, residential area, energy intake	7

						tion (boy: ≥208 g., girl: ≥187.2 g.) **Milk/milk products:** ≥ median consumption (boy: ≥249.6 g, girl: ≥212 g)			
Joseph (2015)[22]	India	12-16y	Only boys	Cross-sectional	FFQ	**Fast food:** Daily or more than daily consumption	292	Physical activity	5
Karki (2019)[23]	Nepal	6-13y	Both	Cross-sectional	School Physical and Nutrition survey 2010 (past 7 days)	**Soft drinks:** Yes. **Junk food:** ≥2 times/week	575	All independent variables	7
Katzmarzyk (2016)[24]	Australia, Brazil, Canada, China, Columbia, Finland, India, Kenya, Portugal, South Africa, UK, US	9-11y	Both (separate)	Cross-sectional	FFQ (HBSC)	**Regular soft drinks:** Once a day or more	6162	Age, study site, highest parental education, meeting physical activity guidelines	7
Kollias (2011)[25]	Greece	6-13y (age-divided)	Both	Cross-sectional	FFQ	**Sweets, fast food:** Yes	780	Age	7
Kostopoulou (2021)[26]	Greece	10-16y	Both	Cross-sectional	FFQ	**Fast food, sweets:** Frequent consumption	3504	Gender, siblings, daily meals, breakfast consumption, consumption of poor-quality food at school	7
Lee (2018)[27]	South Korea	9-13y	Both	Longitudinal study (FU)	FFQ	**Fast food:** ≥1 times/week	833	Age, sex, BMI	7
Leon-Guerrero (2020)[28]	Guam (US)	2-8y	Both	Cross-sectional	2-day food log	**SSB:** ≥1.09 cups/day	634	Community, age, sex, ethnicity	7
Liu (2012)[29]	US	2-19y (age-divided)	Both	Cross-sectional	24 hour dietary interview	**SSB:** ≥24 oz./day. **Whole grain:** ≥1 serving/day. **Vegetables:** ≥1 cup/day. **Fruit:** ≥2 cups/day. **Dairy:** ≥3 cups/day.	14332	Age, race/ethnicity, perceived health, household income level, reference person's education, region, survey year, total energy intake.	10
Maitland (2015)[30]	Turk and Caicos Islands	10.9 (mean age)	Both	Cross-sectional	FFQ	**Fruit, vegetables, junk food (Miscellaneous):** ≥2 times/day. **Fast food/fried food:** ≥1 times/day.	297	Gender, age, nationality, number of years in the Turk and Caicos Islands	7
Marcos-Pasero (2019)[31]	Spain	6-9y	Both	Cross-sectional	48-h food record	**Dairy:** Increase in number of dairy portion/day	221	Sex, age	8
Martinez-Ospina (2019)[32]	Columbia	7-14y	Both	Cross-sectional	FFQ (HBSC)	**SSB:** >4 days/week. **Fat-free-milk:** Less than once/day or more	714	Age, sex, socioeconomic status	8
Matthews (2011)[33]	US	6-19y	Both	Cross-sectional	FFQ	**Grains, vegetable, fruit, meat, dairy, junk food:** Highest quartile (Q4)	1764	Gender, type of school, soda intake, frequency of consumption of	8

								all of the other six food groups	
Mekonnen (2018)[34]	Ethiopia	6-12y	Both	Cross-sectional	QUA	**Fast food:** Yes	616	Maternal level of education, husband/partner occupation, fruit/vegetable intake, mode of transport, fast food intake, household wealth status, watching television, type of school, missing meal, physical activity, age	7
Mihrshahi (2017)[35]	Australia	5-16y	Both	Cross-sectional	QUA	**Fast food:** ≥1 times/week	7568	Age, sex, SES tertile, residential location, cultural background, meeting daily physical activity recommendations (60 mins daily)	7
Muckelbauer (2016)[36]	Germany	8.3 (mean age)	Both	Longitudinal study (FU)	24h recall QUA	**SSB:** Increase by 1 glass/day (1 glass=200 ml)	1987	Baseline BMI, baseline consumption of all beverage categories, change in milk, tea and other beverages consumption, age, sex, migrational background, study arm, follow-up duration	9
Nasreddine (2014)[37]	Lebanon	6-19y (age-divided)	Both	Cross-sectional	24-h recall	**Bread/cereals, milk/dairy, meat, fast food, sugar/sweets, SSB:** High consumption (3rd tertile based on percent contribution to daily energy intake)	868	Baseline socio-demographic, lifestyle, dietary characteristics	7
Nguyen (2021)[38]	Vietnam	8y	Both	Longitudinal study (FU)	FFQ	**Milk/milk products, packaged sweets/snacks:** Highest (4th) quartile	1961	Sex, site type, wealth index, interaction term of wealth and site type	6
Nicklas (2003)[39]	US	10y	Both	Cross-sectional	24-h recall	**Vegetables:** + 161 g/day. **Grain:** + 187 g/day. **Meat:** +60 g/day. **Candy:** +40 g/day. SSB: +399 g/day. **Salty snacks:** +12 g/day. **Milk:** +409 g/day. **Cheese:** 22 g/day.	1562	Total calorie intake, age, study year, ethnicity, gender, and ethnicity	
Notara (2020)[40]	Greece	10-12y	Both	Cross-sectional	FFQ	**Dietary fibers:** >15 g/1000 kcal/day	1659	Age, gender, breakfast consumption, daily walking time, computer use, parental education level, parental BMI, KIDMED index	7
O´Niel (2011)[41]	US	2-18y	Both	Cross-sectional	24-h dietary recall interview	**Chocolate candy, sugar candy:** Consumers	11181	Gender, ethnicity, age, energy	9

Payab (2015)[42]	Iran	6-18y	Both	Cross-sectional	FFQ	**Sweets, SSB, fast food, salty snacks:** Daily	13486	Family history of chronic disease, physical activity, screen time, socio-economic status.	7
Pengpid (2016)[43]	Cambodia, Indonesia, Malaysia, Myanmar, Thailand, the Philippines, Vietnam	13-15y	Both (separate)	Cross-sectional	FFQ - The Global School based Student Health Survey	**Fast food:** ≥2 times/week. **Fruits**: ≥2 servings/day. **Vegetables:** ≥3 servings/day.	2261	Age, country income, diet, hunger, tobacco use, active transport, sedentary behavior, psychosocial and social-familial factors	5
Pirincci (2010)[44]	Turkey	6-11y	Both	Cross-sectional	QUA	**Fast food:** ≥2 times/week	3642	Variables with significant associations (i.e. p-value <0.05) in the bivariate logistic regressions	6
Sakaki (2019)[45]	US	9-16y	Both (separate)	Cross-sectional	FFQ	**100% OJ consumption:** >1 glass/day	1308	Cohort, age, race, total energy intake excluding OJ, moderate/physical activity, screen time	8
Sanigorski (2007)[46]	Australia	4-12y	Both	Cross-sectional	FFQ	**Fruit, vegetables, fruit juice/drinks, soft drinks:** ≥2/day. **Fast food:** >1/week.	1944	Age, gender, socio-economic status	7
Santiago (2013)[47]	Spain	6-12y	Both (separate)	Cross-sectional	FFQ	**Fruit:** ≥2/day. **Buns, sweets:** ≥1/day. **Fast food:** ≥1/week.	2814	Sport activities, breakfast consumption, dietary intake (fruit, buns, fast food, sweet)	7
Shan (2010)[48]	China	6-18y	Both	Cross-sectional	QUA	**SSB, fast food:** ≥3 times/week.	21198	Age, gender, Tanner stage, urban/rural residence	7
Shin (2017)[49]	Korea	6-18y	Both	Cross-sectional	The Student Health Examination and Survey	**Cereal (instant noodles), SSB, fast food, milk, meat:** Every day.	3225	Gender, survey year, school grade, food intakes/week and breakfast	7
Siddarth (2013)[50]	US	7-18y (age-divided)	Both	Cross-sectional	FFQ	**Fast food:** ≥3 meals/week	1956	Physical and sedentary activity level, sex, ethnicity, income level	8
Valente (2011)[51]	Portugal	5-10y	Both (separate)	Cross-sectional	FFQ	**SSB:** ≥3 servings/day	1675	Energy intake, parents' education level, time of sleep, questionnaire responder, total carbohydrates, sugars, MUFA, television watching	7
Vinciguerra (2019)[52]	Italy	6-15y	Both	Cross-sectional	FFQ (HBSC)	**SSB:** Drinkers	1702	Gender, level of PA ST, SSB, parental risk factors	7
Walsh (2020)[53]	US	2-12y	Both	Cross-sectional	The Beverage and Snack QUA - total monthly consumption	**Salty snacks, SSB, Sweet snacks:** Each additional monthly consumption	300	Child age, child sex, race, caregiver education, NFS household income, FV access, food insecurity	7

White (2020)[54]	US	2-20y	Both	Cross-sectional	Diet behavior and nutrition interview (NHANES)	**Milk:** Daily	20039	Age, race/ethnicity, daily milk consumption, income, NHANES cycle.	7
Wijnhoven (2015)[55]	Bulgaria, Lithuania, Portugal, Sweeden, Czech Republic	6-9y	Both	Cross-sectional	FFQ (HBSC)	**Fruit, vegetables:** ≥7 days/week. **SSB, Salty snacks, Sweets, Sweet bakery (cakes), Fast food:** ≥3 days/week.	8512	Children's sex, age, all thirteen health-risk behaviors, children's residential urbanization grade, parental education, parental occupation, random effects for the primary sampling units	7
Xu (2016)[56]	China	7-12y	Both	Cross-sectional	QUA	**SSB:** ≥3/week	4644	Not specified	5
Xue (2016)[57]	China	6-18y	Both (separate)	Longitudinal study (BA - Wave 2004)	China Health and Nutritional Survey	**Fast food:** ≥1 time in past 3 months	1497	Age, ethnicity, household income, urbanicity, geographical region and physical activity levels	8
Zhang (2016)[58]	China	7-12y	Both	Cross-sectional	FFQ (past 7 days)	**Fruits, Vegetables, Meat:** + servings/day. **SSB:** + cups/day. **Fried food, Western fast food:** + times/week.	3766	Age, gender, only child or not, paternal and maternal educational level, paternal and maternal occupation, monthly household income	7
Zhang (2018)[59]	China	6-10y	Both	Cross-sectional	FFQ	**SSB:** ≥1 times/day. **Vegetables:** ≥1 times/day.	13001	Age, sex, sleep, outdoor activity, vegetables intake, snack intake, SSB intake	5
Zhao (2017)[60]	China	6-16y	Both	Longitudinal study (BA)	FFQ (past 3 months)	**Fast food:** ≥3 times/week	1626	Child factors (age, sex, and school location) and maternal factors (BMI and education level)	7

Characteristics of included trials. Abbreviations: NOS = Newcastle-Ottawa Scale (risk of bias and study quality assessment score); FFQ = Food Frequency Questionnaire; YAQ = Youth and Adolescents Questionnaire; SSB = Sugar-sweetened beverages; QUA = Questionnaire; HBSC = Health Behavior in School-aged Children; FU = follow-up data used for meta-analysis; BA = baseline data used for meta-analysis.

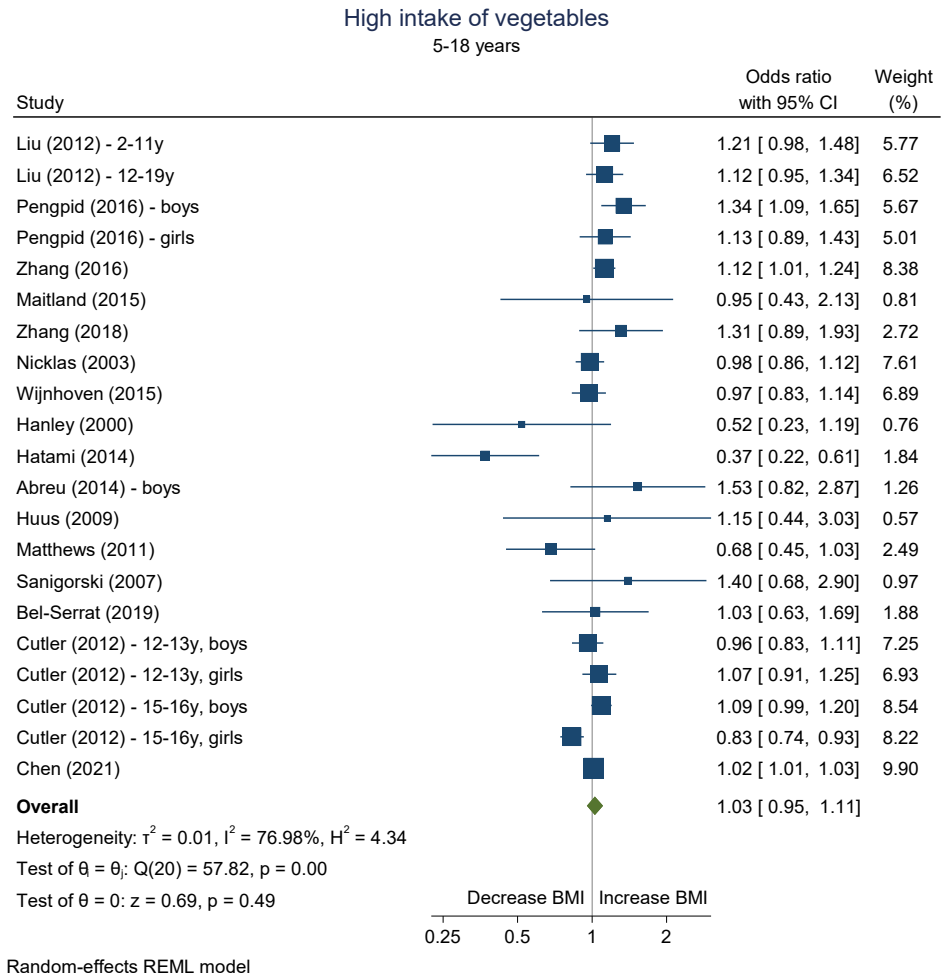


Figure S1. Association between a high intake of vegetables and risk of overweight/obesity in children and adolescents 5-18 years.

