



**UNIVERSITY
OF TURKU**

This is a self-archived – parallel published version of an original article. This version may differ from the original in pagination and typographic details. When using please cite the original.

AUTHOR Jing Chen Ph.D., Feitong Wu Ph.D., Costan G. Magnussen Ph.D., Katja Pahkala Ph.D., Markus Juonala M.D., Ph.D., Juuso O. Hakala M.D., Satu Männistö Ph.D., Nina Hutri-Kähönen M.D., Ph.D., Jorma S. A. Viikari M.D., Ph.D.h, Olli T. Raitakari M.D., Ph.D., Suvi P. Rovio Ph.D.

TITLE Dietary patterns from youth to adulthood and cognitive function in midlife: The cardiovascular risk in Young Finns Study

YEAR 2023

DOI <https://doi.org/10.1016/j.nut.2023.112063>

VERSION Author's accepted manuscript

COPYRIGHT License: [CC BY NC ND](https://creativecommons.org/licenses/by-nc-nd/4.0/)

CITATION Jing Chen, Feitong Wu, Costan G. Magnussen, Katja Pahkala, Markus Juonala, Juuso O. Hakala, Satu Männistö, Nina Hutri-Kähönen, Jorma S.A. Viikari, Olli T. Raitakari, Suvi P. Rovio, Dietary patterns from youth to adulthood and cognitive function in midlife: The cardiovascular risk in Young Finns Study, Nutrition, Volume 112, 2023, 112063, ISSN 0899-9007, <https://doi.org/10.1016/j.nut.2023.112063>. (<https://www.sciencedirect.com/science/article/pii/S089990072300093X>)

1 **Dietary patterns from youth to adulthood with cognitive function in midlife: the**
2 **Cardiovascular Risk in Young Finns Study**

3 **Abstract**

4 **Importance** Diet plays an important role in cognitive health, but the long-term association of
5 early life diet with cognitive function in adulthood remains unknown.

6 **Objective** To examine if youth, adulthood, and long-term dietary patterns from youth to
7 adulthood associate with cognitive function in midlife.

8 **Design, Setting, and Participants** Population-based cohort study that had dietary intake
9 assessed in year 1980 (baseline, participants aged 3-18 years), 1986, 2001, 2007, and 2011
10 and cognitive function assessed in year 2011.

11 **Exposures** Six dietary patterns were derived from 48-h food recall or food frequency
12 questionnaire using factor analysis: traditional Finnish, high-carbohydrate, vegetables and
13 dairy products, traditional Finnish and high-carbohydrate, red meat, and healthy. Scores of
14 long-term dietary patterns were calculated as the average between youth and adulthood.

15 **Main Outcome and Measures** Cognitive function outcomes assessed include episodic
16 memory and associative learning, short-term working memory and problem solving, reaction
17 and movement time, and visual processing and sustained attention. Standardised z-scores of
18 exposures and outcomes were used for analyses.

19 **Results** Participants (n=790, mean age=11.2 years) were followed up for 31 years.
20 Multivariable models showed that both youth and long-term ‘vegetables and dairy products’
21 and ‘healthy’ patterns were positively associated with episodic memory and associative
22 learning scores (β : from 0.080 to 0.111, $p<0.05$ for all). Both youth and long-term ‘traditional
23 Finnish’ patterns were negatively associated with spatial working memory and problem

1 solving ($\beta = -0.085$ and -0.097 , respectively; $p < 0.05$ for both). Long-term ‘high-carbohydrate’
2 and ‘traditional Finnish and high-carbohydrate’ patterns were inversely associated with visual
3 processing and sustained attention, whereas ‘vegetables and dairy products’ pattern was
4 positively associated with this cognitive domain ($\beta = -0.117$ to 0.073 , $p < 0.05$ for all).
5 Adulthood ‘high-carbohydrate’ and ‘traditional Finnish and high-carbohydrate’ patterns were
6 inversely associated with all cognitive domains except for reaction and movement time ($\beta =$
7 0.072 to -0.161 , $p < 0.05$ for all). Both long-term and adulthood ‘red meat’ pattern was
8 positively associated with visual processing and sustained attention ($\beta = 0.079$ and 0.104 ,
9 respectively; $p < 0.05$ for both). These effect sizes correspond to approximately 1.6 to 16.1
10 years of cognitive aging on these cognitive domains.

11 **Conclusions and Relevance** Higher adherence to ‘traditional Finnish’, ‘high carbohydrate’
12 and ‘traditional Finnish and high-carbohydrate’ patterns across the early life-course was
13 associated with poorer cognitive function in midlife, whereas higher adherence to ‘healthy’
14 and ‘vegetables and dairy products’ patterns was associated with better cognitive function.
15 The findings, if causative, highlight the importance of maintaining a healthy dietary pattern
16 from early life to adulthood in the attempt to promote cognitive health.

17

1 **Introduction**

2 Early life factors have been linked to cognitive function in adulthood[1-3], suggesting a
3 window of opportunity for early prevention of cognitive deficit and dementia in later life[4].
4 Diet plays a pivotal role in cognitive health[5]. However, most studies have only examined
5 the association of a single food or nutrient in childhood with cognitive function later in life.
6 This is an evident limitation as different components of diet interact with one another and
7 may have cumulative and synergistic effects, which are not captured in analysis of a single
8 food or nutrient.

9 Dietary pattern analysis is one approach to assess the association of overall diet with health
10 outcomes[6]. A few studies have examined the effect of overall diet, such as dietary pattern,
11 on cognitive function in children or adolescents, with inconsistent findings[7-15]. However,
12 these studies have generally assessed diet at one or two time points and typically had a short
13 duration of follow-up (less than 10 years), with long-term data on the association of overall
14 diet since early life with cognitive function in adulthood not available. Thus, we aimed to
15 examine the associations of youth, adulthood, and long-term dietary patterns from youth to
16 adulthood with cognitive function in midlife.

17 **Methods**

18 *Participants*

19 Participants were from the Cardiovascular Risk in Young Finns Study (YFS), a prospective
20 cohort that began in 1980 (baseline), who were re-measured in 1983, 1986, 2001, 2007 and
21 2011[16]. Of those randomly selected from the national register of all five university cities
22 with medical schools and their rural surroundings in Finland, 3596 children (83.2% response
23 rate) aged 3-18 years participated in the baseline survey in 1980. At baseline, half of the
24 participants were randomly selected to participate in the 48-hour dietary recall interview

1 (N=1767) and were re-interviewed in 1986 (n=1212) and 2001 (n=1037). All participants
2 were invited to complete the Food Frequency Questionnaire assessment in 2007 (n=1996)
3 and 2011 (n=1736). To assess the association between long-term dietary patterns and
4 cognitive function, participants were included if they had complete data on long-term dietary
5 patterns and confounders (see statistical analysis) and at least one of the four cognitive
6 function domains assessed in 2011 (n=790). A flowchart of participation is given in Figure 1.
7 All participants gave written informed consent, and local ethics committees approved the
8 study.

9 *Cognitive function*

10 Cognitive function was measured in 2011 using a computerized cognitive testing battery
11 (CANTAB[®], Cambridge Cognition, Cambridge, United Kingdom), with full details described
12 elsewhere[1, 17]. Briefly, the test battery in the YFS included four domains: 1) paired-
13 associates learning (PAL) test measuring visual and episodic memory and visuospatial
14 associative learning (hereafter episodic memory and associative learning); 2) spatial working
15 memory (SWM) test measuring short-term and spatial working memory and problem solving
16 (short-term working memory and problem solving); 3) reaction time (RTI) test measuring
17 reaction and movement speed and attention (reaction and movement time); and 4) rapid
18 visual information test (RVP) measuring visual processing, recognition, and sustained
19 attention (visual processing and sustained attention).

20 Each test produced several variables. Principal component analyses were conducted
21 separately for all individual tests to identify components accounting for most of the variation
22 within the dataset. The first principal component identified for each test was used to represent
23 cognitive function in the specific cognitive domains. All components were normalized using

1 a rank order normalization procedure resulting in four variables, each with a mean of 0 and
2 standard deviation of 1.

