Supplementary Material

Table.S1 Overview of the studies about the association between dietary quality and executive functions.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Author** | **Country** | **Participants** | **Sample size** | **Age** | **Executive functions measures** | **Dietary measures** | **Dietary relation to executive functions** |
| **Randomized controlled trial** |
| 2012 | Chan | China | ASD | 24 | 7-17 years | D2 Test of ConcentrationGo/No-Go TaskChildren's Color Trails TestThe Five-Point TestThe Tower of California Test | Specific Diet Modification. Experimental group children were recommended to reduce their intake of some foods | Experimental group demonstrated significantly improved mental flexibility and inhibitory control after the diet modification |
| 2010 | Kirby | UK | TD | 235 | 8-9 years | Working Memory Test Battery for Children | Supplements given to children then cheek cell analysis of fatty acid conducted to verify consumption | No relation between supplementation of omega-3 fatty acids and performance on the Working Memory Test Battery for Children after 24 weeks |
| 2016 | Whyte | UK | TD | 21 | 7-10 years | Go/No-Go TaskFlanker Task | Lab-Based Food Task | Positive relation between consumption of a wild blueberry powder drink and performance on Flanker TaskNo relation between consumption of a wild blueberry powder drink and performance on a Go/No-Go Task |
| 2016 | Ames | USA | TD | 168 | 14-17 years | Inhibition Survey for recruitment; Go/No Go Task for intervention; Implementation Intentions for intervention; Self-Ordered Point Task for working memory moderation analyses | Food Frequency QuestionnaireLab-Based Food Task | No relation between sugar sweetened beverage (SSB) and Go/No-Go Task trainingNo relation between SSB related Implementation Intentions and sugar consumed, or type of beverages consumed in the lab.Negative effect of completing SSB related Implementation Intentions as compared with control condition on calories consumed and total amount of sugar consumed.Negative effect of completing SSB related Implementation Intentions and participating in SSB related Go/No-Go Task as compared with control condition on choosing unhealthy drinks and grams of sugar consumedNo effect of completing SSB related Go/No-Go Task on number of calories consumed, number of calories consumed from beverages, grams of sugar consumed, or grams of sugar from drinks consumed.No moderation or main effect of working memory on any of the analyse |
| 2011 | Chung | Korea | TD | 28 | Tenth, Eleventh Grade Years | Computerized Neuro-psychological Test (CNT)-Stroop Task | Meals provided to participants and complicance checks conducted | No relation between diet type and (mixed grain or control group) performance on Stroop Task after 9 weeks |
| 2012 | Mohd Taib | Malaysia | TD | 30 | Kindergarten year | Cognitive Drug Research Battery (CDR)-Computerized Spatial Working Memory Task and Numeric Working Memory Task | Lab-Based Food Task | Positive relation between consumption of glucose fortified drink and spatial working memory. Positive relation between isomaltulose drink and numeric working memory. Better numeric working memory in children who received isomaltulose drink as compared with reformulated lactose drink or glucose drink |
| 2013 | Brindal | Australia | TD | 40 | 10-12 years | Attention Switching Task | Lab-Based Food Task | No relation between test drink consumed and Attention Switching Task performance |
| 2014 | Nyaradi | Australia | TD | 589 | 14 years | Groton Maze Learning Task | Food Frequency Questionnaire"Healthy" and "Western" dietary patterns were identified by factor analysis. | No relation between “healthy” diet (e.g., high in fruits, vegetables, whole grains, legumes, fish, versus “Western”) at age 14 and errors in performance on Groton Maze Learning Task at age 17Positive relation between “Western” diet (e.g., high in take-out, red meat, soft drinks, fried/refined foods, versus “Healthy”) at age 14 and errors in performance on Groton Maze Learning Task, Delayed Recall at age 17 |
| 2009 | Kennedy | UK | TD | 90 | 10-12 years | CDR Battery-Computerized Numeric Working Memory Task | Diary card to conduct compliance with intervention | No relation between any level of DHA supplementation and performance on Numeric Working Memory Task after 56 days of supplementation |
| **Longitudinal** |
| 2010 | Riggs | USA | TD | 184 | Fourth grade year | Behavior Rating Inventory of Executive Function (BRIEF-SR) | Food Frequency QuestionnaireCalculated the intake of Snack food, Vegetable and Fruit | No relation between BRIEF-SR scores and snack food consumptionPositive relation between BRIEF-SR scores and fruit/vegetable consumption  |
| 2015 | Tate | USA | TD | 1005 | Fourth grade year | Behavior Rating Inventory of Executive Function (BRIEF-SR) | Food Frequency QuestionnaireCalculated the intake of Snack food | No relation between BRIEF-SR scores and “high-calorie low nutrient” snack food consumption |
| **Cohort** |
| 2016 | Stautz | UK | TD | 6069 | 7-13 years | Stop Signal Task | Food DiaryCalculated the average amount of fruit and vegetables, in grams, consumed per day over the three day period | No relation between Stop-Signal Task performance and fruit and vegetable consumption |
| **Cross-sectional** |
| 2012 | Riggs | USA | TD | 1587 | Fourth grade year | Behavior Rating Inventory of Executive Function (BRIEF-SR) | Food Frequency QuestionnaireCalculated the intake of Snack food, Vegetable and Fruit | Negative relation between BRIEF-SR scores and snack food consumptionPositive relation between BRIEF-SR scores and fruit/vegetable consumption |
| 2010 | Riggs | USA | TD | 107 | Fourth grade year | Behavior Rating Inventory of Executive Function (BRIEF-SR) | Food Frequency QuestionnaireCalculated the intake of Snack food, Vegetable and Fruit | Negative relation between BRIEF-SR scores and snack food consumptionNo relation between BRIEF-SR scores and fruit or vegetable intake |
| 2015 | Khan | USA | TD | 65 | 7-9 years | Flanker Task | Three-day food records were used to conduct nutrient-level analyses and to calculate diet quality (Healthy Eating Index-2005) scores | Positive relation between Flanker task performance and dietary fiber intake, overall diet qualityNegative relation between Flanker task performance and fat, cholesterol intake |
| 2015 | Levitan | Canadian | TD | 193 | 48 months | Stop-Signal Task | Lab-Based Food TaskCalculated the intake of fat, carbohydrates and protein | Negative relation between Stop-Signal Task performance and intake of carbohydrates, sugarsNo relation between Stop-Signal Task performance and total caloric intake, intake of protein, fats |
| 2015 | Nederkoorn | Netherlands | TD | 88 | 7-9 years | Stop-Signal Task | Lab-Based Food TaskMeasured caloric intake | Negative relation between Stop-Signal Task performance and intake of candy, chips |
| 2014 | Ames | USA | TD | 198 | 14-17 years | Go/No-Go Task | Food Frequency QuestionnaireCalculated average intake | Negative relation between Go/No-Go Task performance and sweet, salty/fatty snack consumption(males)No relation between Go/No-Go Task performance and sweet, salty/fatty snack consumption(females)No relation between Go/No-Go Task performance and sugar sweetened beverage consumption(males or females) |
| 2008 | Guerrieri | Netherlands | TD | 78 | 8-10 years | Stop-Signal Task | Lab-Based Food TaskCalculated total caloric intake | No relation between Stop-Signal Task performance and caloric intake |
| 2013 | Pieper | USA | TD | 29 | 3-6 years | Flanker Task | Lab-Based Food TaskMeasured caloric intake | No relation between calories consumed (total, sweet or savory) and performance on the Flanker Task |
| 2017 | Sheppard | USA | TD | 41 | 7-9 years | CANTAB-Computerized Spatial Working Memory Task | 24-Hour Dietary RecallBlood samples were collected for fatty acids identification and quantification | No relation between n-6: n-3 fatty acid ratio or mean n-3 fatty acid intake and Spatial Working Memory Task performance |
| 2005 | Zhang | USA | TD | 3666 | 6-16 years | Digit Span subtests-Wechsler Intelligence Scale for Children Revised (WISC-R) | 24-Hour Dietary Recall Estimated dietary intakes of total fat, SFA, monounsaturated fatty, PUFAs, and cholesterol | Positive relation between Digit Span performance and polyunsaturated fat consumptionNegative relation between Digit Span performance and cholesterol consumptionNo relation between Digit Span performance and other dietary variables |
| 2013 | Sheppard | USA | TD | 69 | 7-9 years | Cambridge Neuropsychological Test Assessment Battery(CANTAB)-Spatial Span Task(computerized digit span task); Spatial Working Memory Task | 24-Hour Dietary RecallCalculated total n-6 fatty acids, total n-3 fatty acids, and kilocalorie intake | No relation between consumption of fatty acids and Spatial Span Task performanceTrending positive relation between n:6-n:3 fatty acid ratio and performance on the Spatial Working Memory TaskNo relation between other consumption variables and Spatial Working Memory Task |