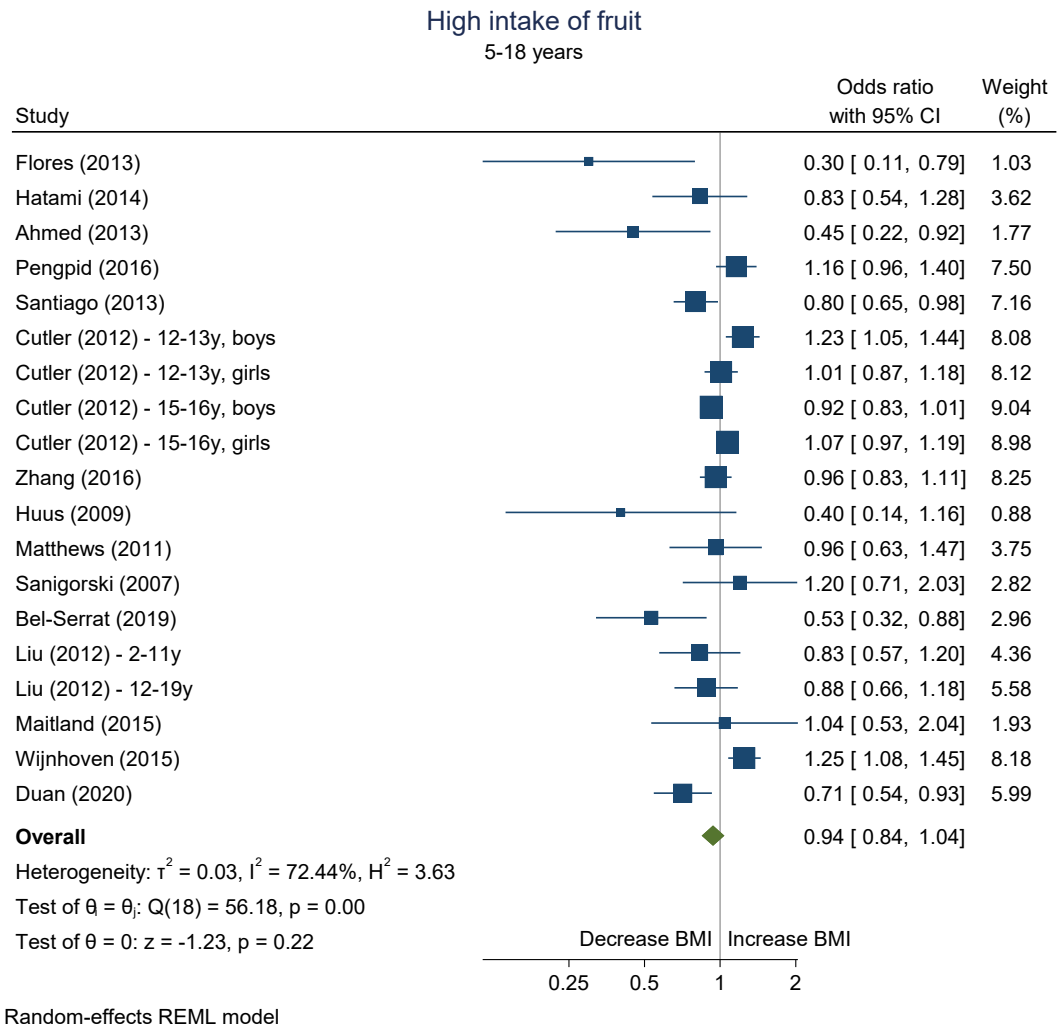


Figure S2. Association between a high intake of fruit and risk of overweight/obesity in children and adolescents 5-18 years.

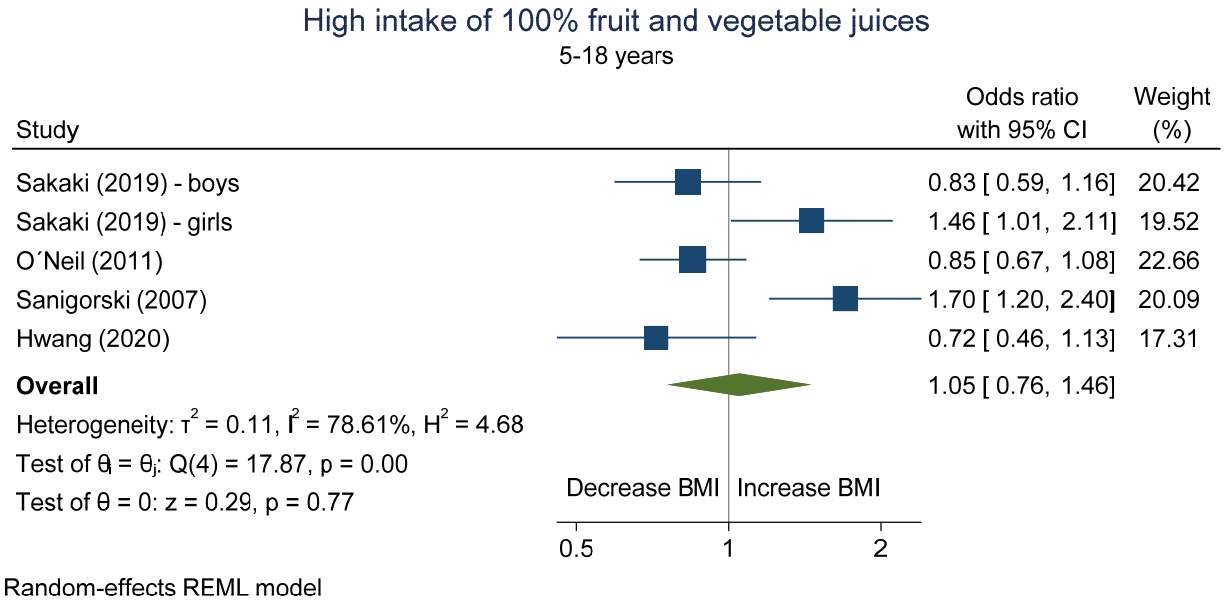


Figure S3. Association between a high intake of 100% fruit and vegetable juices and risk of overweight/obesity in children and adolescents 5-18 years.

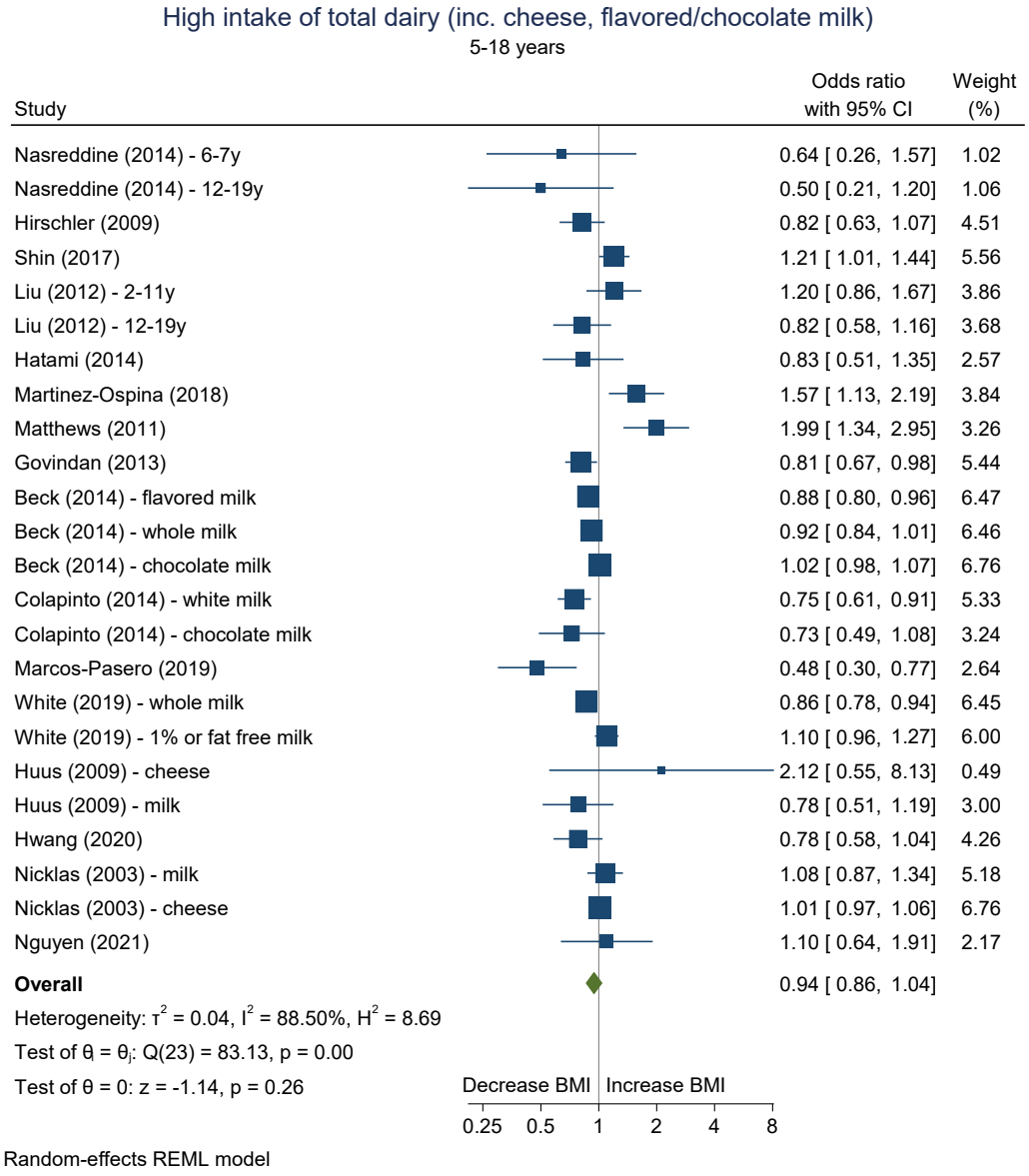


Figure S4. Association between a high intake of total dairy and risk of overweight/obesity in children and adolescents 5-18 years.

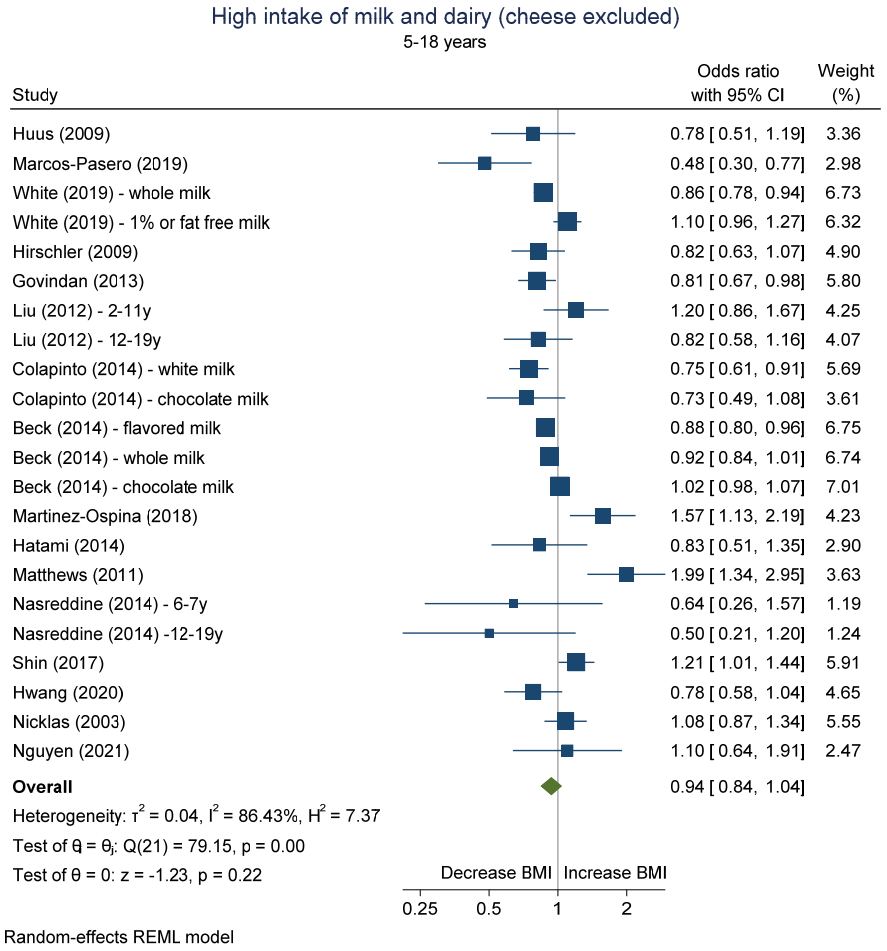


Figure S5. Association between a high intake of milk and dairy and risk of overweight/obesity in children and adolescents 5-18 years.

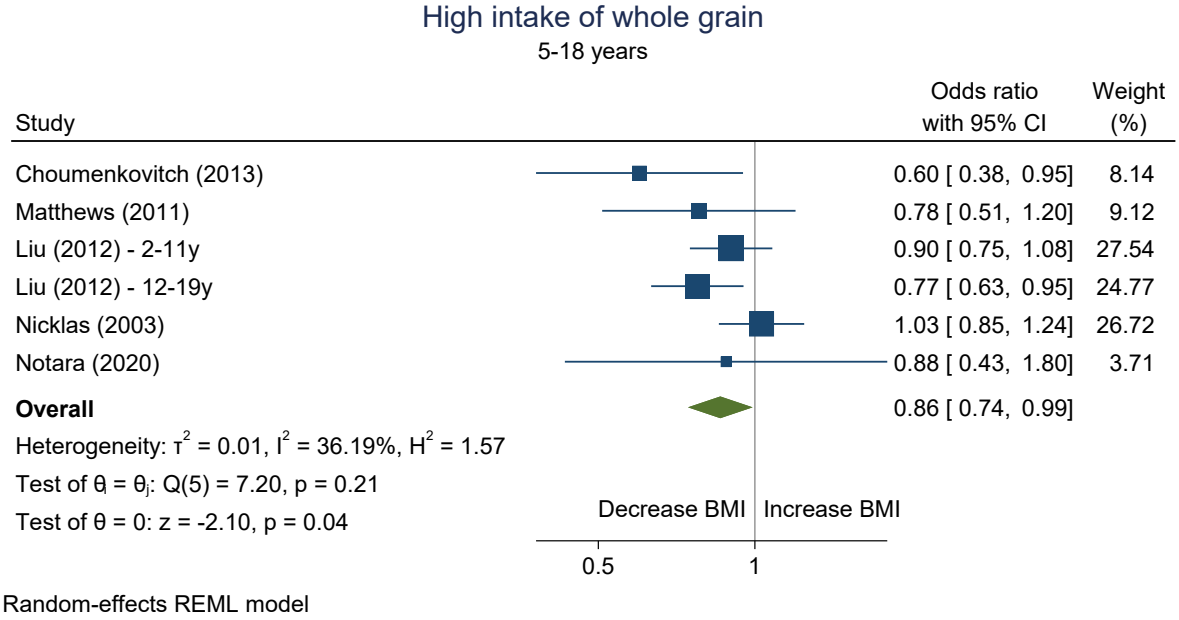


Figure S6. Association between a high intake of whole grain and risk of overweight/obesity in children and adolescents 5-18 years.

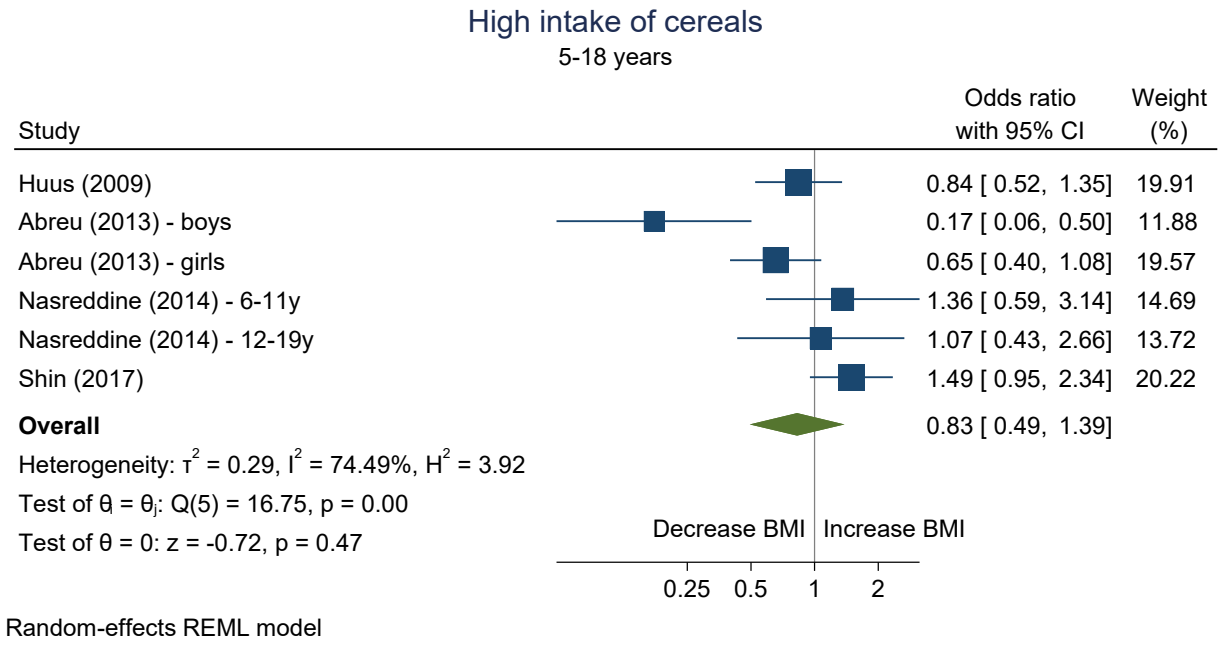


Figure S7. Association between a high intake of cereals and risk of overweight/obesity in children and adolescents 5-18 years.