3 *Diet assessment*

4 Details of diet assessment in 1980, 1986 and 2001 have been described elsewhere[18].
5 Briefly, diet was assessed by trained dietitians using a 48-hour dietary recall method by
6 recording the type and amount of food eaten by the participant during the two days prior to
7 the interview. In 2007 and 2011, diet was assessed by a validated 131-item food frequency
8 questionnaire[19, 20]. Participants were asked about their habitual diet during the past 12
9 months, which were presented under 12 subgroups (e.g., dairy products, vegetables, and fruits
10 and berries). The average use of 131 food items and mixed dishes was recorded by nine
11 frequency categories ranging from never or seldom to at least six times a day. The portion
12 size was fixed for each food item or mixed dish (e.g., slice and glass) based on the dietary
13 interviews of the national FINDIET 2007 Study. Food consumption was calculated in grams
14 per day by the National Food Composition Database[21].

15 *Other factors*

16 All measures were from baseline (1980) unless otherwise stated. Height and weight were
17 measured and body mass index (BMI) calculated as $\text{weight}/\text{height}^2$ (kg/m^2). Smoking habits
18 were asked during a health examination in a solitary room from participants aged 12 years
19 and older. Smoking for participants aged <12 years at baseline was defined based on follow-
20 up data when they were aged 12-18 years. **Smokers were defined as smoking once a day or**
21 **more often. Participants were defined as adult smokers if they smoked at any adult follow-**
22 **ups in 2001, 2007 and 2011 (as non-smokers if they did not smoke at any adult follow-ups**
23 **and had at least one adult measurement).** Questionnaires were used to collect physical activity
24 information. We used a parent-completed questionnaire for participants aged 3 and 6 years

1 and self-reported questionnaire for those aged 9 to 18 years. An age-standardised physical
2 activity index was calculated[22], which has been shown to be reliable and valid[23].
3 Socioeconomic status (SES) was assessed by: 1) the length of the parent's education (in years
4 for the parent with the highest education), 2) mean household income and 3) any history of
5 parental unemployment. Education and income variables were standardized and then
6 multiplied by -1. SES was defined as the mean of the three variables (higher score indicates
7 lower SES). Youth school performance was measured as the mean of grades in all individual
8 school subjects; data for those who were not of school age at baseline were obtained from the
9 subsequent 3- and 6-year follow-ups. Blood pressure and triglycerides were measured using
10 standard methods, with details described elsewhere[24].

11 Adult height, weight (BMI calculated as $\text{weight}/\text{height}^2$), systolic blood pressure, serum total
12 cholesterol and triglycerides, and physical activity were measured in 2001, 2007 and 2011
13 and the mean value from these three time points were used in analyses. Adulthood blood
14 pressure was measured using a random zero sphygmomanometer in adulthood with the
15 average of three measurements calculated. Venous blood samples were drawn after an
16 overnight fast to measure serum total cholesterol and triglycerides using standard enzymatic
17 methods as previously described[25]. Questionnaire was used to obtain information on adult
18 physical activity.

19 **Statistical analysis**

20 *Dietary pattern analysis*

21 Methods for identifying dietary patterns have been described elsewhere[26] and are provided
22 in detail in Supplemental Materials. Briefly, all food items measured in each survey were
23 classified into 23 food groups and exploratory factor analysis was used to identify dietary
24 patterns for each survey year. Three dietary patterns were identified in 1980. For consistency,

1 three dietary patterns with the largest eigenvalues were retained for all follow-up surveys,
2 resulting in a total of 15 patterns (Supplementary Tables 1 and 2). In consideration of
3 similarity, six different dietary patterns were finally chosen to broadly represent the different
4 patterns identified across the five survey years in the study sample (Supplementary Table 1
5 and Supplementary Figure 1), three each in 1980 and 2011. In 1980, the patterns were
6 ‘traditional Finnish’ characterised by high intake of butter, rye, potatoes, coffee, milk, and
7 sausages and low intake of fruit and berries; ‘high-carbohydrate’ by high intake of margarine
8 and oils, wheat, sugar, eggs, milk, other meat, other grain products, potatoes, and fruit and
9 berries; ‘vegetables and dairy products’ by high intake of vegetables, cheese, and other dairy
10 products. In 2011, they were ‘traditional Finnish and high-carbohydrate’ characterised by
11 high intake of grain products, potatoes, butter, sugar, and margarine and oils, ‘red meat’ by
12 high intake of pork, eggs, sausages, offal, other meat and fish; ‘healthy’ by high intake of
13 vegetables, legumes and nuts, fish, fruit and berries, cheese, and tea. Dietary pattern scores
14 were calculated for all five survey years by summing the intake of food groups weighted by
15 the factor loadings of the food groups with absolute loadings ≥ 0.2 (12). A higher score
16 indicates higher adherence to that specific dietary pattern. At each time point, dietary pattern
17 scores were adjusted for total energy intake using the residual method to account for under-
18 or over-reporting and eliminate the confounding effect of the amount of food consumed[27].
19 Moreover, energy adjusted dietary pattern scores were further standardised by survey years to
20 improve comparability across study years.

21 Youth dietary pattern was generated as the mean of all available data when participants were
22 aged ≤ 18 years at the time the diet was measured (e.g., mean of 1980 and 1986 for those aged
23 ≤ 18 years in 1986). Adulthood dietary pattern was generated as the mean of all available data
24 when participants were aged > 18 years at the time the diet was measured (e.g., mean of 1986,

1 2001, 2007 and 2011 for those aged >18 years in 1986). Long-term dietary pattern scores
2 were generated as the average between youth and adulthood[28, 29].

3 *Descriptive and main analyses*

4 Mean (standard deviation) and number (%) were used, as appropriate, to describe variables.
5 Univariable and multivariable linear regression was used to assess the associations between
6 youth, adulthood, and long-term dietary patterns from youth to adulthood with adult cognitive
7 function. We selected potential confounders based on the biological plausibility and statistical
8 significance of an association of the selected variable with both the outcome and the exposure
9 of interest. All analyses were adjusted for age, sex, and youth socioeconomic status, school
10 performance, BMI, physical activity, smoking, systolic blood pressure, and adulthood
11 systolic blood pressure, total cholesterol, triglycerides, and physical activity. Adult dietary
12 pattern was used as a covariate when youth dietary pattern was the exposure of interest, and
13 vice versa. To demonstrate the clinical relevance of the data, we also estimated the years of
14 cognitive aging for all significant associations between dietary pattern scores and cognitive
15 function[17]. Adjusted associations of quartiles of long-term dietary patterns with each
16 cognitive function domain were also estimated, with p values for trend assessed using
17 quartiles as continuous variables.

18 We assessed interactions between sex and age with dietary patterns by including the product
19 term between sex or age with each youth, adulthood, and long-term dietary pattern score.

20 Sensitivity analysis was performed by re-analysing the associations of these dietary pattern
21 scores with cognitive functions using inverse probability weighting to account for missing
22 data[30, 31]. Briefly, age, sex, and baseline BMI, socioeconomic status, physical activity and
23 smoking, and systolic blood pressure were used to predict the participants' probabilities of
24 being a complete case using logistic regression. To deal with missing data, the inverse

1 probabilities were used to weight the fully adjusted linear regression models for the
2 association between each dietary pattern score and cognitive function. We assumed all values
3 were missing at random.

4 All analyses were performed in Stata version 15.1 (Stata Corporation, Texas, USA). A two-
5 tailed p value <0.05 was considered statistically significant.

6 **Results**

7 *Participants' characteristics*

8 Figure 1 shows the flow of study participants. Of the 3596 participants, 2806 were excluded
9 due to no diet assessments in youth (N=1,817) or adulthood (N=414), missing outcomes
10 (N=410), or missing covariates (N=165). Finally, 790 participants were included in the
11 analysis of this study. We compared those included in the study with those not included.
12 Generally, those included were slight older, and were less likely to be males, had slightly
13 lower systolic blood pressure in adulthood and lower scores of long-term 'high-
14 carbohydrate', 'traditional Finnish and high-carbohydrate', and 'red meat' dietary patterns
15 (Table 1).

16 *Sensitivity analyses*

17 Overall, the multivariable regression analysis consistently showed that both youth and long-
18 term 'vegetables and dairy products' and 'healthy' patterns were positively associated with
19 episodic memory and associative learning (β : from 0.080 to 0.111, $p < 0.05$ for all) (Table 2).
20 Both youth and long-term 'traditional Finnish' pattern was negatively associated with spatial
21 working memory and problem solving ($\beta = -0.085$ and -0.097 , respectively; $p < 0.05$ for both).
22 Long-term 'high-carbohydrate' and 'traditional Finnish and high-carbohydrate' patterns were
23 inversely associated with visual processing and sustained attention, whereas 'vegetables and
24 dairy products' pattern was positively associated with this cognitive domain ($\beta = -0.117$ to
25 0.073, $p < 0.05$ for all).