Table.S2 Components of DBI\_16(1)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Components** | **Score** | **Subgroup** | **Score** | **Intake range by energy levels based on the *Chinese Dietary Guidelines* (2016)** |
| **4180kJ** | **5020kJ** | **5860kJ** | **6700kJ** | **7550kJ** | **8350kJ** | **9200kJ** | **10050kJ** | **10900kJ** | **11700kJ** | **12550kJ** |
| **1000kcal** | **1200kcal** | **1400kcal** | **1600kcal** | **1800kcal** | **2000kcal** | **2200kcal** | **2400kcal** | **2600kcal** | **2800kcal** | **3000kcal** |
| C1- Cereal\* | (-12)-12 | Cereal  | (-12)-12# | 0g=-12 | <15g=-12 | 0g=-12 | <10g=-12 | <35g=-12 | <5g=-12 | <30g=-12 | 0g=-12 | 0g=-12 | <75g=-12 | <100g=-12 |
| 75-95g=0 | 90-110g=0 | 125-175g=0 | 175-225g=0 | 200-250g=0 | 225-275g=0 | 250-300g=0 | 275-325g=0 | 275-325g=0 | 350-400g=0 | 375-425g=0 |
| >170g=12 | >185g=12 | >250g=12 | >390g=12 | >415g=12 | >495g=12 | >520g=12 | >600g=12 | >600g=12 | >675g=12 | >700g=12 |
| C2- Vegetable and fruit | (-12)-0 | Vegetable | (-6)-0 | ≥ 200g=0 | ≥ 250g=0 | ≥ 300g=0 | ≥ 400g=0 | ≥ 450g=0 | ≥ 500g=0 | ≥ 600g=0 |
| 160-199g=-1 | 200-249g=-1 | 240-299g=-1 | 320-399g=-1 | 360-449g=-1 | 400-499g=-1 | 480-599g=-1 |
| score decreased 1 with intake amount decreased 40g | score decreased 1 with intake amount decreased 50g | score decreased 1 with intake amount decreased 60g | score decreased 1 with intake amount decreased 80g | score decreased 1 with intake amount decreased 90g | score decreased 1 with intake amount decreased 100g | score decreased 1 with intake amount decreased 120g |
| 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 |
| Fruit | (-6)-0 | ≥ 150g=0; 120-149g=-1 | ≥ 200g=0; 160-199g=-1 | ≥ 300g=0; 240-299g=-1 | ≥ 350g=0; 280-349g=-1 | ≥ 400g=0; 320-399g=-1 |
| score decreased 1 with intake amount decreased 30g | score decreased 1 with intake amount decreased 40g | score decreased 1 with intake amount decreased 60g | score decreased 1 with intake amount decreased 70g | score decreased 1 with intake amount decreased 80g |
| 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 | 0g=-6 |