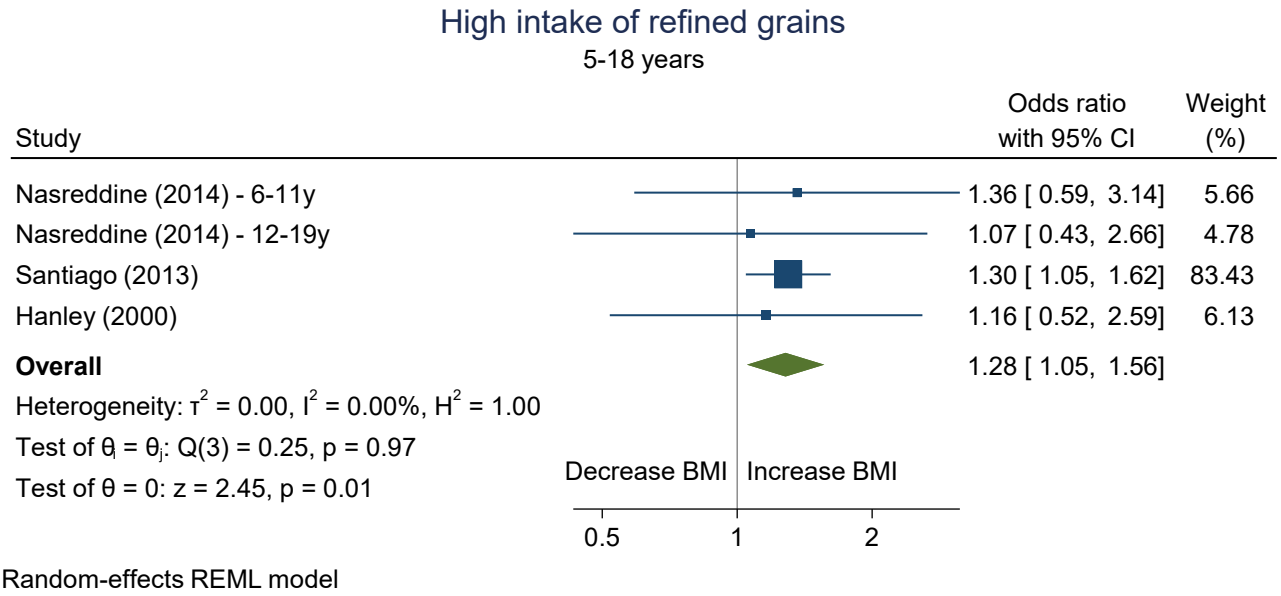


Figure S8. Association between a high intake of refined grains and risk of overweight/obesity in children and adolescents 5-18 years.

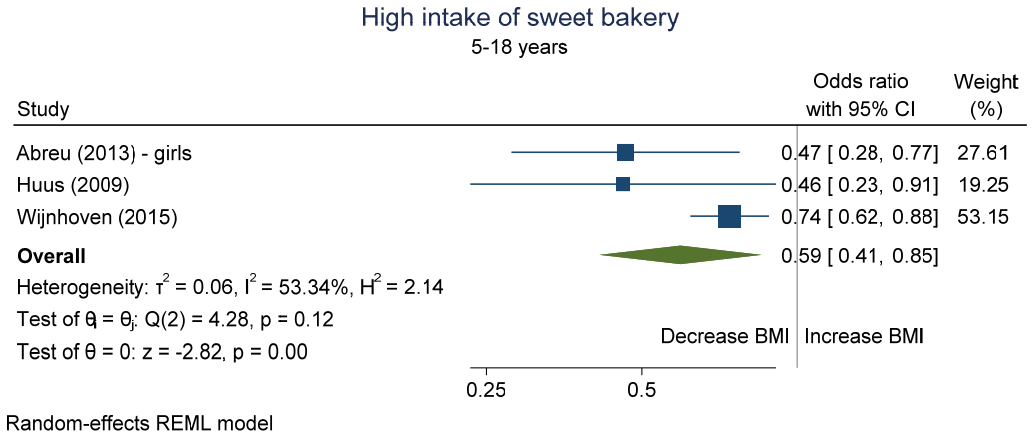


Figure S9. Association between a high intake of sweet bakery and risk of overweight/obesity in children and adolescents 5-18 years.

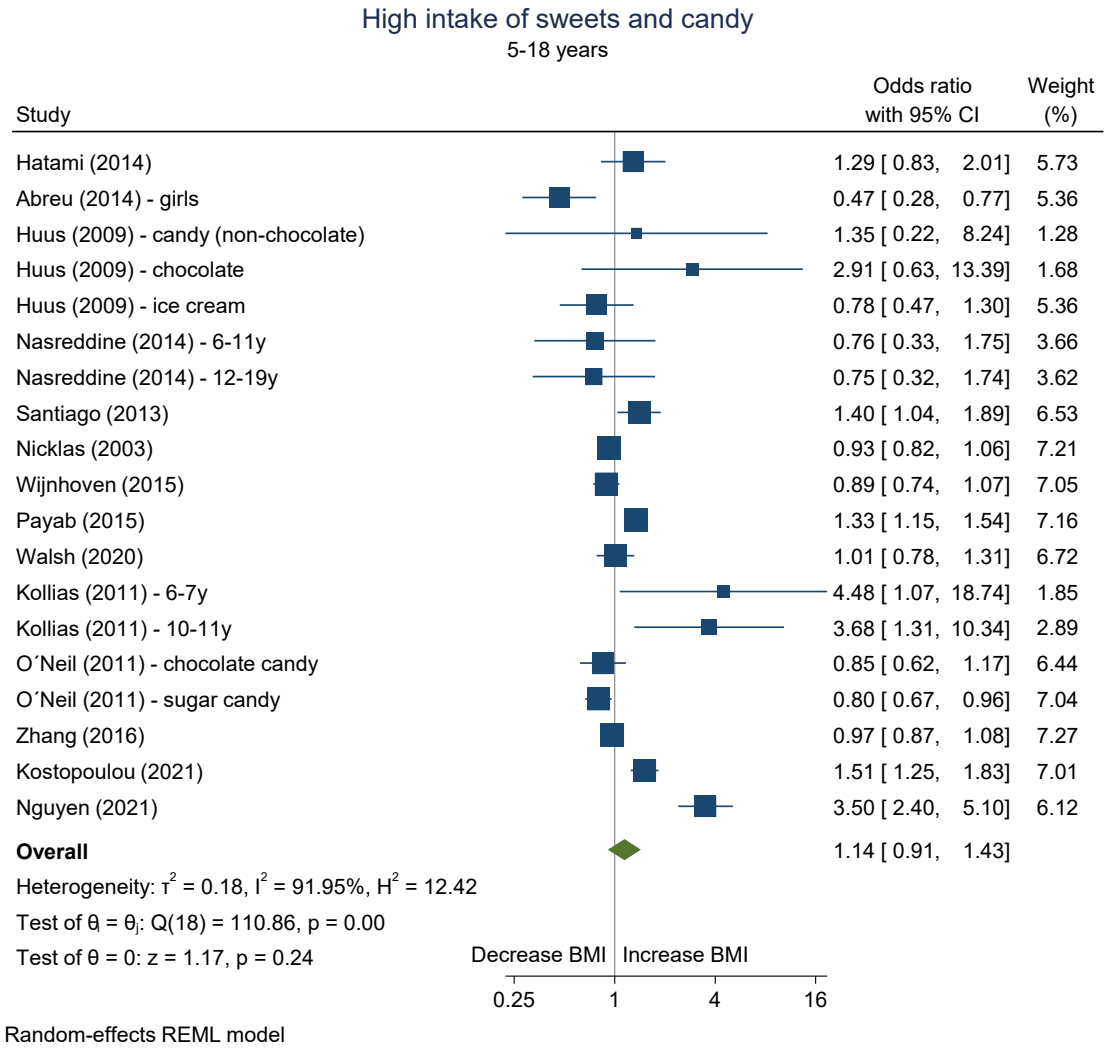


Figure S10. Association between a high intake of sweets and candy and risk of overweight/obesity in children and adolescents 5-18 years.

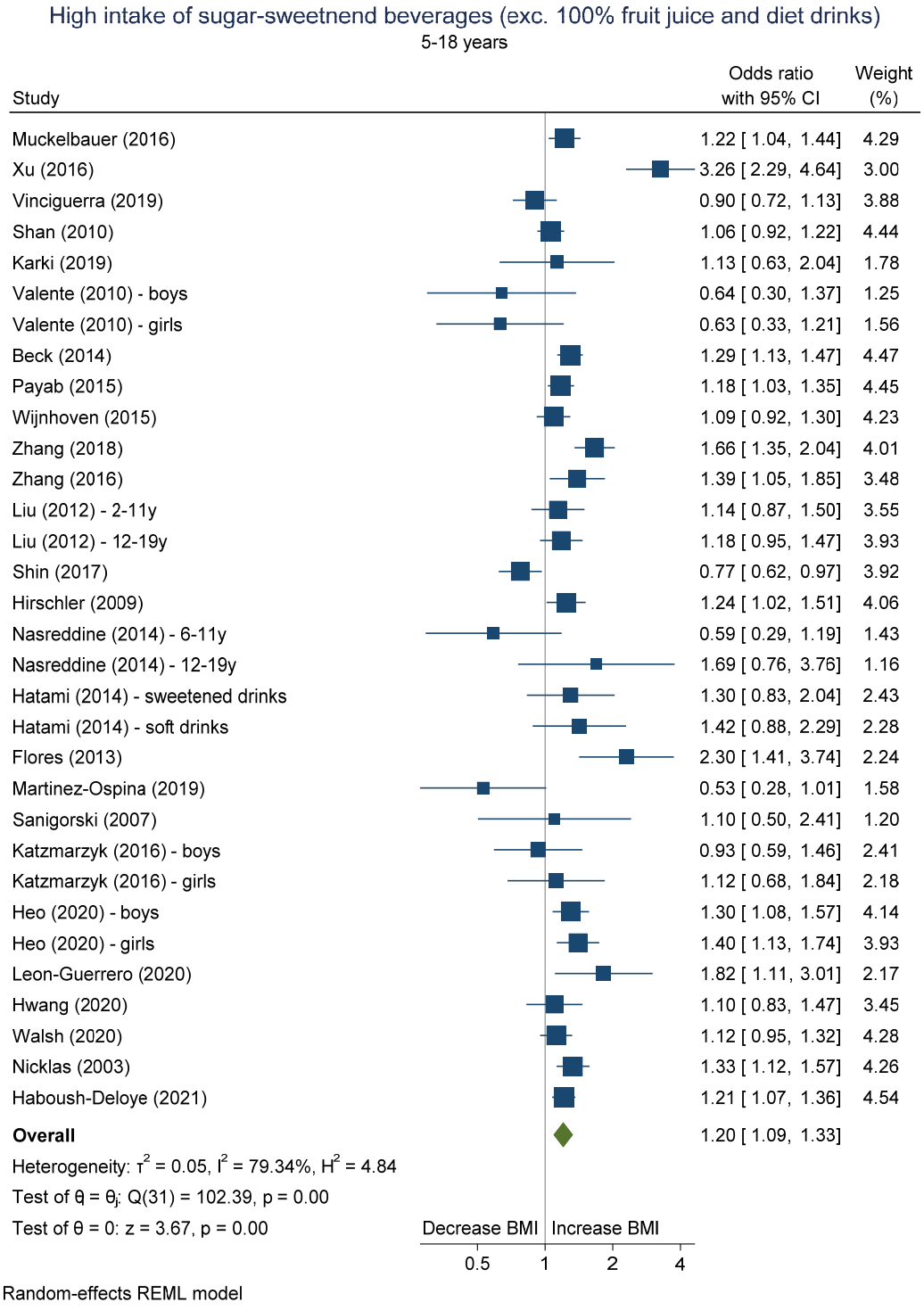


Figure S11. Association between a high intake of sugar-sweetened beverages and risk of overweight/obesity in children and adolescents 5-18 years.

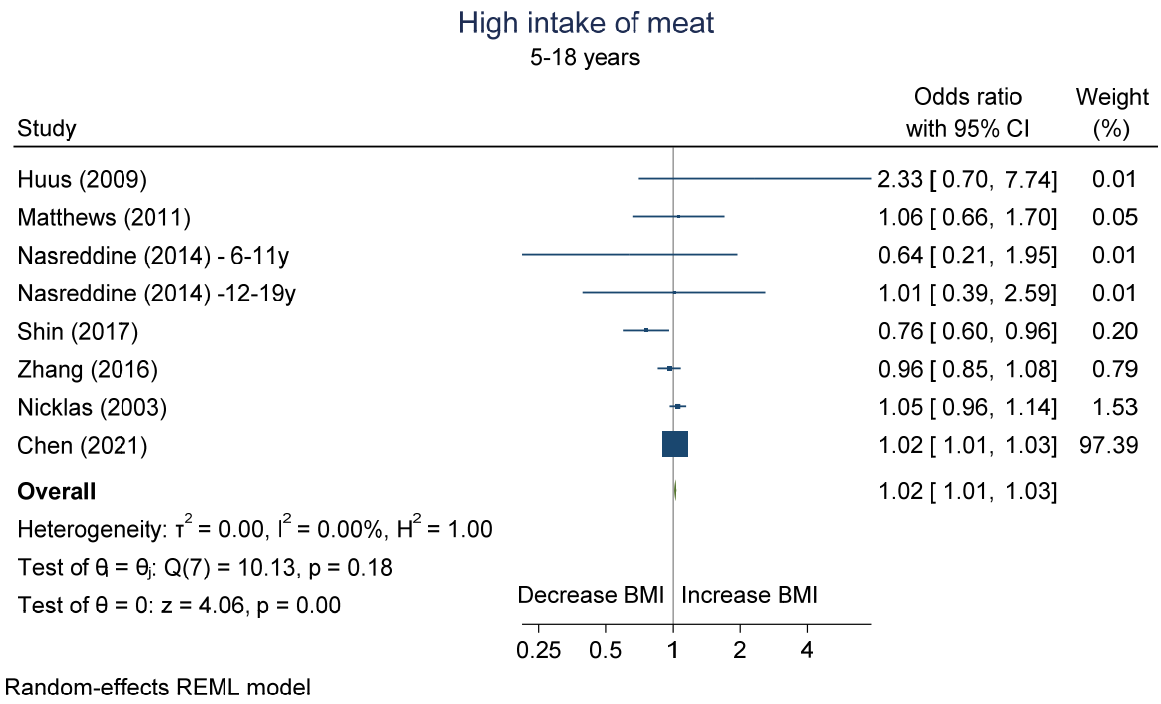


Figure S12. Association between a high intake of meat and risk of overweight/obesity in children and adolescents 5-18 years.