1 Adulthood ‘high-carbohydrate’ and ‘traditional Finnish and high-carbohydrate’ patterns were
2 inversely associated with all cognitive domains except for reaction and movement time ($\beta =$
3 0.072 to -0.161 , $p < 0.05$ for all). Both long-term and adulthood ‘red meat’ pattern was
4 positively associated with visual processing and sustained attention ($\beta = 0.079$ and 0.104 ,
5 respectively; $p < 0.05$ for both), while the significant association were not seen for youth.
6 These effect sizes correspond to approximately 1.6 to 16.1 years of cognitive aging on these
7 cognitive domains[17]. For most of the patterns that were significantly associated with
8 cognitive function, we observed a dose-response association with the strongest association
9 observed for the highest quantile (Figure 2).

10 There were no significant interactions between youth dietary patterns and age or sex with
11 cognitive function. With regard to long-term and adulthood dietary patterns, the associations
12 of ‘traditional Finnish’, ‘vegetables and dairy products’ and/or ‘healthy’ patterns with
13 episodic memory and associative learning and/or reaction and movement time were mainly
14 found in adolescence (15-18 years), whereas the association of ‘red meat’ pattern with
15 episodic memory and associative learning was mainly found in early childhood (3-6 years)
16 (Supplementary Table 3). The associations of long-term and adulthood ‘vegetables and dairy
17 products’ pattern with visual processing and sustained attention and/or episodic memory and
18 associative learning were only significant in males (Supplementary Table 4).

19 *Sensitivity analyses*

20 Inverse probability weighting showed largely similar results, except that the associations of
21 youth ‘high carbohydrate’ pattern with spatial working memory and problem solving and
22 adulthood ‘healthy’ pattern with visual processing and sustained attention were slightly
23 increased and became significant ($\beta = 0.072$, 95%CI: 0.003 to 0.141 and $\beta = -0.084$, 95%CI: -
24 0.166 to -0.002 , respectively), while the associations of long-term ‘vegetables and dairy
25 products’ pattern with visual processing and sustained attention and ‘healthy’ pattern with

1 episodic memory and associative learning were reduced and no longer significant ($\beta = 0.067$,
2 95%CI: -0.009 to 0.144 and 0.062, -0.026 to 0.149, respectively) (data not shown).

3 **Discussion**

4 Higher adherence to ‘traditional Finnish’, ‘high carbohydrate’ and ‘traditional Finnish and
5 high-carbohydrate’ patterns across the early life-course was associated with poorer cognitive
6 function in midlife, whereas higher adherence to ‘healthy’ and ‘vegetables and dairy
7 products’ patterns was associated with better cognitive function. These effect sizes
8 correspond to approximately 1.6 to 16.1 years of cognitive aging on these cognitive domains
9 [17], which have potential clinical importance. These data, if causative, suggest maintaining
10 healthier dietary patterns (e.g., those characterised by high consumption of vegetables, fruits,
11 legumes and nuts, cheese and other dairy products, but low consumption of margarine and
12 oils, sausages and sugar) from early life to adulthood could provide meaningful benefits to
13 cognitive health later in life.

14 Our findings add to the existing literature by extending the long-term influence of dietary
15 patterns across early-life course into adult cognitive function. Direct comparison between
16 studies is difficult because of different methods for identifying dietary patterns and measuring
17 cognitive function, diet variability across populations, and control of confounders.

18 Nonetheless, a few previous studies in children and adolescents have generally shown a
19 positive association of ‘good’ patterns (e.g., ‘High protein’[8] and ‘Health-conscious’[14])
20 while a negative association of ‘bad’ patterns (e.g., ‘Snacky’[9, 10] and ‘Western’[12]) with
21 cognitive function[7-15]. In the current study, long-term ‘traditional Finnish’ pattern
22 (characterised by high intake of rye, potatoes, butter, milk, coffee and sausages but low
23 consumption of fruit and berries) had a negative association with cognitive function in a
24 dose-response manner, which is predominantly driven by youth exposure to this pattern. In

1 comparison, the negative association of ‘high carbohydrate’ and ‘traditional Finnish and high
2 carbohydrate’ patterns with cognitive function were mostly seen in adulthood. These data
3 may suggest a different nutritional requirement for cognitive development at different life
4 stages. Plausible biological mechanisms for these associations, and possibly the associations
5 for any dietary exposures, include inflammation, oxidative stress, and vascular risk
6 factors[32]. For example, the ‘traditional Finnish and high carbohydrate’ pattern is
7 characterised by a high intake of foods that are pro-inflammatory (e.g., refined carbohydrates,
8 sugar, sausages)[33] and chronic low-grade inflammation may contribute to the pathogenesis
9 of cognitive dysfunction[34].

10 In line with findings from some but not all previous studies, we found a positive association
11 between youth and long-term ‘healthy’ and ‘vegetables and dairy products’ patterns with
12 adult cognitive function. For example, a birth cohort study did not find an association
13 between ‘healthy’ dietary pattern with any tasks of the CogState cognitive battery (e.g., visual
14 learning and memory by Continuous Paired Association Learning Task) in children aged 14
15 years[12]. Another study showed that a ‘healthy’ pattern trajectory from age 6 to 24 months
16 was weakly associated with higher intelligence quotient at age 8 but not 15 years[13].
17 Together, these data may suggest a temporary effect of early life healthy diet and supports the
18 implementation of preventive interventions to develop a healthy dietary pattern at an early
19 stage of life and maintain it through to adulthood.

20 Previous studies did not specifically examine a ‘red meat’ pattern in youth or its long-term
21 status since early life, but a few studies showed a negative association of patterns including
22 red meat as a main component with cognitive function[8, 12]. In contrast, our finding of the
23 positive association of ‘red meat’ pattern with visual processing and sustained attention may
24 be explained by reverse causation as this association was found for adulthood but not youth
25 ‘red meat’ pattern. Indeed, those who had better performance on visual processing and

1 sustained attention (top quartile) had increased ‘red meat’ pattern score from youth to
2 adulthood while those with poorer performance (bottom quartile) had a slight decrease,
3 particularly in those aged 3-6 years at baseline (data not shown). This may also explain why
4 the positive association between long-term and adulthood ‘red meat’ pattern with cognitive
5 function was mainly found in early childhood. Taken together, the positive association of ‘red
6 meat’ dietary pattern with cognitive function needs to be interpreted with caution and
7 investigated further.

8 We also found that the associations of long-term and adulthood ‘traditional Finnish’,
9 ‘vegetables and dairy products’, and/or ‘healthy’ patterns with cognitive function were
10 mainly seen in adolescence. Although the reasons are not known, a possible explanation for
11 this might be that those of older age at baseline were born prior to the North Karelia
12 project[35] that was launched in the beginning of the 70’s and thus, had developed a quite
13 different diet habit since their childhood compared to those of younger age at baseline. In
14 light of this, there was an overall positive change in the Finnish diet during the 60’s and
15 70’s[36]. Interestingly, the association of ‘vegetables and dairy products’ with cognitive
16 function was only significant in males. This may be because females had a generally higher
17 adherence to this pattern while a less diverse distribution (i.e., higher smallest score). As a
18 result, it is likely that most females had already achieved an appropriate level of adherence to
19 this pattern. Taken together, these findings suggest that age and sex should be considered in
20 the development of future preventive diet interventions.

21 The main strength of this study is the youth-onset follow-up of a large population-based
22 nationwide cohort, allowing us to examine the long-term dietary habits starting in early-life
23 with adult cognitive function. Moreover, repeated measures of diet improve data quality. Our
24 study has limitations. Causality could not be established due to the observational design.
25 Although, to our knowledge, the effect of youth or long-term dietary interventions on adult

1 cognitive function remains unknown, a few short-term trials that focused on a single or a few
2 nutrients have shown benefits to cognitive function in infants and children[37-39].
3 Nonetheless, long-term trials that focus on promoting the whole diet are warranted, and the
4 ongoing Special Turku Coronary Risk Factor Intervention Project (STRIP) coupling data on
5 diet and cognitive function will provide such evidence[40]. We used both 48-hour dietary
6 recall and FFQ, which may have partly affected the long-term dietary pattern scores.
7 However, food items were largely comparable between the two different methods and were
8 all grouped in the same way[27]. Moreover, we standardised dietary pattern scores by survey
9 years to improve comparability between different methods and survey years. Like all long
10 follow-up studies, we had missing data due to loss to follow-up after an extensive study
11 period of 31 years. We showed that participants who were lost to follow-up were younger and
12 more likely to be males and had lower BMI, poorer school performance, and more
13 disadvantaged SES. Nonetheless, we used inverse probability weighting to deal with missing
14 data, and the analysis showed largely similar results, suggesting minor influence of missing
15 data. Lastly, youth cognitive function was not measured. Instead, we used youth school
16 performance as a proxy, which is strongly correlated with cognitive function in children[41].
17 In conclusion, higher adherence to ‘traditional Finnish’, ‘high carbohydrate’ and ‘traditional
18 Finnish and high-carbohydrate’ patterns across the early life-course was associated with
19 poorer cognitive function in midlife, whereas higher adherence to ‘healthy’ and ‘vegetables
20 and dairy products’ patterns was associated with better cognitive function. The associations,
21 if causative, suggest that maintaining a healthy dietary pattern from early life to adulthood
22 could provide meaningful benefits to cognitive health later in life. More research is needed to
23 confirm the causality and uncover underlying mechanisms.