|  |
| --- |
| (Continued) |
| **Components** | **Score** | **Subgroup** | **Score** | **Intake range by energy levels based on the *Chinese Dietary Guidelines* (2016)** |
| **4180kJ** | **5020kJ** | **5860kJ** | **6700kJ** | **7550kJ** | **8350kJ** | **9200kJ** | **10050kJ** | **10900kJ** | **11700kJ** | **12550kJ** |
| **1000kcal** | **1200kcal** | **1400kcal** | **1600kcal** | **1800kcal** | **2000kcal** | **2200kcal** | **2400kcal** | **2600kcal** | **2800kcal** | **3000kcal** |
| C3-Milk and dairy products Soybean and soybean products | (-12)-0 | Dairy | (-6)-0 | ≥ 500g=0, | ≥ 350g=0, | ≥ 300g=0, score decreased 1 with intake amount decreased 60g |
|  |  | score decreased 1 with intake amount decreased 100g | score decreased 1 with intake amount decreased 70g | 0g=-6 |
|  |  | 0g=-6 | 0g=-6 |  |
| Soybean | (-6)-0 | ≥ 5g=0 | ≥ 15g=0 | ≥ 25g=0 |
|  |  | score decreased 1 with intake amount decreased 1g | score decreased 1 with intake amount decreased 3g | score decreased 1 with intake amount decreased 5g |
|  |  | 0g=-6 | 0g=-6 | 0g=-6 |