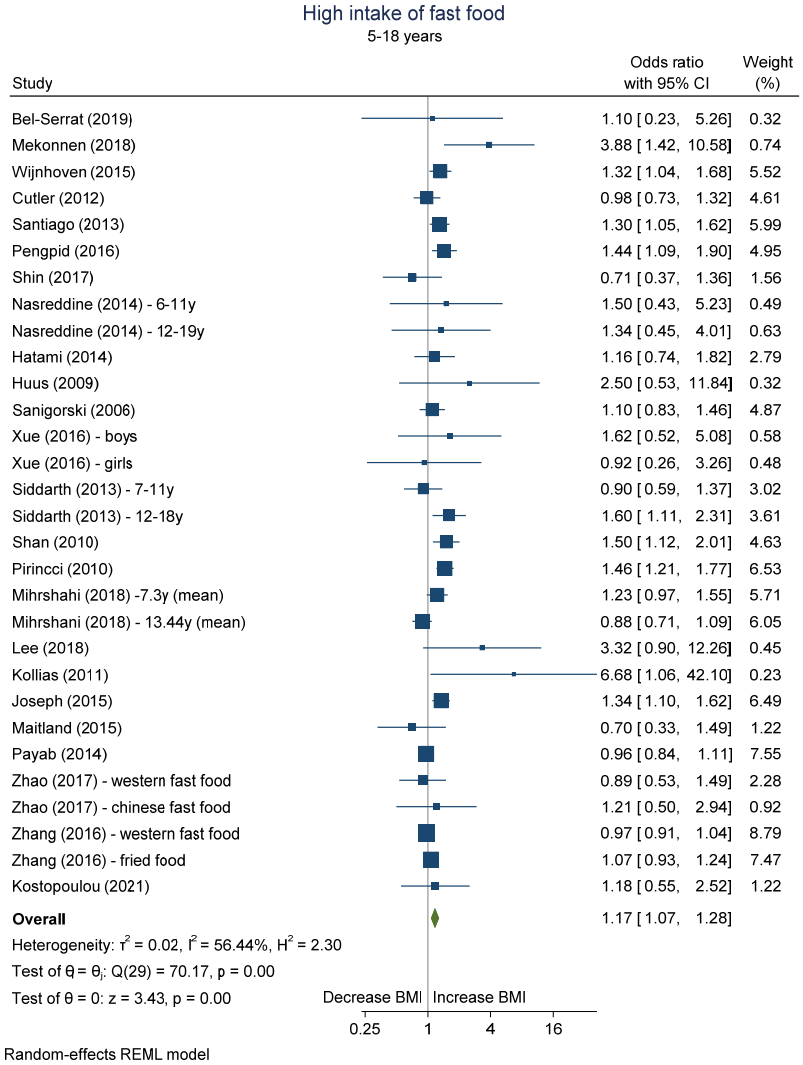


Figure S13. Association between a high intake of fast food and risk of overweight/obesity in children and adolescents 5-18 years.

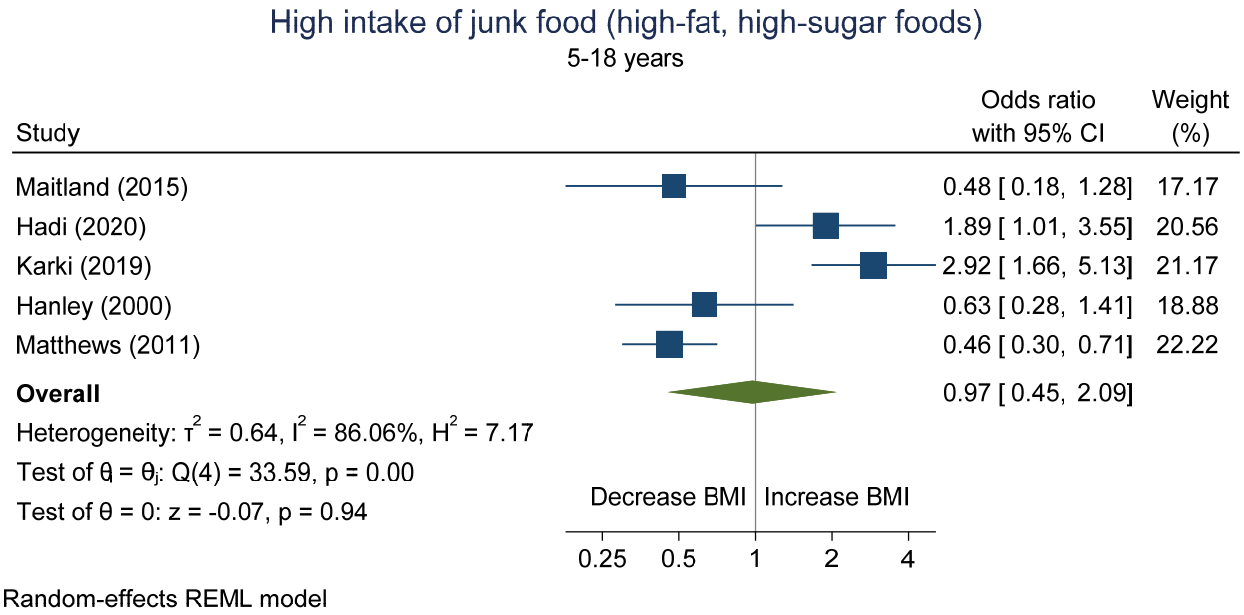


Figure S14. Association between a high intake of junk food and risk of overweight/obesity in children and adolescents 5-18 years.

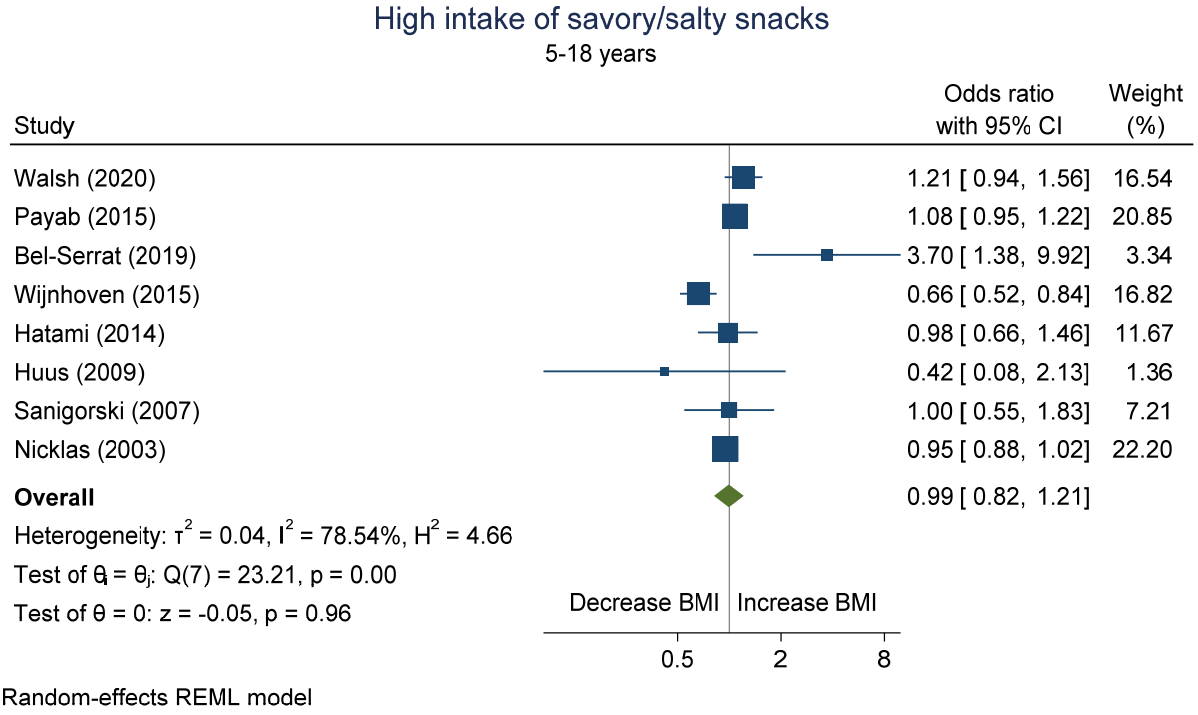


Figure S15. Association between a high intake of savory/salty snacks and risk of overweight/obesity in children and adolescents 5-18 years.

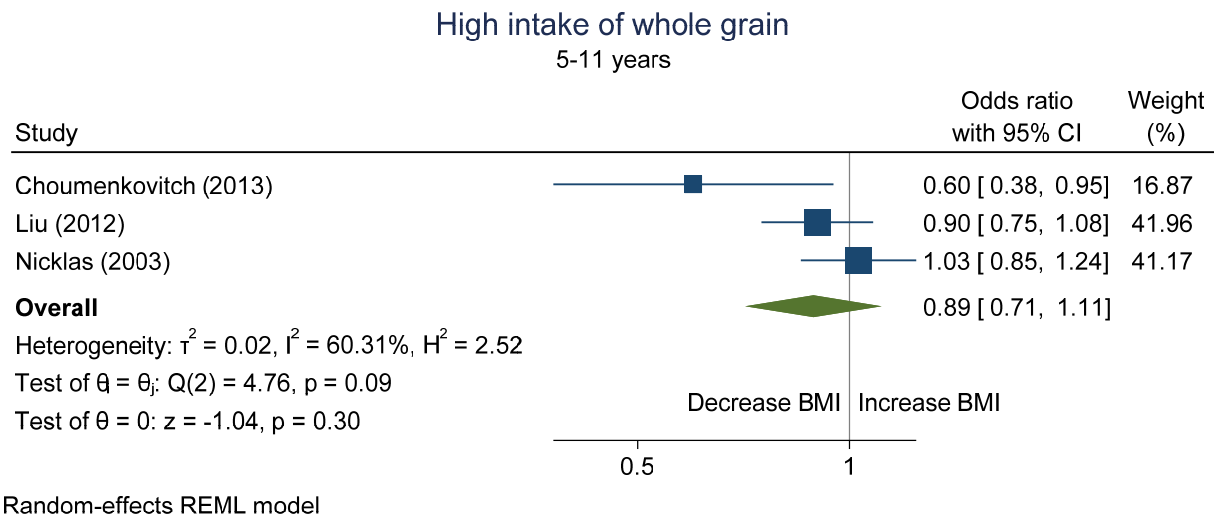


Figure S16. Association between a high intake of whole grain and risk of overweight/obesity in children and adolescents 5-11 years.

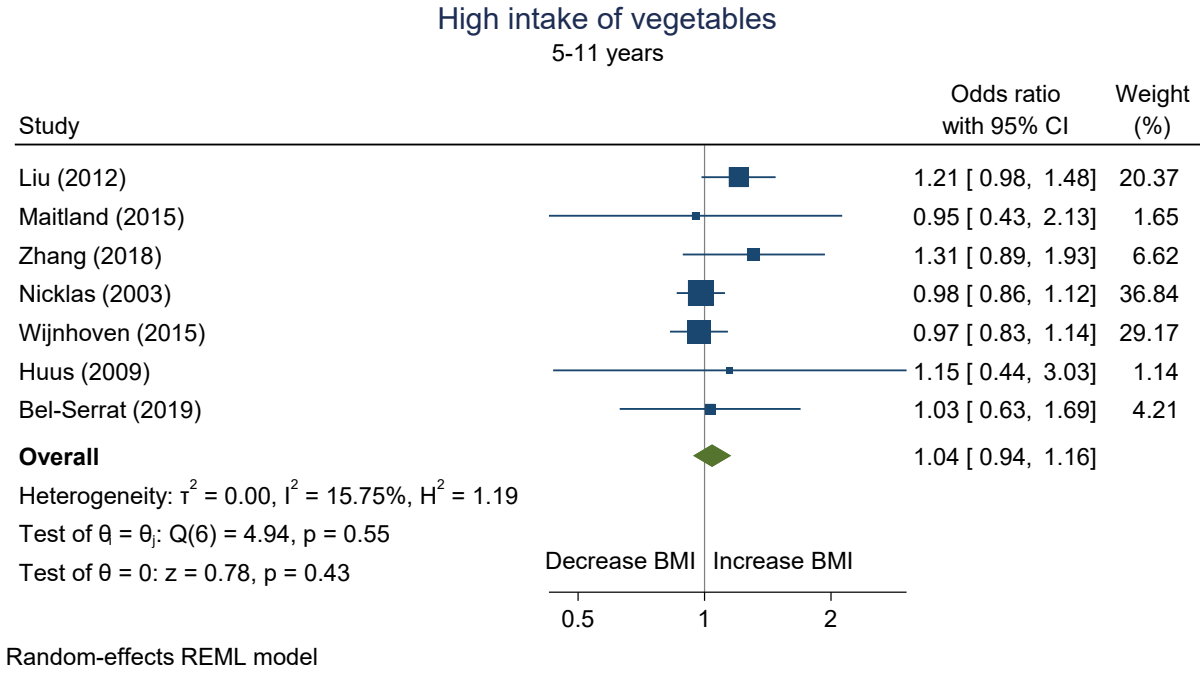


Figure S17. Association between a high intake of vegetables and risk of overweight/obesity in children and adolescents 5-11 years.

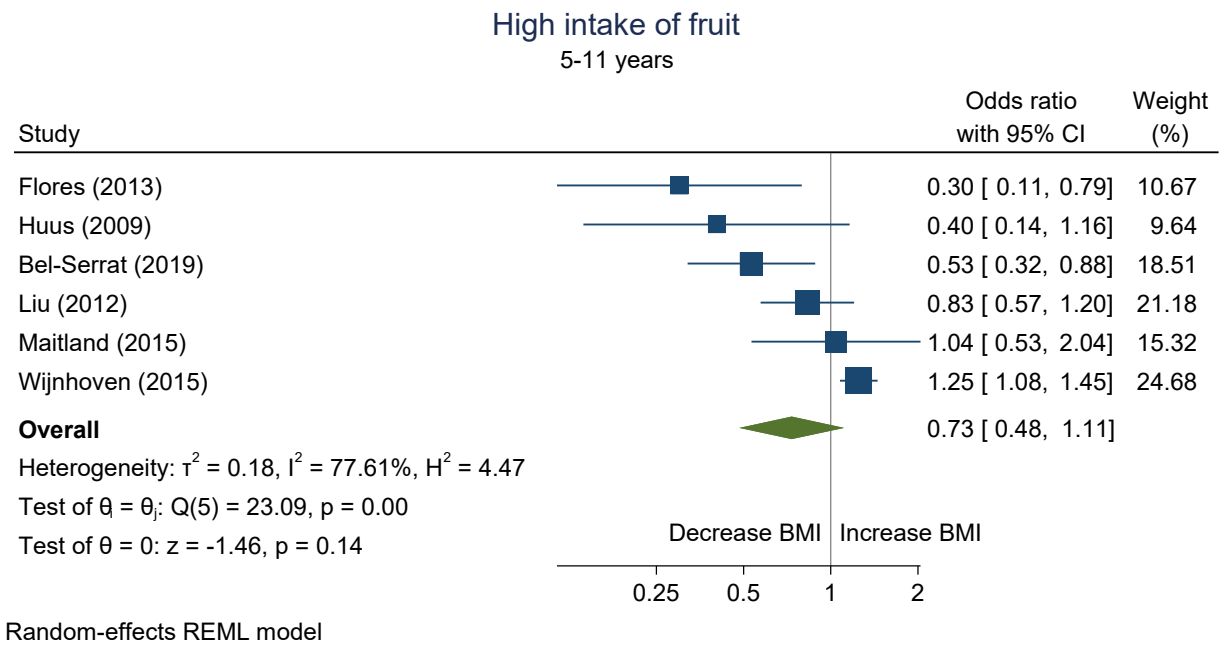


Figure S18. Association between a high intake of fruit and risk of overweight/obesity in children and adolescents 5-11 years.