24

1 **References**

- 2 [1] Rovio SP, Pahkala K, Nevalainen J, Juonala M, Salo P, Kahonen M, et al. Cardiovascular
3 Risk Factors From Childhood and Midlife Cognitive Performance: The Young Finns Study. *J*
4 *Am Coll Cardiol.* 2017;69:2279-89.
- 5 [2] Ayaz E, Shenkin SD, Craig L, Starr JM, Deary IJ, Whalley LJ, et al. Early-life
6 determinants of cognitive ability in childhood and old age. *The Lancet.* 2012;380:S23.
- 7 [3] Lu K, Nicholas JM, Collins JD, James SN, Parker TD, Lane CA, et al. Cognition at age
8 70: Life course predictors and associations with brain pathologies. *Neurology.*
9 2019;93:e2144-e56.
- 10 [4] Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al.
11 Dementia prevention, intervention, and care. *Lancet.* 2017;390:2673-734.
- 12 [5] Scarmeas N, Anastasiou CA, Yannakoulia M. Nutrition and prevention of cognitive
13 impairment. *Lancet Neurol.* 2018;17:1006-15.
- 14 [6] Schulze MB, Martinez-Gonzalez MA, Fung TT, Lichtenstein AH, Forouhi NG. Food
15 based dietary patterns and chronic disease prevention. *BMJ.* 2018;361:k2396.
- 16 [7] Cohen JF, Gorski MT, Gruber SA, Kurdziel LB, Rimm EB. The effect of healthy dietary
17 consumption on executive cognitive functioning in children and adolescents: a systematic
18 review. *Br J Nutr.* 2016;116:989-1000.
- 19 [8] Wang T, Cao S, Li D, Chen F, Jiang Q, Zeng J. Association between dietary patterns and
20 cognitive ability in Chinese children aged 10-15 years: evidence from the 2010 China Family
21 Panel Studies. *BMC Public Health.* 2021;21:2212.
- 22 [9] Marinho AR, Severo M, Vilela S, Costa R, de Lauzon-Guillain B, Torres D, et al. Is the
23 association between dietary patterns and cognition mediated by children's adiposity? A
24 longitudinal approach in Generation XXI birth cohort. *Clinical Nutrition.* 2021.

- 1 [10] Leventakou V, Roumeliotaki T, Sarri K, Koutra K, Kampouri M, Kyriklaki A, et al.
2 Dietary patterns in early childhood and child cognitive and psychomotor development: the
3 Rhea mother-child cohort study in Crete. *Br J Nutr.* 2016;115:1431-7.
- 4 [11] Khan NA, Raine LB, Drollette ES, Scudder MR, Kramer AF, Hillman CH. Dietary fiber
5 is positively associated with cognitive control among prepubertal children. *J Nutr.*
6 2015;145:143-9.
- 7 [12] Nyaradi A, Foster JK, Hickling S, Li J, Ambrosini GL, Jacques A, et al. Prospective
8 associations between dietary patterns and cognitive performance during adolescence. *J Child*
9 *Psychol Psychiatry.* 2014;55:1017-24.
- 10 [13] Smithers LG, Golley RK, Mittinty MN, Brazionis L, Northstone K, Emmett P, et al. Do
11 dietary trajectories between infancy and toddlerhood influence IQ in childhood and
12 adolescence? Results from a prospective birth cohort study. *PLoS One.* 2013;8:e58904.
- 13 [14] Northstone K, Joinson C, Emmett P, Ness A, Paus T. Are dietary patterns in childhood
14 associated with IQ at 8 years of age? A population-based cohort study. *J Epidemiol*
15 *Community Health.* 2012;66:624-8.
- 16 [15] Gale CR, Martyn CN, Marriott LD, Limond J, Crozier S, Inskip HM, et al. Dietary
17 patterns in infancy and cognitive and neuropsychological function in childhood. *J Child*
18 *Psychol Psychiatry.* 2009;50:816-23.
- 19 [16] Raitakari OT, Juonala M, Ronnema T, Keltikangas-Jarvinen L, Rasanen L, Pietikainen
20 M, et al. Cohort profile: the cardiovascular risk in Young Finns Study. *Int J Epidemiol.*
21 2008;37:1220-6.
- 22 [17] Rovio SP, Pahkala K, Nevalainen J, Juonala M, Salo P, Kahonen M, et al. Cognitive
23 performance in young adulthood and midlife: Relations with age, sex, and education-The
24 Cardiovascular Risk in Young Finns Study. *Neuropsychology.* 2016;30:532-42.

- 1 [18] Rasanen L, Laitinen S, Stirrkinen R, Kimppa S, Viikari J, Uhari M, et al. Composition
2 of the diet of young Finns in 1986. *Ann Med.* 1991;23:73-80.
- 3 [19] Paalanen L, Mannisto S, Virtanen MJ, Knekt P, Rasanen L, Montonen J, et al. Validity
4 of a food frequency questionnaire varied by age and body mass index. *J Clin Epidemiol.*
5 2006;59:994-1001.
- 6 [20] Mannisto S, Virtanen M, Mikkonen T, Pietinen P. Reproducibility and validity of a food
7 frequency questionnaire in a case-control study on breast cancer. *J Clin Epidemiol.*
8 1996;49:401-9.
- 9 [21] Reinivuo H, Hirvonen T, Ovaskainen ML, Korhonen T, Valsta LM. Dietary survey
10 methodology of FINDIET 2007 with a risk assessment perspective. *Public Health Nutr.*
11 2010;13:915-9.
- 12 [22] Telama R, Viikari J, Välimäki I, Siren-Tiusanen H, Akerblom HK, Uhari M, et al.
13 Atherosclerosis precursors in Finnish children and adolescents. X. Leisure-time physical
14 activity. *Acta Paediatr Scand Suppl.* 1985;318:169-80.
- 15 [23] Telama R, Yang X, Leskinen E, Kankaanpää A, Hirvensalo M, Tammelin T, et al.
16 Tracking of physical activity from early childhood through youth into adulthood. *Med Sci*
17 *Sports Exerc.* 2014;46:955-62.
- 18 [24] Porkka KV, Raitakari OT, Leino A, Laitinen S, Rasanen L, Ronnema T, et al. Trends in
19 serum lipid levels during 1980-1992 in children and young adults. The Cardiovascular Risk
20 in Young Finns Study. *Am J Epidemiol.* 1997;146:64-77.
- 21 [25] Juonala M, Magnussen CG, Berenson GS, Venn A, Burns TL, Sabin MA, et al.
22 Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med.*
23 2011;365:1876-85.