|  |
| --- |
| (Continued) |
| **Components** | **Score** | **Subgroup** | **Score** | **Intake range by energy levels based on the *Chinese Dietary Guidelines* (2016)** |
| **4180kJ** | **5020kJ** | **5860kJ** | **6700kJ** | **7550kJ** | **8350kJ** | **9200kJ** | **10050kJ** | **10900kJ** | **11700kJ** | **12550kJ** |
| **1000kcal** | **1200kcal** | **1400kcal** | **1600kcal** | **1800kcal** | **2000kcal** | **2200kcal** | **2400kcal** | **2600kcal** | **2800kcal** | **3000kcal** |
| C4- Animal food | (-12)-8 | Red meat and products, Poultry and game | (-4)-4 | 0g=-3 | 0g=-4 | 0g=-4 | 0g=-4 | 0g=-4 | 0g=-4 |
| 1-5g=-2 | 1-5g=-3 | 1-10g=-3 | 1-15g=-3 | 1-20g=-3 | 1-25g=-3 |
| 6-10g=-1 | 6-10g=-2 | 11-20g=-2 | 16-30g=-2 | 21-40g=-2 | 26-50g=-2 |
| 11-20g=0 | 11-15g=-1 | 21-30g=-1 | 31-45g=-1 | 41-60g=-3 | 51-75g=-1 |
| 21-25g=1 | 16-35g=0 | 31-50g=0 | 46-55g=0 | 61-90g=0 | 76-125g=0 |
| 26-30g=2 | 36-40g=1 | 51-60g=1 | 56-70g=1 | 91-110g=1 | 126-150g=1 |
| 31-35g=3 | 41-45g=2 | 61-70g=2 | 71-85g=2 | 111-130g=2 | 151-175g=2 |
| >35g =4 | 46-50g=3 | 71-80g=-3 | 85-100g=3 | 131-150g=3 | 176-200g=3 |
|  | >50g =4 | >80g =4 | >100g =4 | >150g=4 | >200g=4 |
| Fish and shrimp | (-4)-0 | 0g=-4 | <5g=-4 | <10g=-4 | <10g=-4 | 0g=-4 | <25g=-4 | <50g=-4 |
| 1-4g=-3 | 5-9g=-3 | 10-19g=-3 | 10-19g=-3 | 1-24g=-3 | 25-49g=-3 | 50-74g=-3 |
| 5-9g=-2 | 10-14g=-2 | 20-29g=-2 | 20-29g=-2 | 25-49g=-2 | 50-74g=-2 | 75-99g=-2 |
| 10-14g=-1 | 15-19g=-1 | 30-39g=-1 | 30-39g=-1 | 50~74g=-1 | 75-99g=-1 | 100-124g=-1 |
| ≥ 15g=0 | ≥ 20g=0 | ≥ 40g=0 | ≥ 40g=0 | ≥ 75g=0 | ≥ 100g=0 | ≥ 125g=0 |
| Egg | (-4)-4 | 0g=-4 ; | <5g=-4;6-10g=-3;11-15g= | 0g=-4;1-10g=-3;11-20g=- | 0g=-4;1-15g=-3;16-30g=-2;31-45g=-1;46-55g=0;56-70g=1;71-85g=2;85-100g= |
| 1-5g=-3; | -2;16-20g=-1;21-30g=0;3 | 2;21-30g=-1;31-50g=0;51 | 3;>100g =4 |
| 6-10g=-2; | 1-35g=1;36-40g=2;41-45g | -60g=1;61-70g=2;71-80g |  |
| 11-15g=-1; | =3;>45g =4 | =-3;>80g =4 |  |
| 16-25g=0; |  |  |  |
| 26-30g=1; |  |  |  |
| 31-35g=2; |  |  |  |
| 36-40g=3; |  |  |  |
| >40g =4 |  |  |  |

|  |
| --- |
| (Continued) |
| **Components** | **Score** | **Subgroup** | **Score** | **Intake range by energy levels based on the *Chinese Dietary Guidelines* (2016)** |
| **4180kJ** | **5020kJ** | **5860kJ** | **6700kJ** | **7550kJ** | **8350kJ** | **9200kJ** | **10050kJ** | **10900kJ** | **11700kJ** | **12550kJ** |
| **1000kcal** | **1200kcal** | **1400kcal** | **1600kcal** | **1800kcal** | **2000kcal** | **2200kcal** | **2400kcal** | **2600kcal** | **2800kcal** | **3000kcal** |
| C5-Empty energy food | 0-12 | Cooking oil | 0-6## | ≤ 20g=0 | ≤ 25g=0 | ≤ 30g=0 | ≤ 35g=0 |
| 21-25g=1 | 26-30g=1 | 31-35g=1 | 36-40g=1 |
| >45g=6 | >50g=6 | >55g=6 | >60g=6 |
| Alcoholic beverage | 0-6 | Male：≤ 25g=0 26-40g=1 26-100g score increased 1 with intake amount increased 15g >100g=6(25g alcohol=750ml beer or 250ml wine or 75g liquor (38°) or 50g liquor (> 38°)) |
| Female:≤15g=0 16g=1 16-25g=1 score increased 1 with intake amount increased 10g >65g=6(15g alcohol=450ml beer or 150ml wine or 50g liquor(38°) or 30g liquor(> 38°)) |
| C6-Condiments | 0-12 | Addible sugar | 0-6 | ≤ 25g=0 26g=1 score increased 1 with intake amount increased 5g >50g=6 |
|  |
| C7- Diet variety | (-12)-0 | Diet variety | (-12)-0 | ≥ 12 kinds of food (soybean is 5g)=0, score decreased 1 with decreased 1 kinds of food |  |
|  |
| C8- Drinking water | (-12)-0 | Drinking water | (-12)-0 | ≥ 1200ml=0 score decreased 1 with intake amount decreased 100ml, <100ml=-12 |  |
|  |
| \*Cereal include rice, wheat, dried legumes (exclude soybean) and tubers. Intake amount means fresh amount. Sweat potato: intake amount divided by 3; potato: intake amount divided by 4; yam and yambean: divided by 6; score increased (decreased) 2 with 15g intake increased (decreased) when the energy intake level is 1000 and 1200; score increased (decreased) 2 with 25g intake increased (decreased) when the energy intake level is 1400 kcal; 1 with 15g intake for 1600 and 1800 kcal; 1 with 20g for 2000 and 2200 kcal; and 1 with 25g for the energy intake level more than 2400 kcal；# score increased(decreased) 2 with 50g intake increased(decreased) from 0 to maximal (minimal) score；## score increased 1 with intake amount increased 5g from score 1 to 6. |