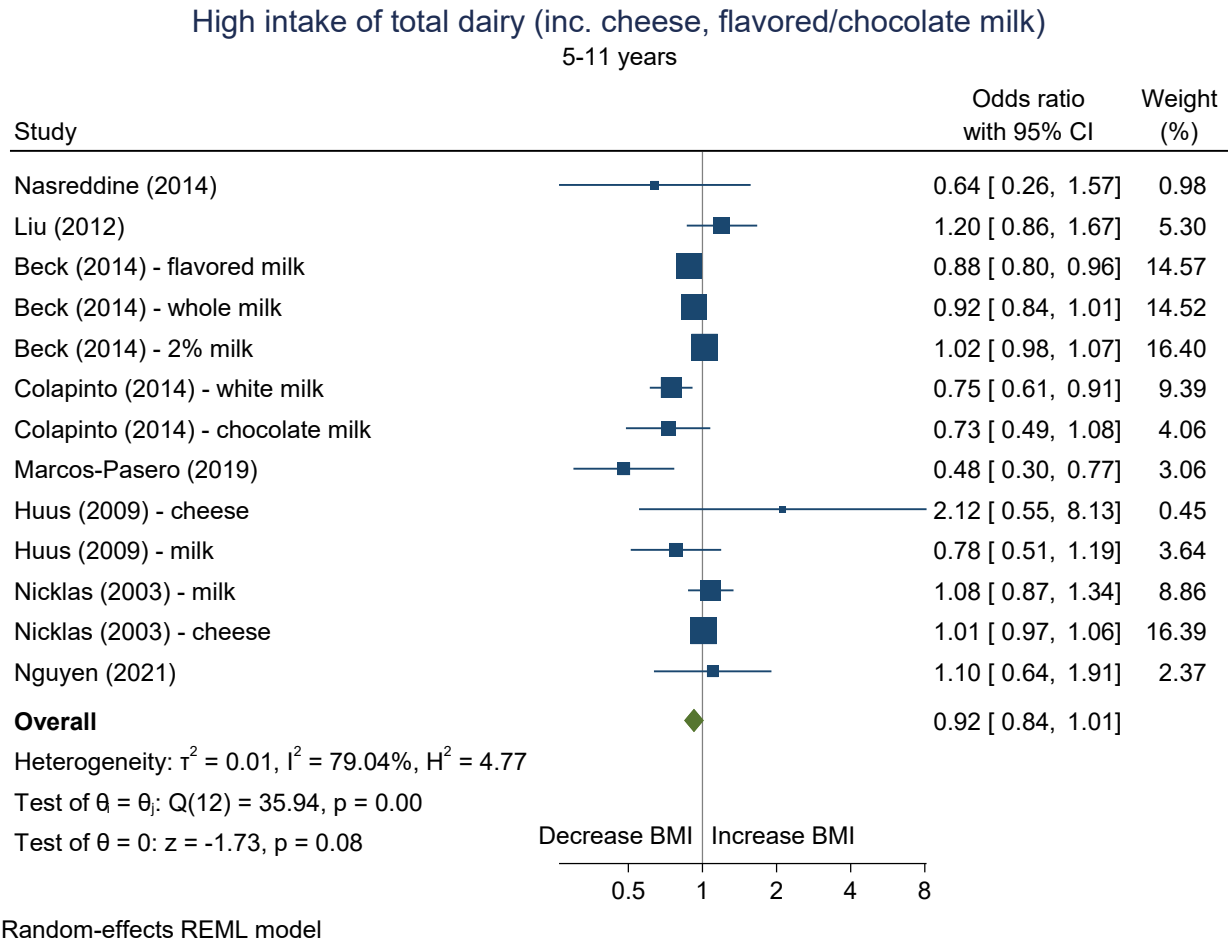


Figure S19. Association between a high intake of total dairy and risk of overweight/obesity in children and adolescents 5-11 years.

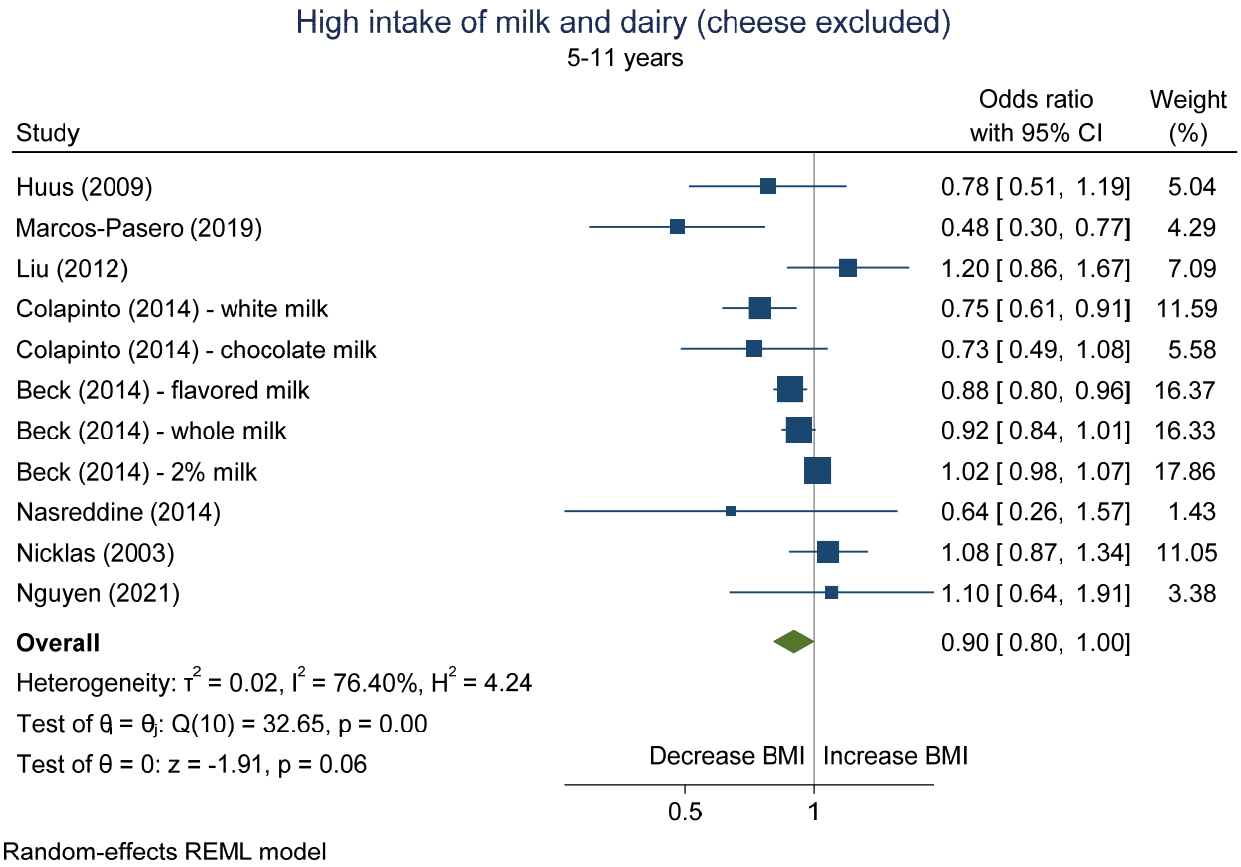


Figure S20. Association between a high intake of milk and dairy and risk of overweight/obesity in children and adolescents 5-11 years.

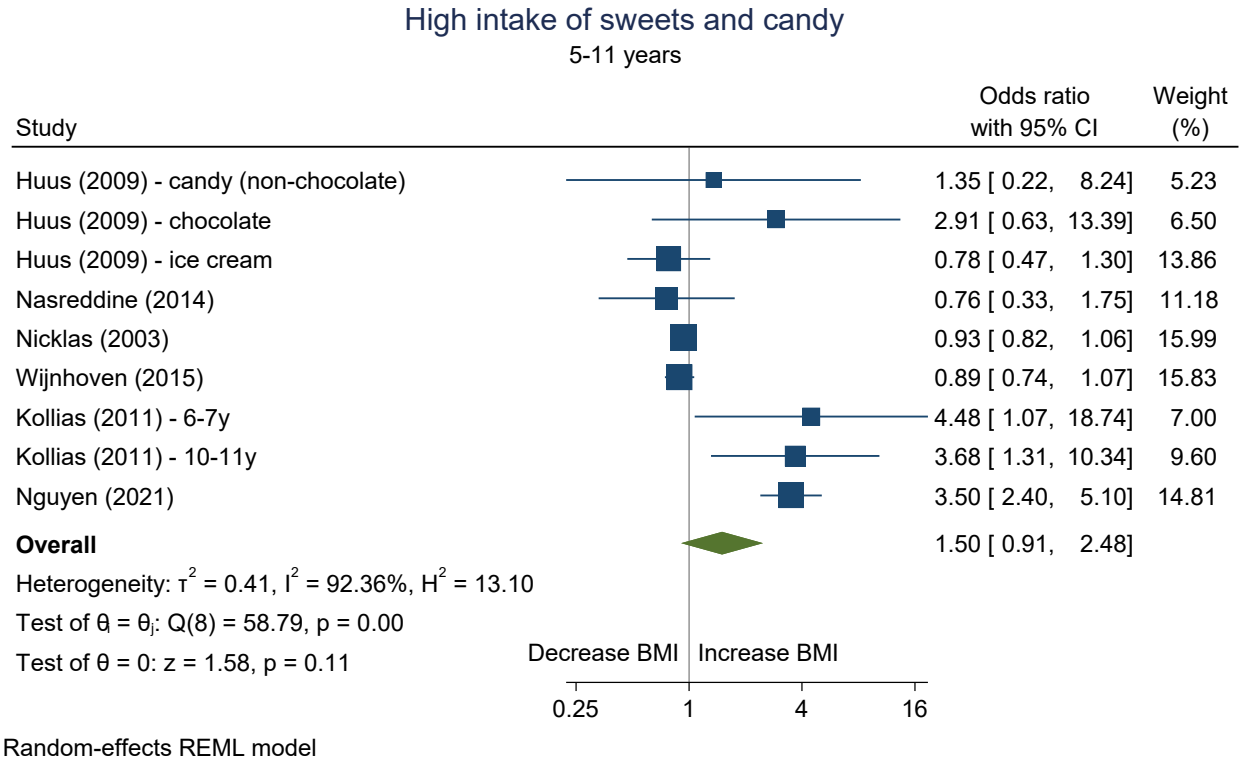


Figure S21. Association between a high intake of sweets and candy and risk of overweight/obesity in children and adolescents 5-11 years.

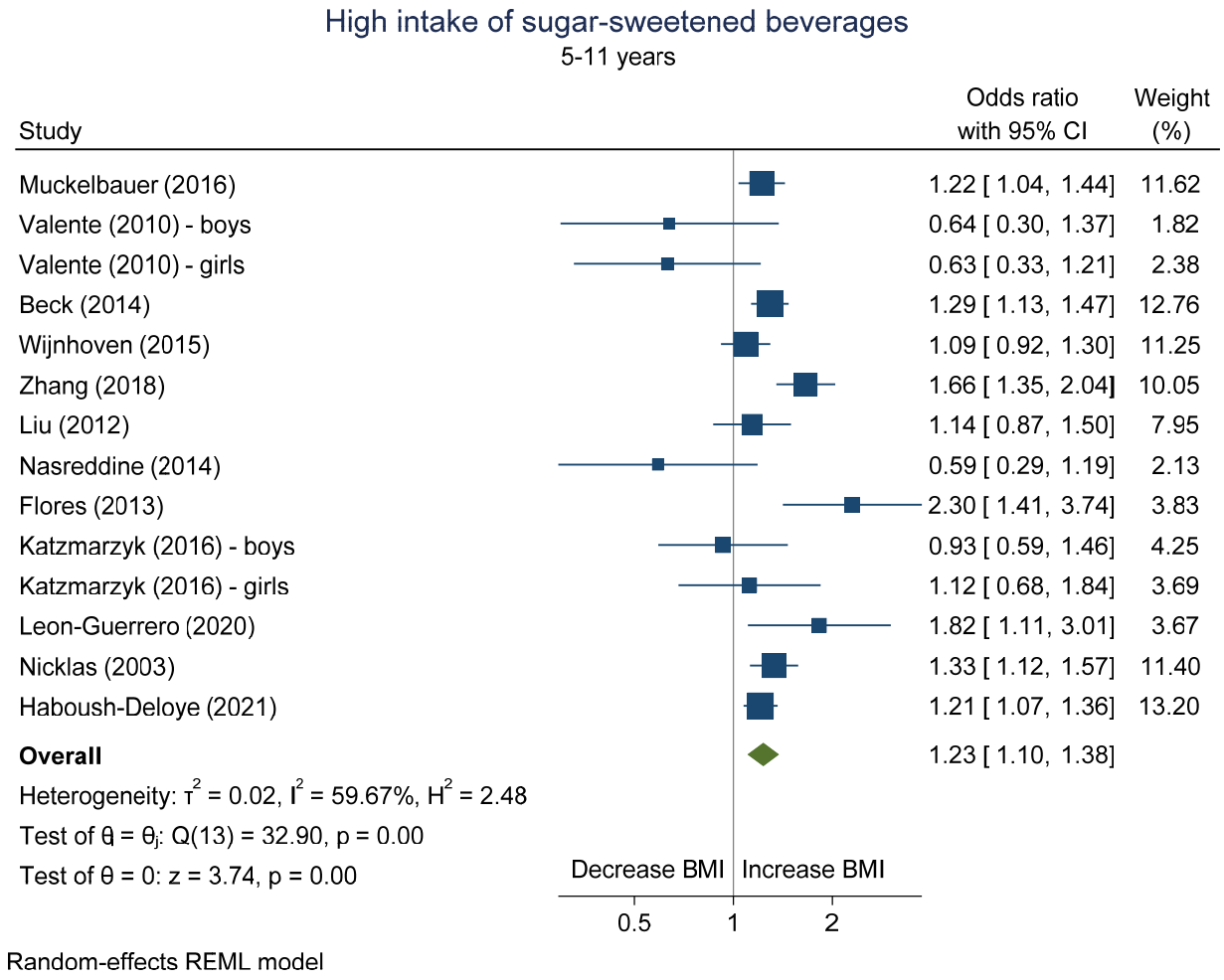


Figure S22. Association between a high intake of sugar-sweetened beverages and risk of overweight/obesity in children and adolescents 5-11 years.