- 1 [26] Wu F, Pahkala K, Juonala M, Rovio SP, Sabin MA, Ronnema T, et al. Dietary Pattern
2 Trajectories from Youth to Adulthood and Adult Risk of Impaired Fasting Glucose: A 31-
3 year Cohort Study. *J Clin Endocrinol Metab.* 2021;106:e2078-e86.
- 4 [27] Mikkilä V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns
5 identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J*
6 *Nutr.* 2005;93:923-31.
- 7 [28] Hu FB, Stampfer MJ, Rimm E, Ascherio A, Rosner BA, Spiegelman D, et al. Dietary fat
8 and coronary heart disease: a comparison of approaches for adjusting for total energy intake
9 and modeling repeated dietary measurements. *Am J Epidemiol.* 1999;149:531-40.
- 10 [29] Wu F, Pahkala K, Juonala M, Rovio SP, Sabin MA, Ronnema T, et al. Childhood and
11 long-term dietary calcium intake and adult cardiovascular risk in a population with high
12 calcium intake. *Clin Nutr.* 2021;40:1926-31.
- 13 [30] Wu F, Callisaya M, Wills K, Laslett LL, Jones G, Winzenberg T. Both Baseline and
14 Change in Lower Limb Muscle Strength in Younger Women Are Independent Predictors of
15 Balance in Middle Age: A 12-Year Population-Based Prospective Study. *J Bone Miner Res.*
16 2017;32:1201-8.
- 17 [31] Seaman SR, White IR. Review of inverse probability weighting for dealing with missing
18 data. *Stat Methods Med Res.* 2013;22:278-95.
- 19 [32] van de Rest O, Berendsen AA, Haveman-Nies A, de Groot LC. Dietary patterns,
20 cognitive decline, and dementia: a systematic review. *Adv Nutr.* 2015;6:154-68.
- 21 [33] Giugliano D, Ceriello A, Esposito K. The effects of diet on inflammation: emphasis on
22 the metabolic syndrome. *J Am Coll Cardiol.* 2006;48:677-85.
- 23 [34] Adelantado-Renau M, Beltran-Valls MR, Moliner-Urdiales D. Inflammation and
24 Cognition in Children and Adolescents: A Call for Action. *Front Pediatr.* 2020;8:583.

- 1 [35] Jauho M. The North Karelia Project (1972-1997) and the Origins of the Community
2 Approach to Cardiovascular Disease Prevention. *Am J Public Health*. 2021;111:890-5.
- 3 [36] Rasanen L, Ahlstrom A. Nutrition survey of Finnish rural children. II. Food
4 consumption. *Ann Acad Sci Fenn A*. 1975:1-40.
- 5 [37] Birch EE, Garfield S, Hoffman DR, Uauy R, Birch DG. A randomized controlled trial of
6 early dietary supply of long-chain polyunsaturated fatty acids and mental development in
7 term infants. *Dev Med Child Neurol*. 2000;42:174-81.
- 8 [38] Drover JR, Hoffman DR, Castaneda YS, Morale SE, Garfield S, Wheaton DH, et al.
9 Cognitive function in 18-month-old term infants of the DIAMOND study: a randomized,
10 controlled clinical trial with multiple dietary levels of docosahexaenoic acid. *Early Hum Dev*.
11 2011;87:223-30.
- 12 [39] Osendarp SJ, Baghurst KI, Bryan J, Calvaresi E, Hughes D, Hussaini M, et al. Effect of
13 a 12-mo micronutrient intervention on learning and memory in well-nourished and
14 marginally nourished school-aged children: 2 parallel, randomized, placebo-controlled
15 studies in Australia and Indonesia. *Am J Clin Nutr*. 2007;86:1082-93.
- 16 [40] Pahkala K, Laitinen TT, Niinikoski H, Kartiosuo N, Rovio SP, Lagstrom H, et al. Effects
17 of 20-year infancy-onset dietary counselling on cardiometabolic risk factors in the Special
18 Turku Coronary Risk Factor Intervention Project (STRIP): 6-year post-intervention follow-
19 up. *Lancet Child Adolesc Health*. 2020;4:359-69.
- 20 [41] Nesayan A, Amani M, Asadi Gandomani R. Cognitive Profile of Children and its
21 Relationship With Academic Performance. *Basic Clin Neurosci*. 2019;10:165-74.

22

23

Table 1 Characteristics of participants in the Cardiovascular Risk in Young Finns Study

	Participants included in analysis		p-value
	Included (n=790)	Not included (n=2806 ^c)	
Youth factors			
Age (years)	11.2 (4.7)	10.2 (5.1)	<0.001
Male sex, n (%)	345 (44)	1419 (51)	0.001
BMI (kg/m ²)	17.9 (3.0)	17.8 (3.1)	0.37
Systolic blood pressure (mmHg)	112.7 (11.4)	112.5 (12.4)	0.67
Daily smoking (yes/no), n (%)	135 (17)	392 (14)	0.06
Physical activity ^a	-0.01 (0.98)	0.004 (1.01)	0.67
School performance	7.76 (0.74)	7.71 (0.73)	0.12
Socioeconomic status ^b	0.01 (0.60)	0.05 (0.59)	0.07
Adulthood factors			
Physical activity	8.83 (1.65)	8.86 (1.68)	0.60
Systolic blood pressure (mmHg)	118.2 (12.1)	119.5 (12.8)	0.02
Triglycerides (mmol/L)	1.37 (0.86)	1.37 (0.83)	0.86
Total cholesterol (mmol/L)	5.13 (0.80)	5.15 (0.90)	0.60

Abbreviation: BMI, body mass index.

^a age-specific standardized physical activity index.

^b socioeconomic status was determined by family income, parental education and employment status (see methods in main text).

^c numbers differ from 1978 to 2806 for different variables (n=575 for all dietary pattern scores). See Figure 1 for detailed reasons of being excluded from analysis.

Table 2 Long-term adherence to dietary patterns from youth to adulthood with midlife cognitive function components

Dietary patterns	Episodic memory and associative learning (PAL-test)	Short-term and spatial working memory and problem solving (SWM-test)	Reaction and movement time (RTI-test)	Visual processing and sustained attention (RVP-test)
	β (95% CI) ^a	β (95% CI) ^a	β (95% CI) ^a	β (95% CI) ^a
Long-term				
Traditional Finnish	-0.062 (-0.142 to 0.018)	-0.097 (-0.171 to -0.022)	-0.059 (-0.141 to 0.023)	-0.064 (-0.140 to 0.012)
High carbohydrate	-0.041 (-0.115 to 0.032)	-0.006 (-0.074 to 0.062)	-0.046 (-0.121 to 0.030)	-0.079 (-0.148 to -0.010)
Vegetables and dairy products	0.111 (0.035 to 0.186)^b	0.034 (-0.036 to 0.104)	0.022 (-0.055 to 0.100)	0.073 (0.001 to 0.144)
Traditional Finnish and high carbohydrate	-0.052 (-0.123 to 0.020)	-0.049 (-0.116 to 0.018)	-0.044 (-0.117 to 0.030)	-0.117 (-0.185 to -0.049)^b
Healthy	0.080 (0.001 to 0.158)	-0.032 (-0.106 to 0.042)	-0.006 (-0.088 to 0.076)	-0.054 (-0.131 to 0.022)
Red meat	0.020 (-0.054 to 0.093)	-0.018 (-0.087 to 0.051)	-0.034 (-0.110 to 0.042)	0.079 (0.007 to 0.150)
Youth				
Traditional Finnish	-0.067 (-0.149 to 0.016)	-0.085 (-0.162 to -0.007)	-0.038 (-0.123 to 0.047)	-0.055 (-0.134 to 0.024)
High carbohydrate	0.023 (-0.053 to 0.098)	0.065 (-0.004 to 0.135)	-0.007 (-0.084 to 0.070)	-0.009 (-0.080 to 0.062)
Vegetables and dairy products	0.094 (0.019 to 0.169)	-0.003 (-0.074 to 0.068)	0.021 (-0.056 to 0.098)	0.040 (-0.032 to 0.112)
Traditional Finnish and high carbohydrate	0.050 (-0.024 to 0.124)	0.045 (-0.024 to 0.114)	-0.031 (-0.107 to 0.045)	-0.005 (-0.074 to 0.065)
Healthy	0.110 (0.035 to 0.185)^b	0.026 (-0.045 to 0.098)	0.039 (-0.039 to 0.116)	0.001 (-0.073 to 0.074)
Red meat	-0.018 (-0.090 to 0.053)	-0.068 (-0.136 to 0.0001)	-0.052 (-0.128 to 0.024)	-0.002 (-0.073 to 0.069)
Adulthood				
Traditional Finnish	-0.011 (-0.093 to 0.071)	-0.037 (-0.113 to 0.039)	-0.035 (-0.120 to 0.049)	-0.026 (-0.103 to 0.052)
High carbohydrate	-0.078 (-0.154 to -0.001)	-0.072 (-0.144 to -0.001)	-0.055 (-0.133 to 0.023)	-0.099 (-0.172 to -0.027)
Vegetables and dairy products	0.049 (-0.026 to 0.125)	0.046 (-0.025 to 0.117)	0.008 (-0.069 to 0.086)	0.053 (-0.018 to 0.125)
Traditional Finnish and high carbohydrate	-0.121 (-0.197 to -0.045)^b	-0.115 (-0.187 to -0.043)^b	-0.030 (-0.108 to 0.048)	-0.161 (-0.234 to -0.089)^c
Healthy	-0.018 (-0.103 to 0.066)	-0.075 (-0.156 to 0.005)	-0.054 (-0.141 to 0.034)	-0.075 (-0.158 to 0.007)
Red meat	0.046 (-0.030 to 0.122)	0.049 (-0.024 to 0.121)	0.008 (-0.070 to 0.086)	0.104 (0.031 to 0.178)

Abbreviations: PAL, Paired Associates Learning test; SWM, Spatial Working Memory test; RTI, Reaction Time test; RVP, Rapid Visual Information test; CI, confidence interval.