**Table.S3** **Comparison of DBI\_16 indicator among children with ASD and TD children**

|  |  |  |  |
| --- | --- | --- | --- |
| DBI\_16 indicator | ASDN (%) | TDN (%) | *P* value |
|  | N=106 | N=207 |  |
| HBS |  |  | 0.24 |
| No problem | 0 (0.0) | 2 (1.0) |  |
| Almost no problem | 73 (68.9) | 160 (77.3) |  |
| Low level | 29 (27.4) | 40 (19.3) |  |
| Moderate level and High level | 4 (3.8) | 5 (2.4) |  |
| LBS |  |  | **0.01** |
| No problem and almost no problem | 6 (5.7) | 15 (7.2) |  |
| Low level | 55 (51.9) | 141 (68.1) |  |
| Moderate level | 40 (37.7) | 48 (23.2) |  |
| High level | 5 (4.7) | 3 (1.4) |  |
| DQD |  |  | **0.01** |
| No problem and almost no problem | 3 (2.8) | 12 (5.8) |  |
| Low level | 64 (60.4) | 151 (72.9) |  |
| Moderate level and High level | 39 (36.8) | 44 (21.3) |  |
| **Abbreviation:** ASD, autism spectrum disorder; TD, typically developing; DBI\_16, The Chinese Dietary Balance Index\_16; LBS, Lower Bound Score; HBS, Higher Bound Score; DQD, Diet Quality Distance. |

**Table.S4** **Comparison of** **DBI\_16 components among children with ASD and TD children**

|  |  |  |  |
| --- | --- | --- | --- |
| DBI\_16 components | ASDMean (SD) | TDMean (SD) | *P* value |
|  | N=106 | N=207 |  |
| Cereals | -1.2 (7.0) | 0.8 (6.0) | 0.64 |
| Vegetable | -4.0 (1.4) | -4.1 (1.1) | 0.63 |
| Fruit | -3.8 (1.4) | -3.4 (1.5) | **0.01** |
| Dairy | -2.3 (1.8) | -1.9 (1.6) | **0.02** |
| Soybean | -2.9 (2.3) | -2.6 (2.3) | 0.23 |
| Meat | 2.0 (2.4) | 2.2 (2.1) | 0.36 |
| Fish and shrimp | -2.4 (1.3) | -2.5 (1.2) | 0.67 |
| Egg | -0.2 (1.5) | -0.2 (1.7) | 0.86 |
| Cooking oil | 1.0 (0.5) | 0.9 (0.6) | 0.50 |
| Alcoholic beverage | 0 | 0 | - |
| Addible sugar | 2.4 (2.8) | 2.0 (2.6) | 0.18 |
| Salt | 0.9 (0.3) | 0.9 (0.4) | 0.13 |
| Variety | -4.1 (1.9) | -3.7 (1.9) | **0.047** |
| Water | -4.7 (3.3) | -4.7 (3.0) | 0.87 |

**Abbreviation:** ASD, autism spectrum disorder; TD, typically developing; SD, standard deviation; DBI\_16, The Chinese Dietary Balance Index\_16.

Reference

1. He Y, Fang Y, Xia J. Update of the Chinese Diet Balance Index:DBI\_16. Acta Nutrimenta Sinica. 2018;40(6):526-30.