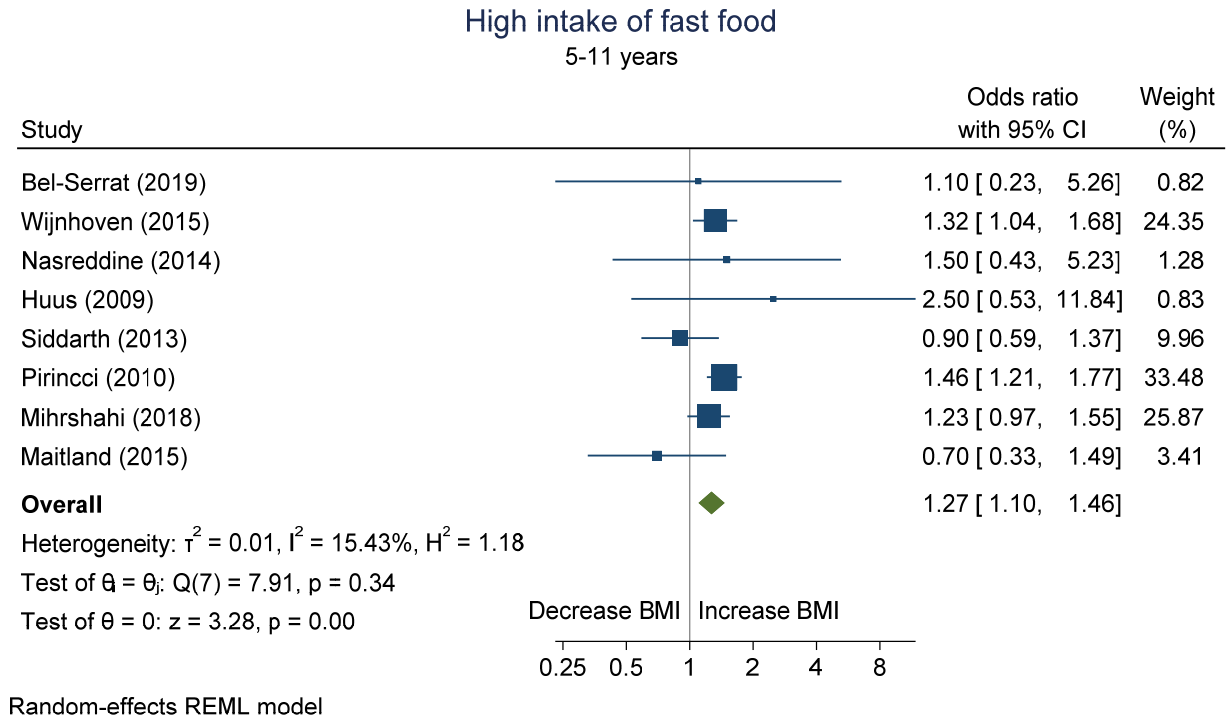


Figure S23. Association between a high intake of fast food and risk of overweight/obesity in children and adolescents 5-11 years.

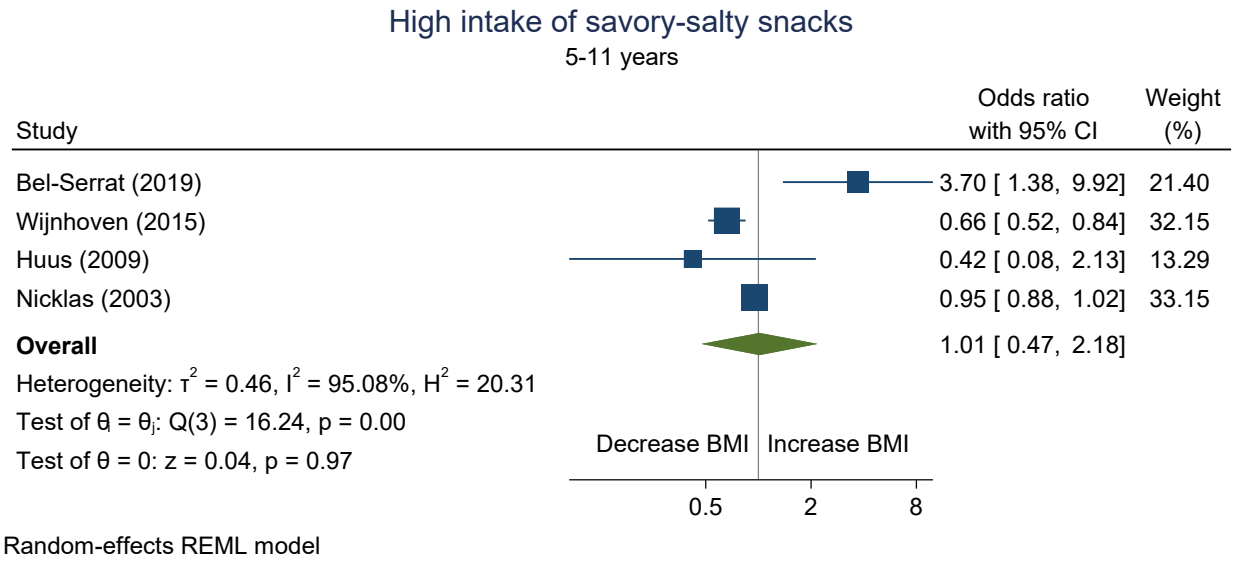


Figure S24. Association between a high intake of savory-salty snacks and risk of overweight/obesity in children and adolescents 5-11 years.

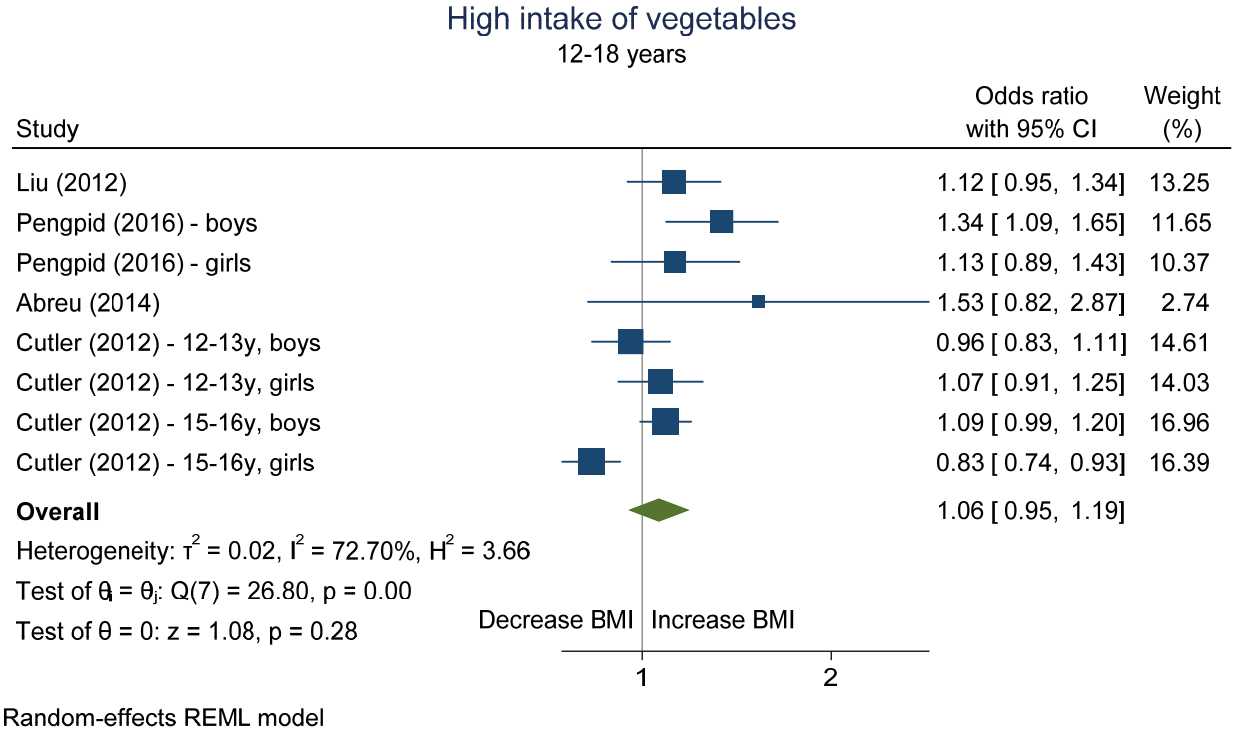


Figure S25. Association between a high intake of vegetables and risk of overweight/obesity in children and adolescents 12-18 years.

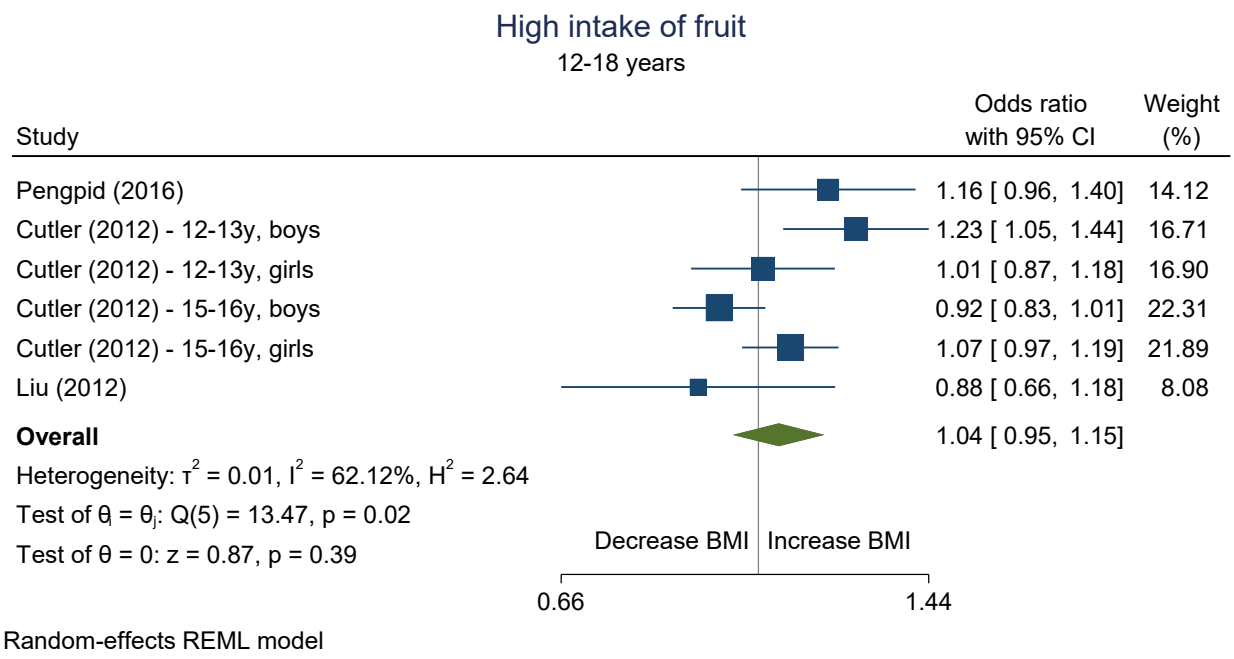


Figure S26. Association between a high intake of fruit and risk of overweight/obesity in children and adolescents 12-18 years.

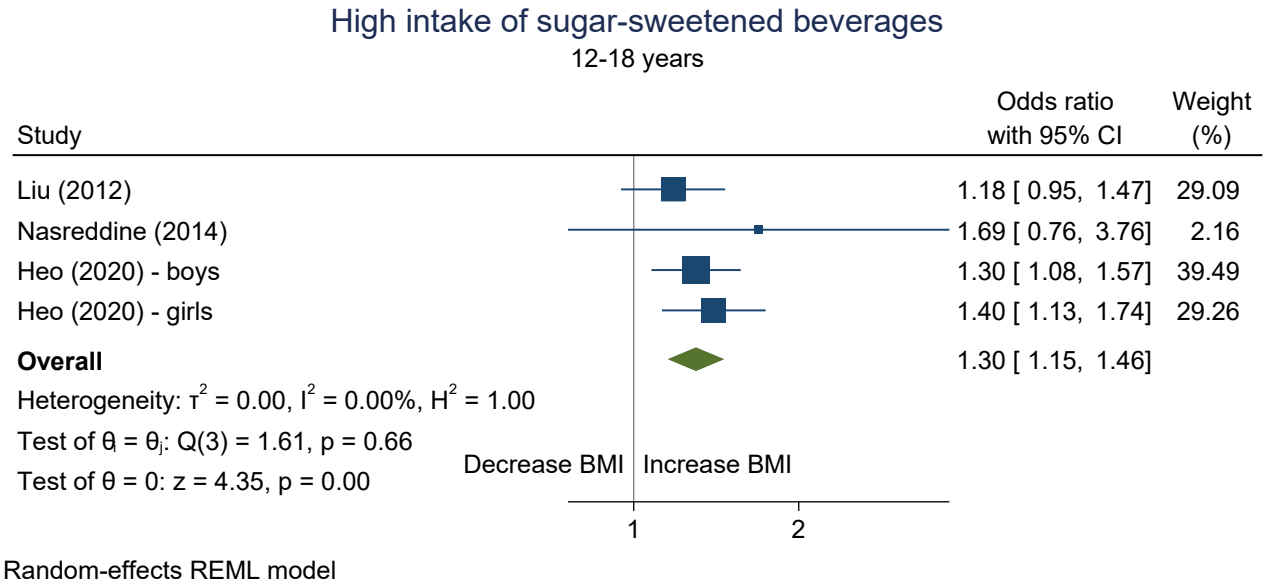


Figure S27. Association between a high intake of sugar-sweetened beverages and risk of overweight/obesity in children and adolescents 12-18 years.

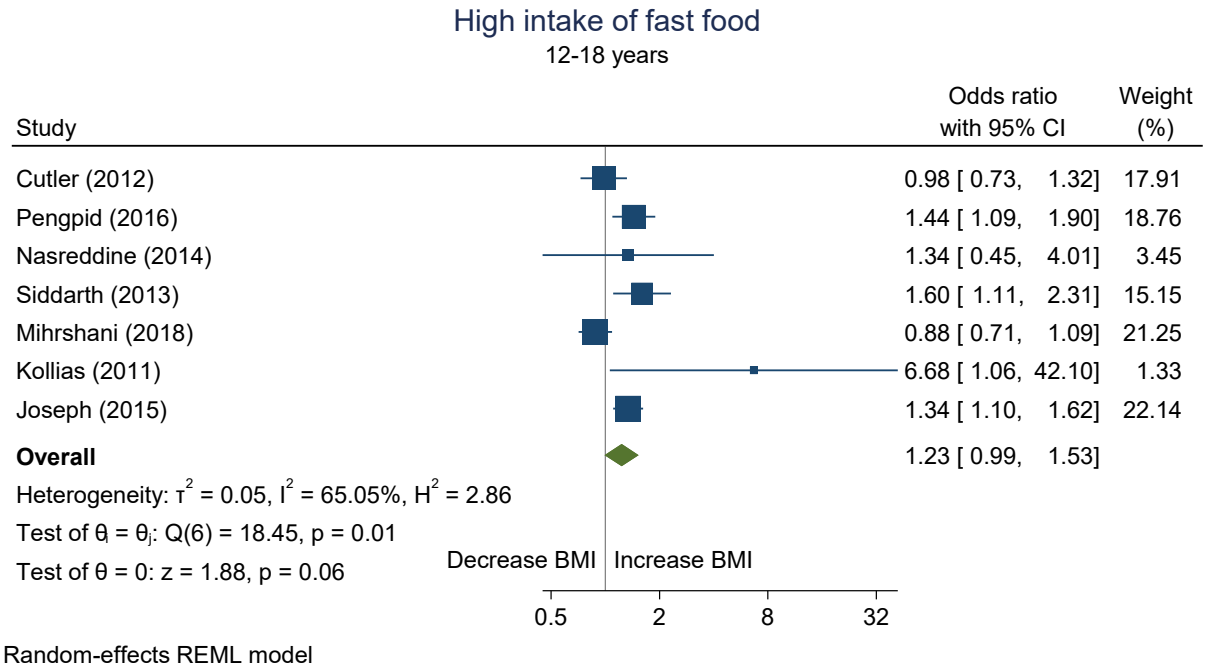


Figure S28. Association between a high intake of fast food and risk of overweight/obesity in children and adolescents 12-18 years.