Bold denotes $p < 0.05$.

^a Beta coefficient represents one SD change in cognitive function components for one SD increase in the dietary pattern score; all analyses were adjusted for age, sex, and youth socioeconomic status, school performance, body mass index, physical activity, smoking, systolic blood pressure, and adulthood systolic blood pressure, total cholesterol, triglycerides, and physical activity; adulthood dietary pattern was also adjusted when youth dietary pattern was the exposure of interest, and vice versa.

^b $p < 0.005$. ^c $p < 0.0001$.

Figure legend

Figure 1. Flowchart of study participants. # from a random sample of 50% of the participants in 1980.

* all participants from the original cohort were invited.

Figure 2. Beta coefficients for the association of long-term dietary pattern scores quartiles with cognitive function. Q1 was used as the reference group. All cognitive function components were standardised. All analyses were adjusted for age, sex, youth body mass index, academic performance, socioeconomic status, physical activity, smoking, systolic blood pressure, and adulthood systolic blood pressure, triglycerides, and physical activity.

Figure 1. Flowchart of study participants.

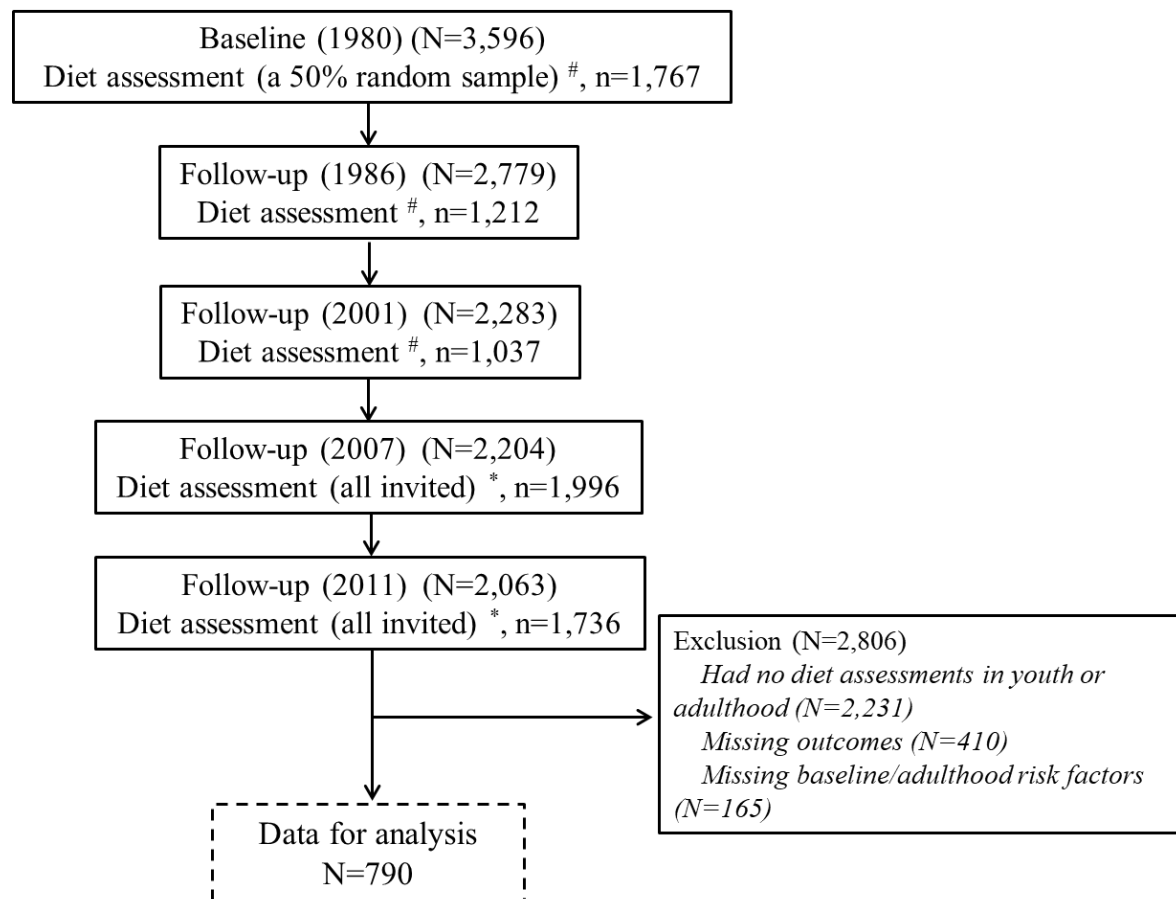
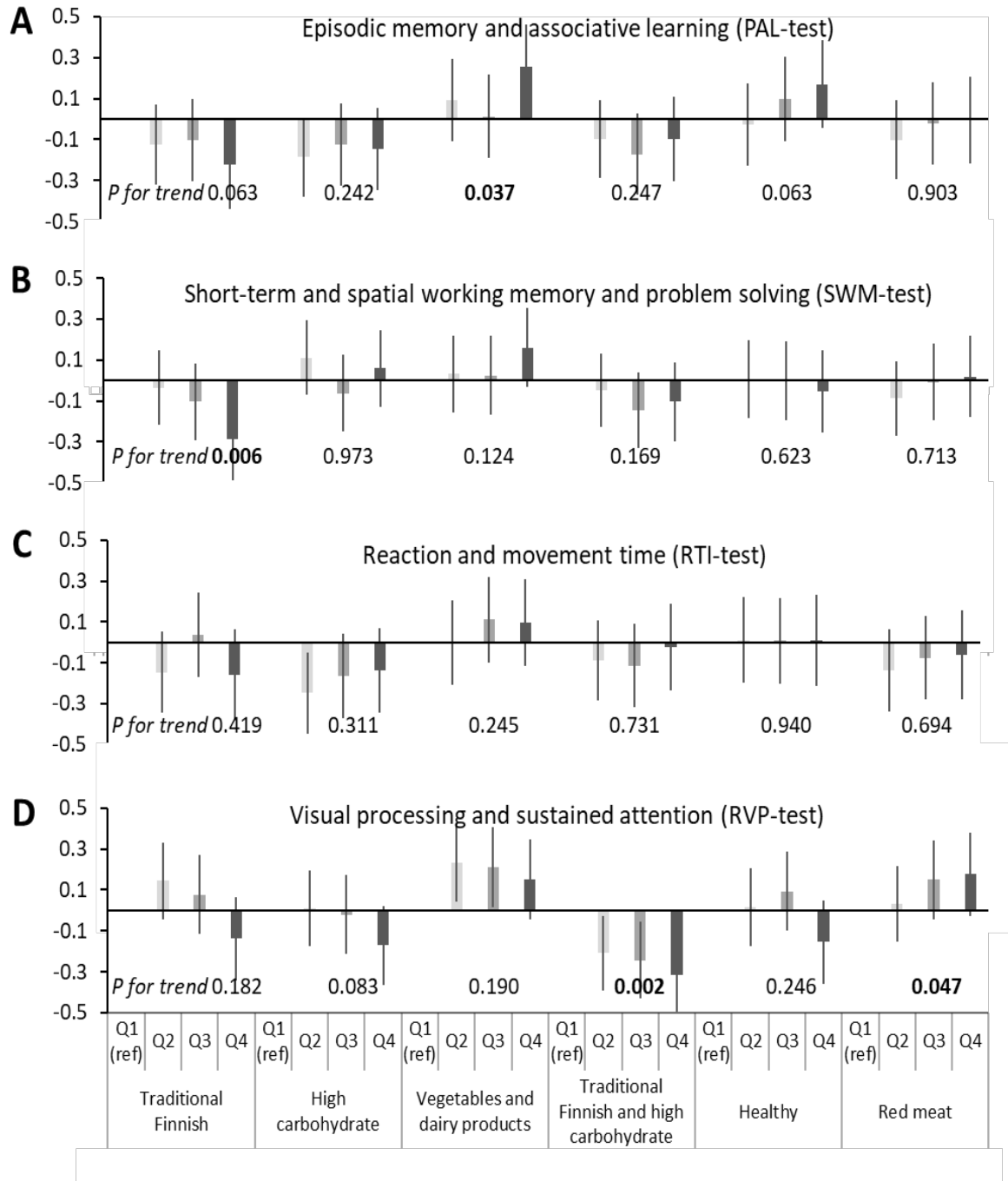


Figure 2. Beta coefficients for the association of long-term dietary pattern scores quartiles with cognitive function.



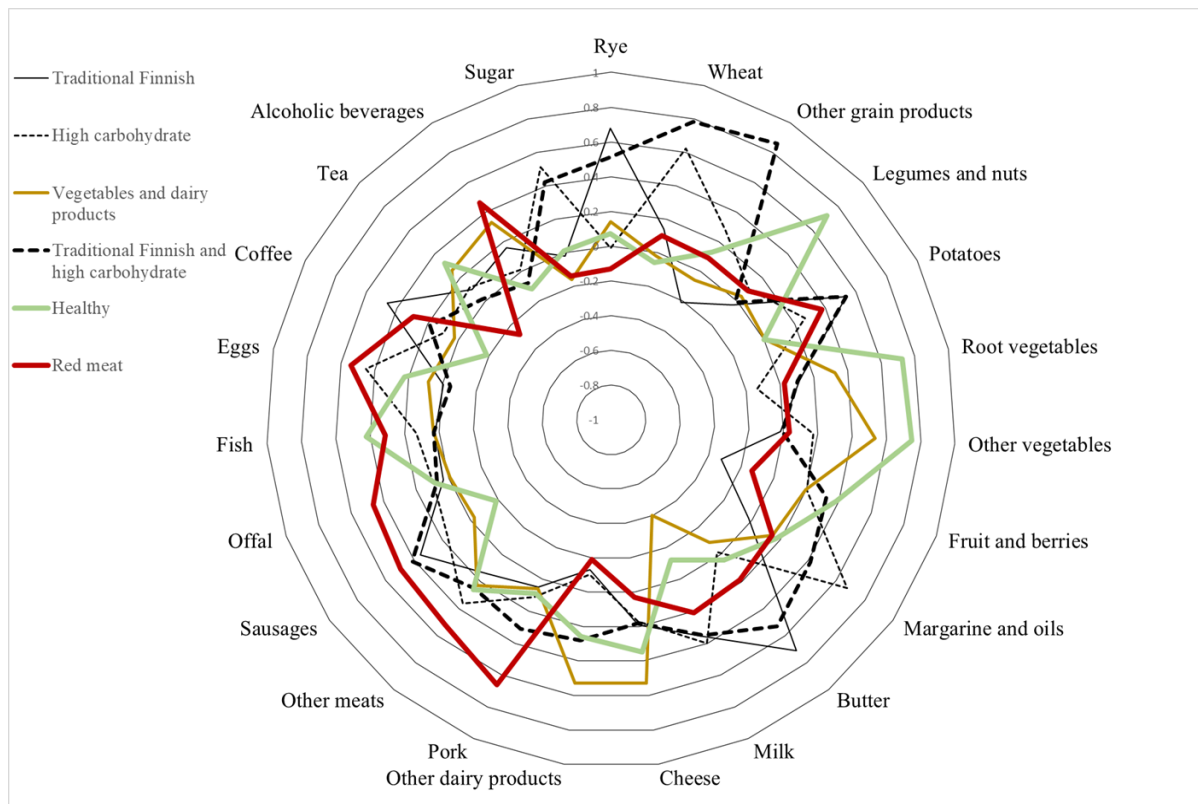
Supplemental Materials

Contents

Supplementary Figure 1. The radar chart for the six dietary patterns identified in 1980 and 2011. ...	2
Method S1. Dietary pattern analysis	3
Supplementary Table 1. Rotated factor loadings for six dietary patterns identified based on diet in 1980 and 2011	5
Supplementary Table 2. Rotated factor loadings for the three dietary patterns identified based on diet in 1986, 2001 and 2007.....	6
Supplementary Table 3. Long-term and adulthood dietary pattern scores with episodic memory and associative learning (PAL-test) and reaction and movement time (RTI-test) by baseline age groups...	7
Supplementary Table 4. Long-term and adulthood ‘vegetables and dairy products’ pattern score with visual processing and sustained attention (RVP-test) and episodic memory and associative learning (PAL-test) by sex	8

Supplementary Figure 1. The radar chart for the six dietary patterns identified in 1980 and 2011.

Figure legend. The radar chart for the six dietary patterns identified in 1980 and 2011. The factor loading ranges from -1.0 (centre) to 1.0 (the largest circle), with a difference of 0.2 between the two adjacent circles (see specific values for factor loadings in Supplementary Tables 1 and 2).



Method S1. Dietary pattern analysis

All food items were classified into 23 food groups based on similarity and habitual culinary use as done previously[1]. Exploratory factor analysis was used to identify dietary patterns for each survey years based on eigenvalues (>1.25) and interpretability of the factors. Three dietary patterns were identified in 1980 with the largest eigenvalues (>1.4)[2]. For consistency, three dietary patterns with the largest eigenvalues were retained for all follow-up surveys. Dietary patterns were similar from 1980 to 2001 but had changed by 2007 and then remained similar in 2011. Thus, six different dietary patterns were retained (three each in 1980/1986/2001 and 2007/2011) to broadly represent the different patterns identified across the five survey years. Dietary pattern scores for the six dietary patterns were calculated for all five survey years by summing the intake of food groups with absolute factor loadings ≥ 0.2 , weighted by the factor loadings of the food groups(12). To avoid the influence of using different factor loadings on dietary pattern scores for the same dietary pattern, the factor loadings for the three dietary patterns observed in 1980 and the three dietary patterns observed in 2011 were consistently applied to all survey years. At each time point, dietary pattern scores were adjusted for total energy intake using the residual method to account for under- or over-reporting and eliminate the confounding effect of the amount of food consumed[1]. Moreover, energy adjusted dietary pattern scores were further standardised by survey years to improve comparability across study years.

Three dietary patterns were identified at baseline (1980) and named, for descriptive purpose, as 'Traditional Finnish' (characterised by high consumption of rye, potatoes, butter, milk, coffee and sausages but low consumption of fruit and berries), 'High-carbohydrate' (by high consumption of wheat, margarine and oils, sugar, milk, beef and eggs) and 'Vegetables and dairy products' (by high consumption of vegetables, fruits, cheese, other dairy products, tea, beef and alcoholic beverages but low consumption of milk) (Supplementary Table 1). These patterns were similar between 1980 and 2001 (Supplementary Tables 1 and 2). By 2007 the patterns had significantly changed and these patterns remained stable in 2011: 'Traditional Finnish and high-carbohydrate' (characterised by high wheat, other grain products, rye, potatoes, butter, sausages and sugar; 'Red meat' (characterised by

high consumption of pork, other meats, sausages, eggs, fish, potatoes and alcoholic beverages but low consumption of tea); 'Healthy' (by high consumption of vegetables, legumes and nuts, fruits, fish, cheese, other dairy products, tea, other meats (i.e., beef, lamb, game, poultry, meat products), eggs) (Supplementary Tables 1 and 2).

References

- [1] Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr.* 2005;93:923-31.
- [2] Wu F, Wills K, Laslett LL, Oldenburg B, Jones G, Winzenberg T. Associations of dietary patterns with bone mass, muscle strength and balance in a cohort of Australian middle-aged women. *Br J Nutr.* 2017;118:598-606.