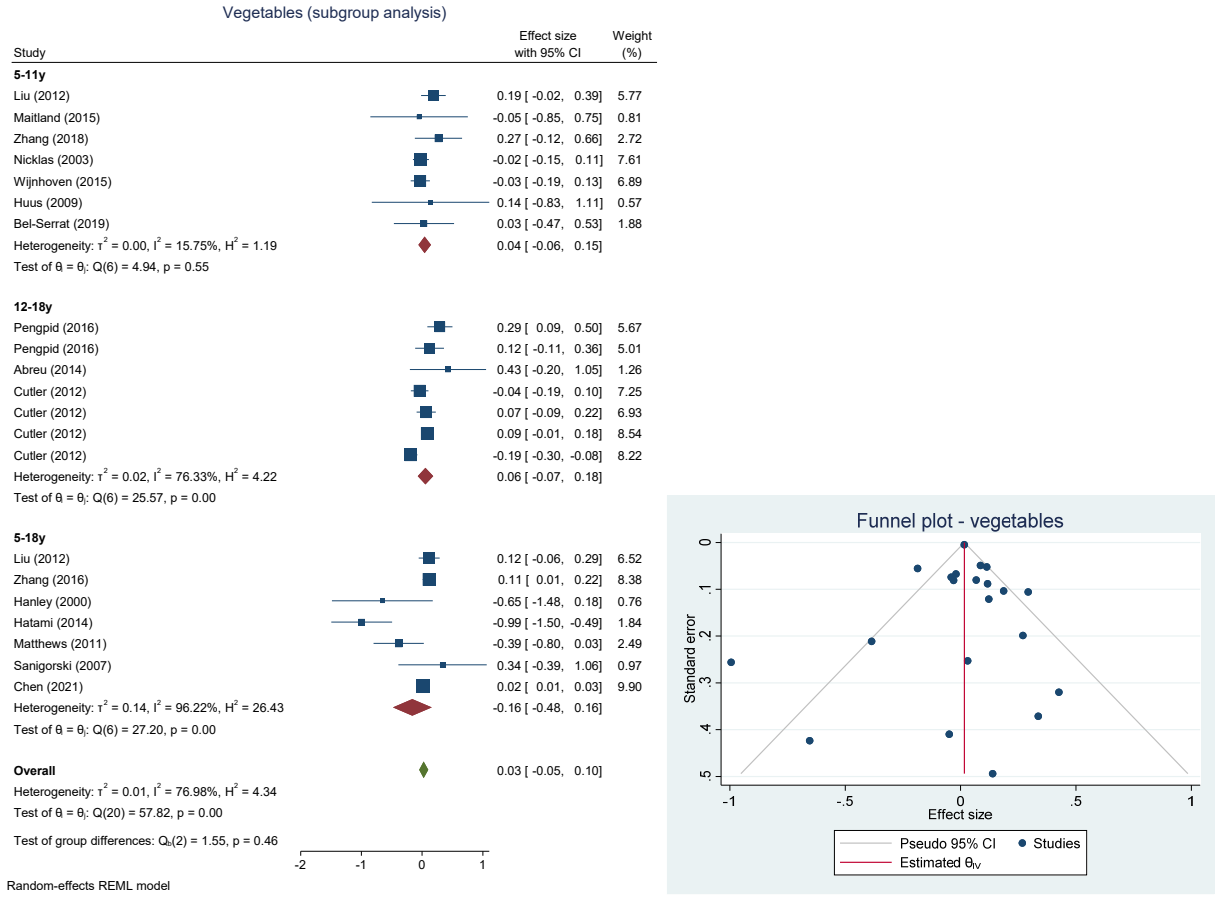


Figure S29. Subgroup analysis according to age and funnel plot investigating heterogeneity - vegetables.

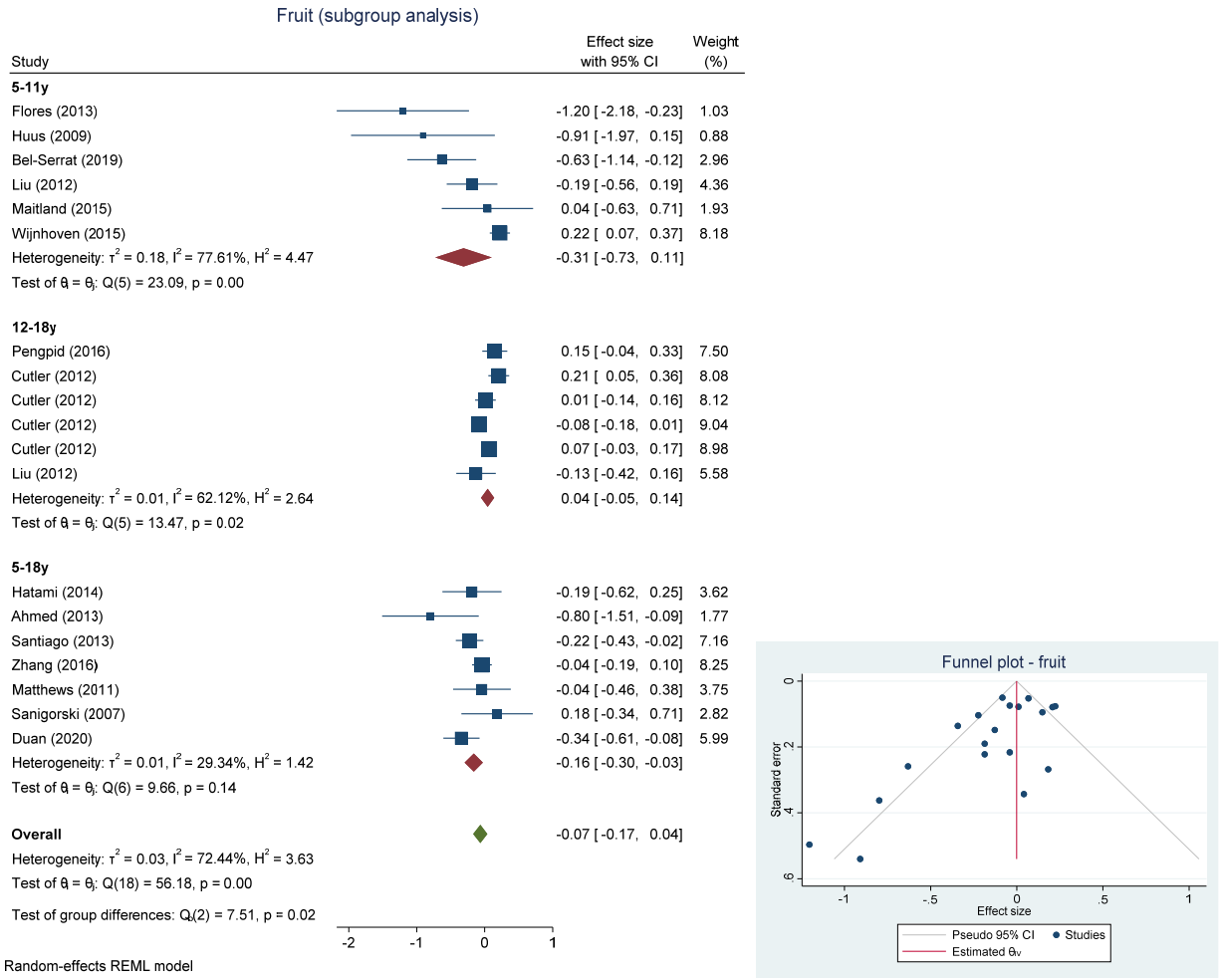


Figure S30. Subgroup analysis according to age and funnel plot investigating heterogeneity - fruit.

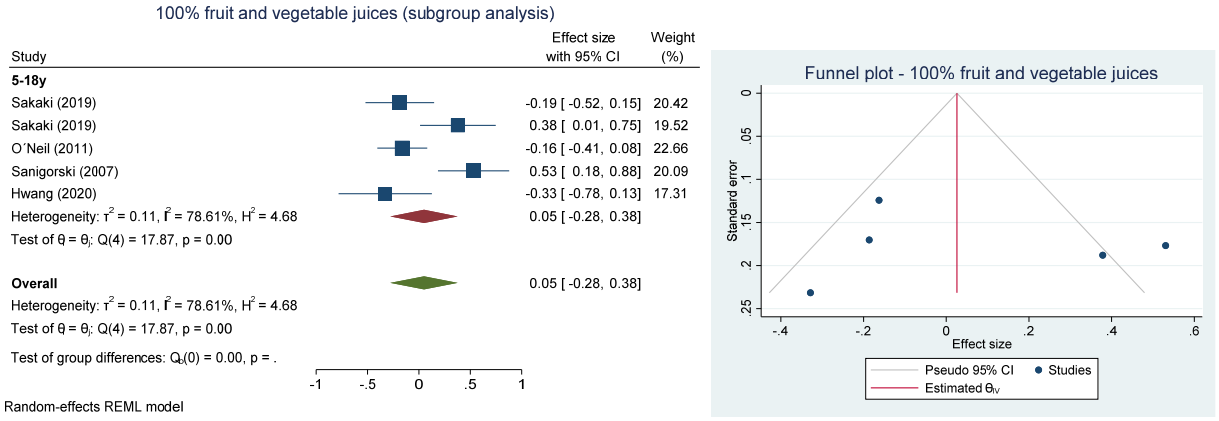
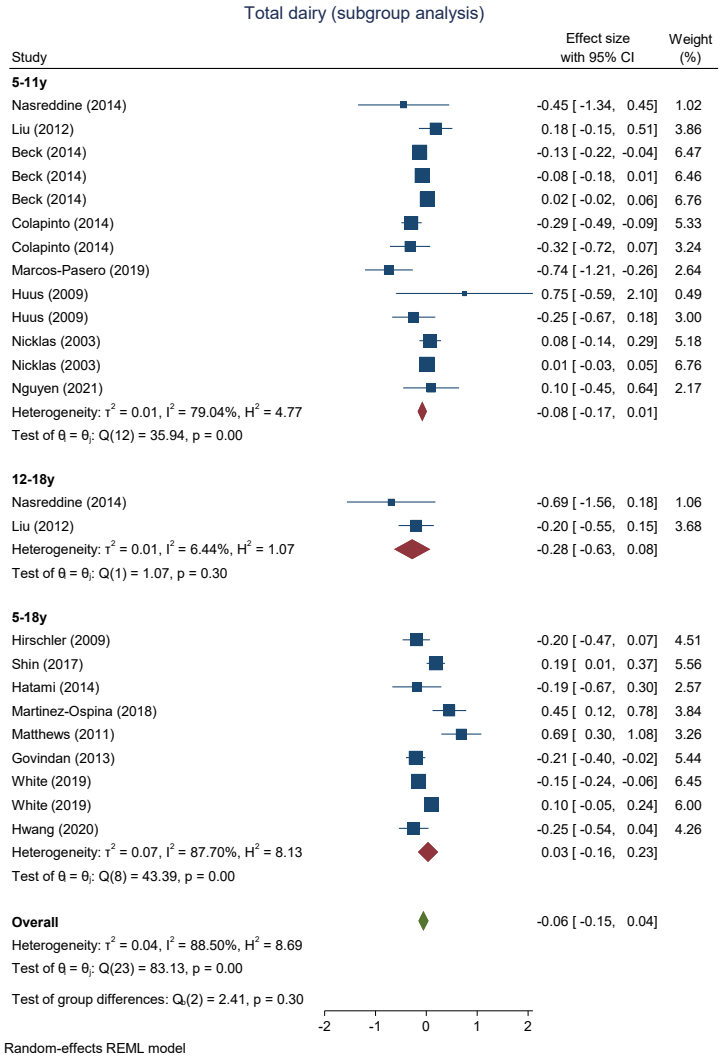


Figure S31. Subgroup analysis according to age and funnel plot investigating heterogeneity – 100% fruit and vegetables juices.



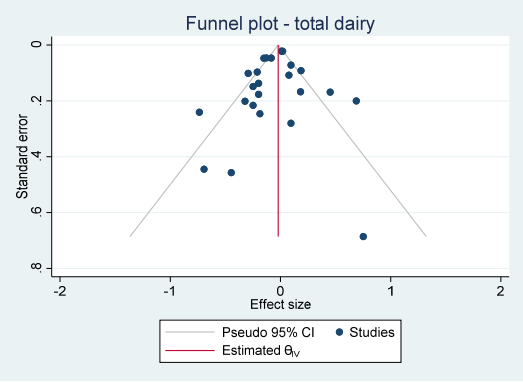
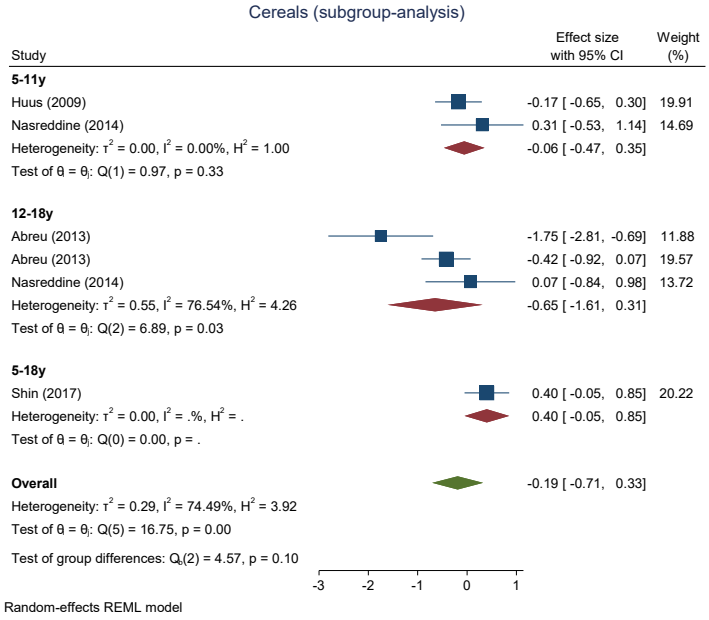


Figure S32. Subgroup analysis according to age and funnel plot investigating heterogeneity – total dairy.



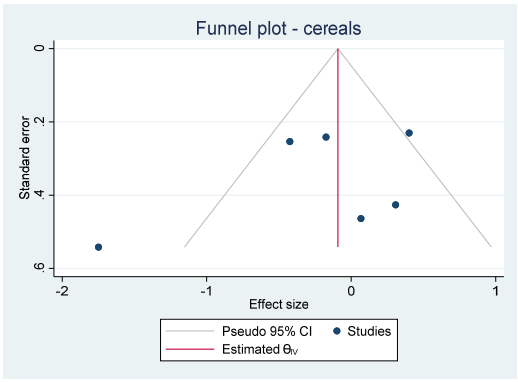


Figure S33. Subgroup analysis according to age and funnel plot investigating heterogeneity – cereals.