Supplementary Table 1. Rotated factor loadings for six dietary patterns identified based on diet in 1980 and 2011

		1980	1980	1980	2011	2011	2011
Food groups	Foods included in the group	Traditional Finnish	High-carbohydrate	Vegetables and dairy products	Traditional Finnish and high-carbohydrate	Healthy	Red meat
Rye	Rye bread, rye porridge	0.68	-0.01	0.14	0.51	0.07	-0.13
Wheat	Wheat bread, pasta	0.14	0.62	-0.02	0.78	-0.06	0.10
Other grain products	Cereals other than rye and wheat, breakfast cereals, biscuits, starch, rice	-0.21	0.28	-0.06	0.86	0.13	0.09
Legumes and nuts	Peas, beans, other legumes, nuts, seeds, soya products	-0.03	0.10	0.04	-0.01	0.72	0.09
Potatoes	Potatoes, potato products	0.54	0.27	0.01	0.54	0.00	0.38
Root vegetables	Root vegetables	0.12	-0.13	0.33	0.11	0.73	0.03
Other vegetables	Leaf vegetables, onions, cabbages, tomatoes, cucumbers, canned vegetables, mushrooms	-0.01	0.18	0.54	-0.00	0.75	0.04
Fruit and berries	Fresh fruits, canned fruits, berries, fruit and berry juices	-0.32	0.21	0.20	0.33	0.39	-0.13
Margarine and oils	Soft margarine, low-fat spreads, oil	-0.02	0.68	0.15	0.42	0.18	0.15
Butter	Butter, butter-oil spreads, lard	0.71	-0.02	-0.09	0.53	0.04	0.19
Milk	Milk	0.36	0.40	-0.40	0.35	-0.12	0.21
Cheese	Cheese	0.19	0.17	0.53	0.18	0.35	0.03
Other dairy products	Cream, sour milk products, yoghurt ice cream	-0.13	-0.10	0.53	0.28	0.26	-0.19
Pork	Pork	0.05	0.11	0.06	0.31	0.09	0.66
Other meat	Beef, lamb, game, poultry, meat products	0.14	0.36	0.23	0.25	0.26	0.52
Sausages	Sausages, frankfurters	0.35	0.16	-0.03	0.41	-0.19	0.49
Offal	Liver, kidney, other offal	0.03	0.09	-0.01	0.07	0.08	0.46
Fish	Fish, shellfish, fish products	0.02	0.13	0.03	0.03	0.42	0.31
Eggs	Eggs	-0.01	0.45	0.08	-0.05	0.22	0.54
Coffee	Coffee	0.46	0.09	0.02	0.18	-0.19	0.29
Tea	Tea	0.10	0.12	0.26	0.02	0.32	-0.28
Alcoholic beverages	Alcoholic beverages	0.16	0.01	0.33	-0.08	-0.12	0.46
Sugar	Sugar, syrup, sweets, chocolate	-0.02	0.51	-0.16	0.42	0.01	-0.14
Variance (%)		8.7	8.7	6.5	14.1	10.9	9.9

Bold denotes an absolute value of larger than 0.2, which was included in the calculation of dietary pattern score.

Supplementary Table 2. Rotated factor loadings for the three dietary patterns identified based on diet in 1986, 2001 and 2007

Food groups	1986 Traditional Finnish	1986 High- carbohydrate	1986 Vegetables and red meat	2001 Traditional Finnish	2001 High- carbohydrate	2001 Vegetables and dairy products	2007 Traditional Finnish and High-carbohydrate	2007 Red meat	2007 Healthy
Rye	0.49	0.05	0.16	0.53	0.29	0.25	0.37	-0.16	0.13
Wheat	0.14	0.66	-0.04	-0.17	0.68	-0.13	0.84	0.04	-0.02
Other grain products	-0.03	-0.04	-0.04	0.23	0.78	0.12	0.84	0.06	0.22
Legumes and nuts	-0.12	0.16	-0.06	-0.41	0.18	0.02	0.00	0.09	0.63
Potatoes	0.30	-0.08	0.69	0.30	0.16	-0.24	0.54	0.34	0.09
Root vegetables	-0.15	-0.09	0.63	0.13	0.03	0.47	0.11	-0.01	0.74
Other vegetables	-0.16	0.27	0.37	-0.46	0.32	0.17	0.10	0.02	0.75
Fruit and berries	-0.25	0.18	0.08	-0.10	0.13	0.32	0.29	-0.20	0.50
Margarine and oils	-0.29	0.47	0.20	0.33	0.35	-0.04	0.52	0.17	0.13
Butter	0.77	0.15	0.02	-0.05	0.51	-0.11	0.68	0.11	0.08
Milk	0.60	-0.19	0.08	0.48	0.25	-0.22	0.34	0.14	-0.17
Cheese	0.04	0.44	0.14	-0.21	0.33	0.07	0.28	-0.03	0.15
Other dairy products	0.00	-0.08	0.00	-0.07	0.04	0.31	0.29	-0.21	0.22
Pork	-0.02	0.22	0.60	0.20	0.27	-0.11	0.46	0.57	0.22
Other meat	0.10	-0.13	0.26	-0.09	0.16	-0.18	0.39	0.39	0.26
Sausages	0.26	0.24	-0.03	0.32	0.27	-0.31	0.41	0.47	-0.14
Offal	0.07	0.20	-0.01	-0.07	0.03	-0.06	0.13	0.23	0.13
Fish	-0.01	-0.02	0.03	-0.22	0.12	0.05	0.17	0.33	0.46
Eggs	0.19	0.47	-0.18	-0.10	0.34	-0.08	0.37	0.37	0.21
Coffee	0.34	0.10	0.03	0.16	0.09	-0.56	0.09	0.40	-0.21
Tea	-0.10	0.36	0.04	0.00	0.07	0.66	0.09	-0.44	0.25
Alcoholic beverages	-0.07	0.01	0.10	-0.33	0.02	-0.36	-0.07	0.56	-0.03
Sugar	0.13	0.19	0.00	-0.08	0.32	0.16	0.56	-0.11	-0.03
<i>Variance (%)</i>	7.8	7.1	6.9	6.9	10.1	7.5	17.4	8.6	10.7

Bold denotes an absolute value of larger than 0.2, which was included in the calculation of dietary pattern score.

Supplementary Table 3. Long-term and adulthood dietary pattern scores with episodic memory and associative learning (PAL-test) and reaction and movement time (RTI-test) by baseline age groups

		Long-term dietary patterns		
		<i>Traditional Finnish pattern</i>		
RTI-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	192	0.111 (-0.068 to 0.290)	0.040
	9-12	275	-0.076 (-0.200 to 0.048)	
	15-18	256	-0.149 (-0.294 to -0.006)	
		<i>Vegetables and dairy products</i>		
PAL-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	193	-0.020 (-0.207 to 0.167)	0.029
	9-12	279	0.070 (-0.051 to 0.191)	
	15-18	260	0.186 (0.073 to 0.300)	
		<i>Healthy</i>		
PAL-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	193	-0.011 (-0.183 to 0.162)	0.043
	9-12	279	0.049 (-0.087 to 0.185)	
	15-18	260	0.140 (0.018 to 0.262)	
		<i>Red meat</i>		
PAL-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	193	0.171 (-0.023 to 0.364)	0.022
	9-12	279	0.050 (-0.077 to 0.176)	
	15-18	260	-0.042 (-0.146 to 0.063)	
		Adulthood dietary patterns		
		<i>Traditional Finnish pattern</i>		
PAL-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	193	0.096 (-0.061 to 0.254)	0.024
	9-12	279	-0.031 (-0.168 to 0.106)	
	15-18	260	-0.109 (-0.260 to 0.043)	
		<i>Red meat</i>		
PAL-test	Age (years)	N	β (95% confidence interval)	P for interaction
	3-6	193	0.162 (0.008 to 0.316)	0.028
	9-12	279	0.006 (-0.115 to 0.128)	
	15-18	260	-0.002 (-0.142 to 0.138)	

Bold denotes $p < 0.05$.

Adjusted for age, sex, youth body mass index, school performance, socioeconomic status, physical activity, smoking, systolic blood pressure, and adulthood systolic blood pressure, total cholesterol, triglycerides, and physical activity; further adjusted for youth dietary pattern score when adulthood dietary pattern was the exposure of interest.

Supplementary Table 4. Long-term and adulthood ‘vegetables and dairy products’ pattern score with visual processing and sustained attention (RVP-test) and episodic memory and associative learning (PAL-test) by sex

		Long-term dietary pattern		
		<i>Vegetables and dairy products</i>		
RVP-test	Sex	N	β (95% confidence interval)	P for interaction
	Females	433	0.0001 (-0.102 to 0.102)	0.045
	Males	335	0.134 (0.037 to 0.232)	
		Adulthood dietary patterns		
		<i>Vegetables and dairy products</i>		
RVP-test	Sex	N	β (95% confidence interval)	P for interaction
	Females	433	-0.024 (-0.138 to 0.089)	0.036
	Males	335	0.109 (0.013 to 0.204)	
		<i>Vegetables and dairy products</i>		
PAL-test	Sex	N	β (95% confidence interval)	P for interaction
	Females	433	-0.050 (-0.175 to 0.075)	0.043
	Males	335	0.124 (0.027 to 0.221)	

Bold denotes $p < 0.05$.

Adjusted for age, youth body mass index, school performance, socioeconomic status, physical activity, smoking, systolic blood pressure, and adulthood systolic blood pressure, total cholesterol, triglycerides, and physical activity; further adjusted for youth dietary pattern score when adulthood dietary pattern was the exposure of interest.