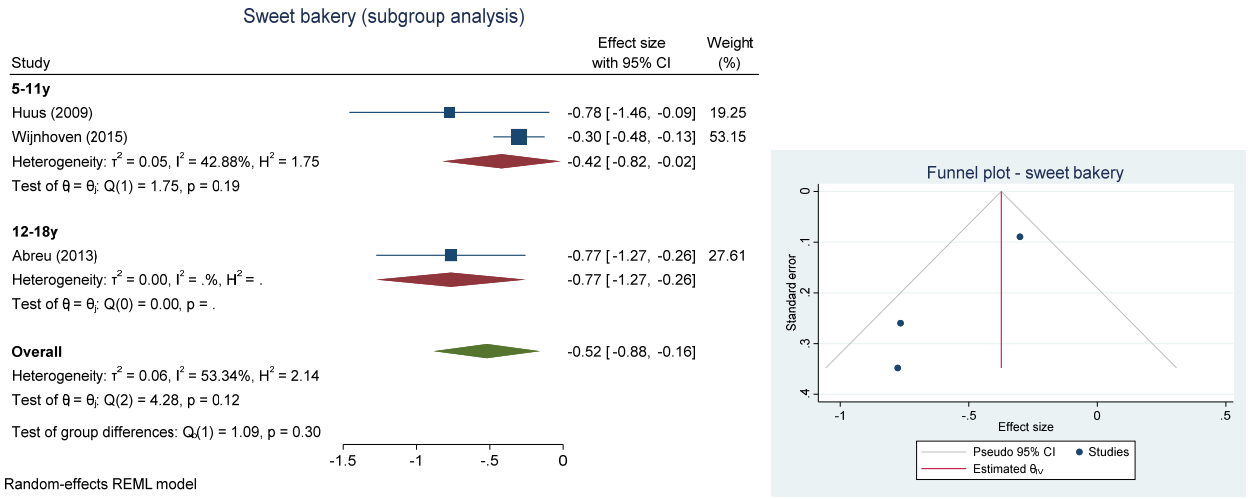


Figure S34. Subgroup analysis according to age and funnel plot investigating heterogeneity – sweet bakery.

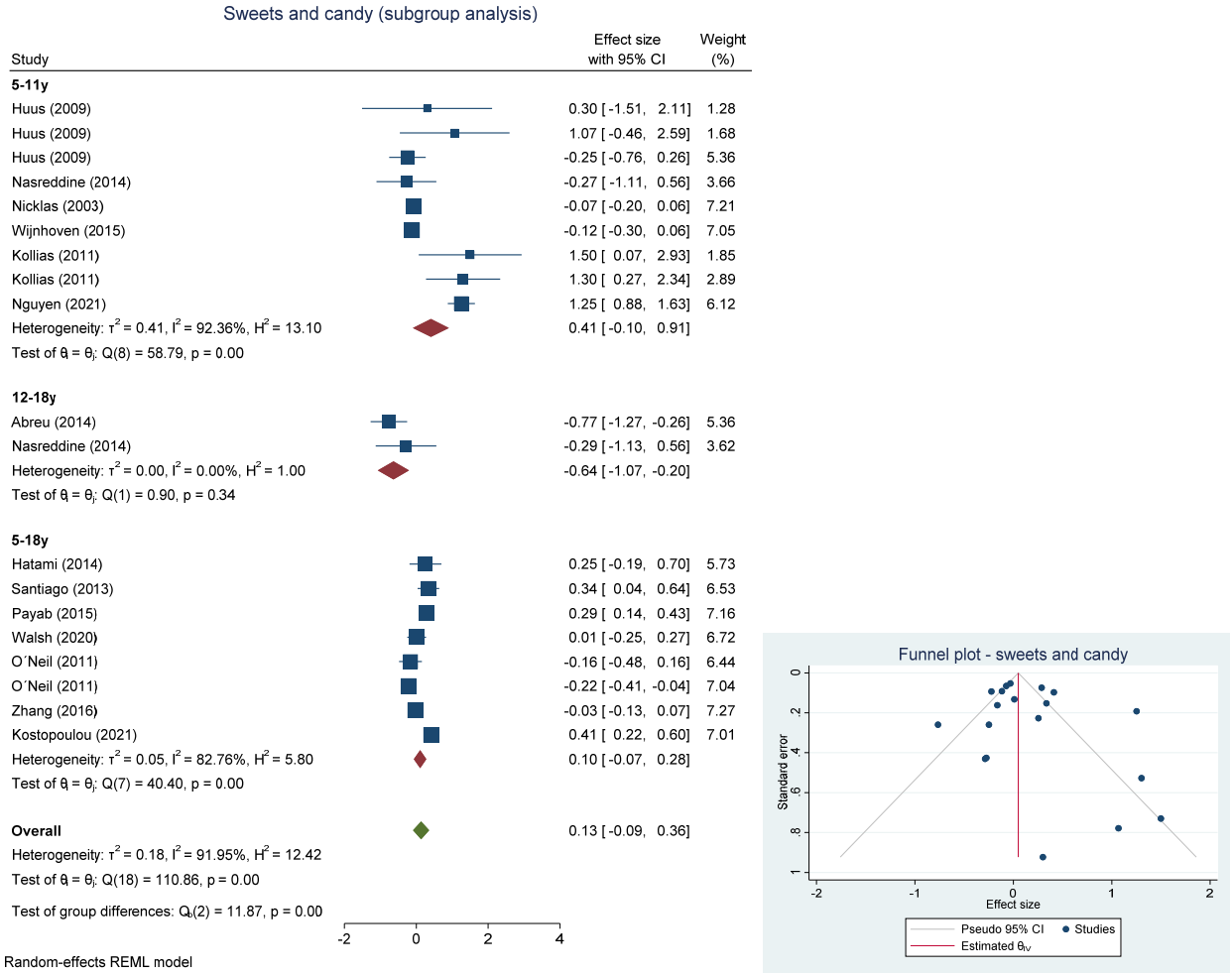


Figure S35. Subgroup analysis according to age and funnel plot investigating heterogeneity – sweets and candy.

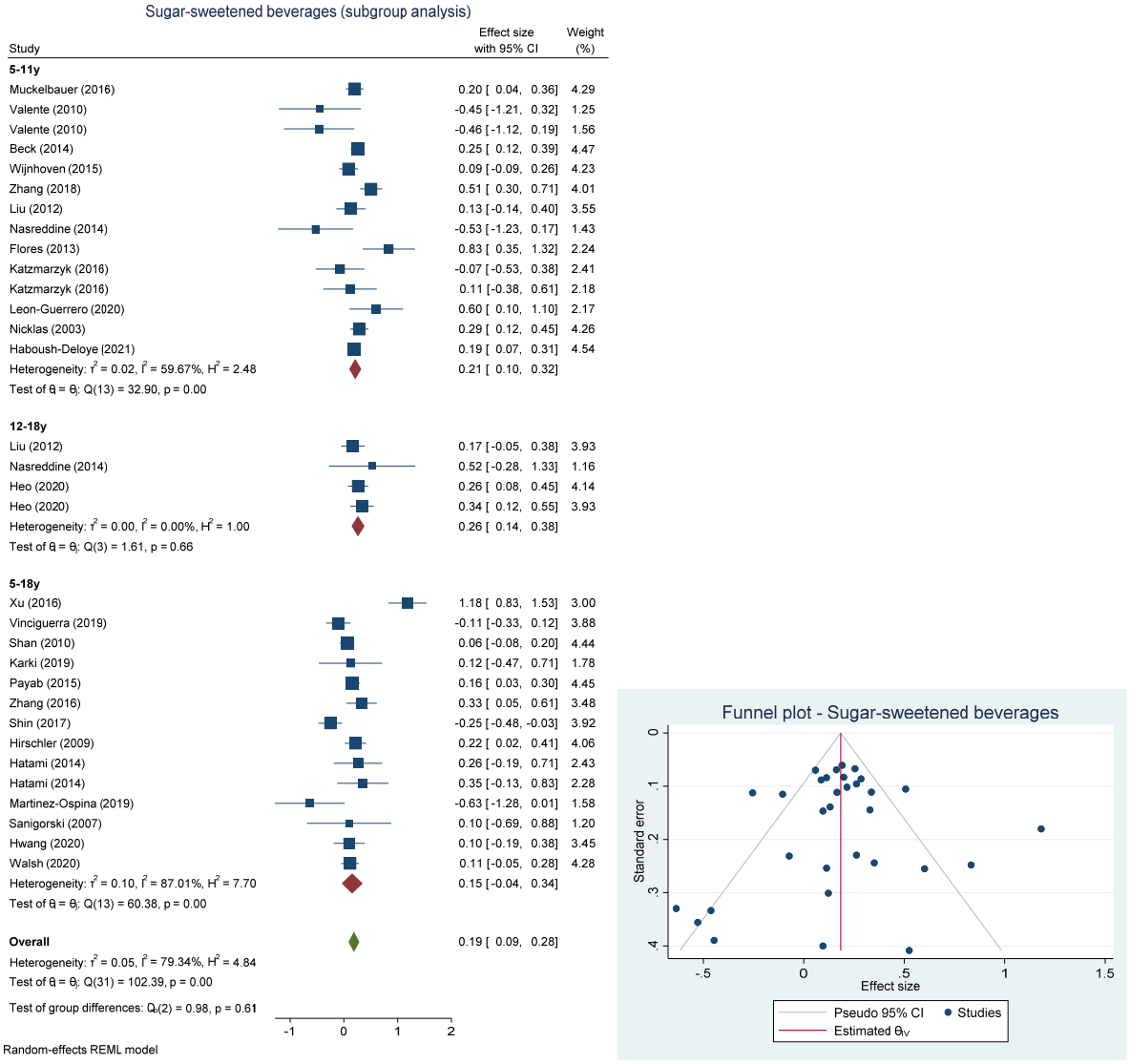


Figure S36. Subgroup analysis according to age and funnel plot investigating heterogeneity – sugar-sweetened beverages.

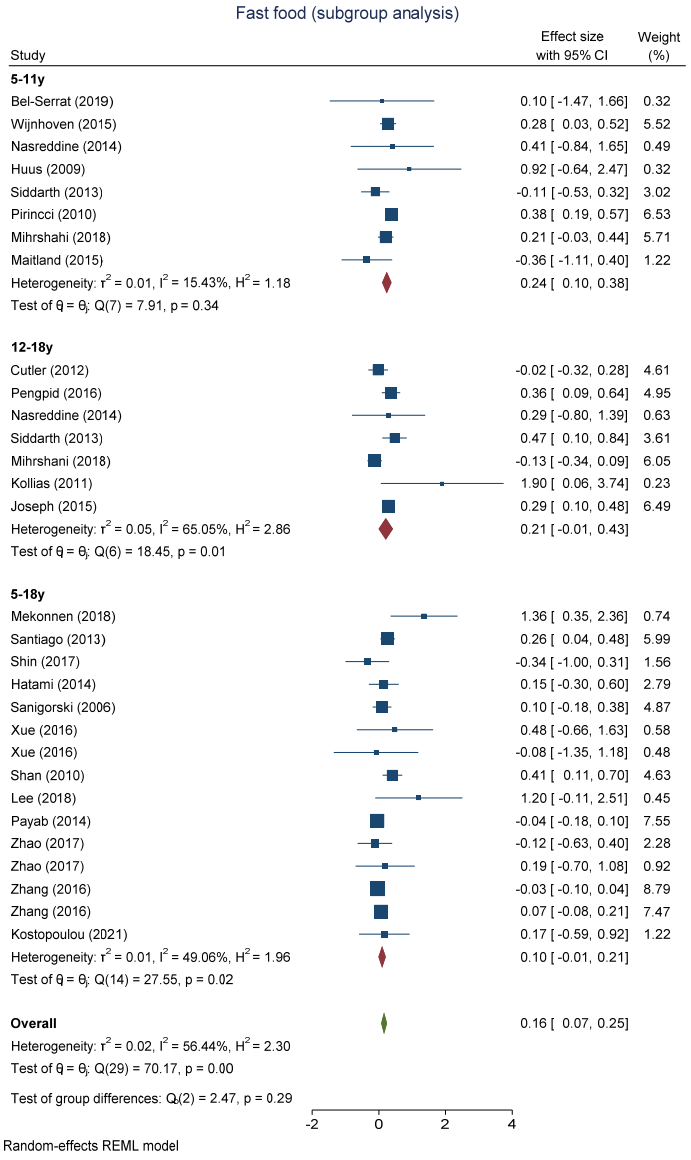


Figure S37. Subgroup analysis according to age and funnel plot investigating heterogeneity – fast food.

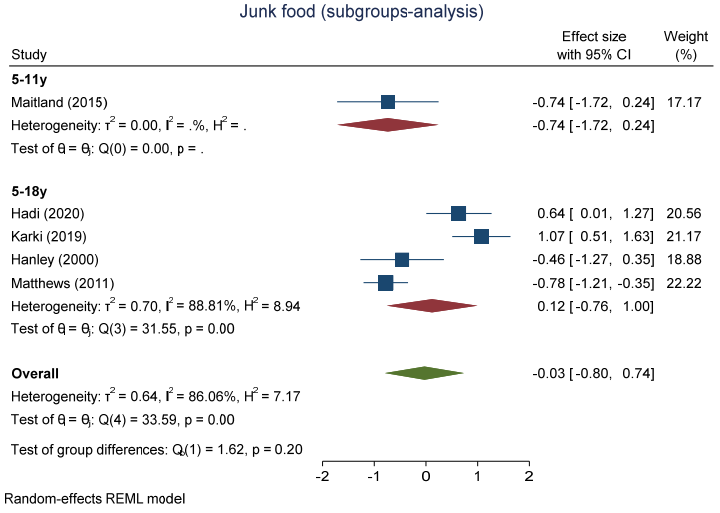


Figure S38. Subgroup analysis according to age and funnel plot investigating heterogeneity – junk food.

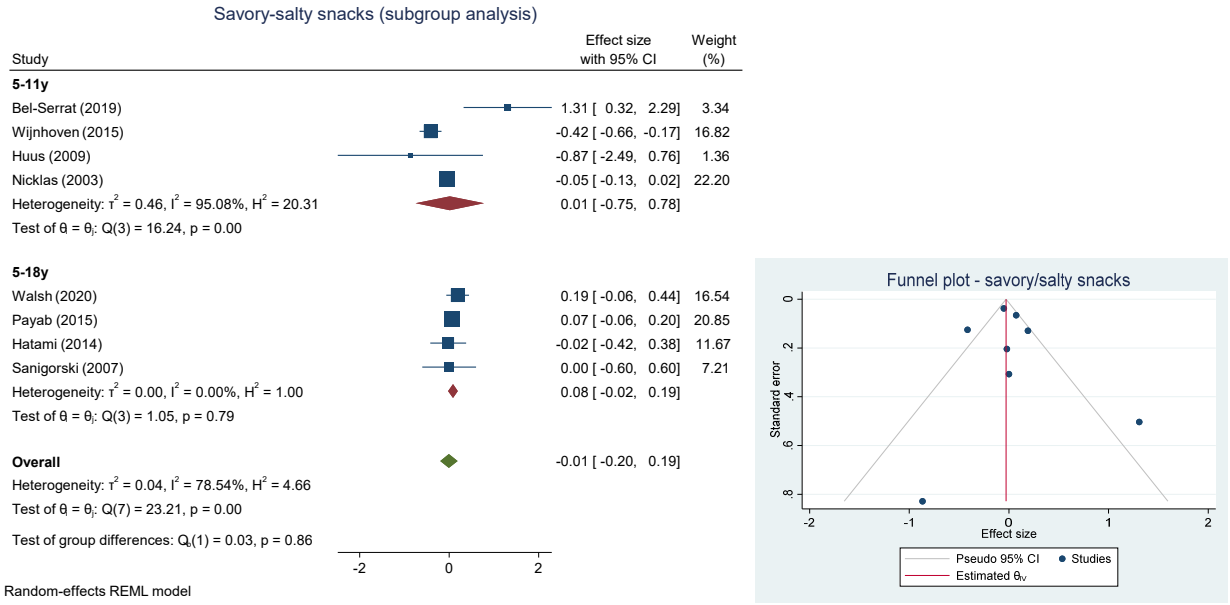


Figure S39. Subgroup analysis according to age and funnel plot investigating heterogeneity – savory-salty snacks.

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