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Fruit and Vegetable Intake: Change with Age across Childhood and Adolescence

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Key words

Fruit, vegetable, children, adolescent, age trend, pseudo-panel, bias

Abbreviations

FV: Fruit and vegetable
NDNS: National diet and nutrition survey
g/day: grams per day

Abstract

Eating fruit and vegetables (FV) offers important health benefits for children and adolescents, but their average intake is low. To explore if negative trends with age exist as children grow, this study modelled differences in fruit and vegetable consumption from childhood to young adulthood. A pseudo-panel was constructed using Years 1-4 (combined) of the Rolling Programme of the UK National Diet and Nutrition Survey (2008/09 – 2011/12). Intake of fruits and vegetables in the NDNS was recorded using 4-day unweighted food diaries. Data consisted of 2131 observations of individuals aged 2 to 23 years. Age-year-cohort decomposition regression analyses were used to separate age effects from year and cohort effects in the data. Total energy intake was included to account for age differences in overall energy consumption. Fruit intake started to decrease from the age of 7 for boys and girls and reached its lowest level during adolescence. By 17 years boys were consuming 0.93 (p = 0.037) less fruit portions compared to the age of two. By 15 years, girls were consuming 0.8 fruit portions less (p = 0.053). Vegetable intake changed little during childhood and adolescence (p = 0.0834 and p = 0.843 for change between 7 and 12 years, boys and girls respectively). There was unclear evidence of recovery of FV intakes in early adulthood. Efforts to improve FV intake should consider these trends, and focus attention on the factors influencing intake across childhood and adolescence in order to improve the nutritional quality of diets during these periods.

1 Introduction

Consumption of fruit and vegetables (FV) during childhood and adolescence is important for healthy growth, the reduction of obesity, and reducing future cancer risks[1; 2; 3; 4]. Nevertheless, national dietary surveys in high-income countries show that large numbers of children and adolescents have FV consumption levels that fall below recommended guidelines, with adolescents at higher risk of low intake[5; 6; 7; 8]. The observed differences in intake across age groups may arise from the multiple changes in lifestyle and physical and social environments that take place between childhood and adolescence. For example, previous studies have shown that children start to eat less FV when they go from primary to secondary school[9; 10; 11]. Given the potential for deterioration of FV intake with children's development, the aim of this study is to explore differences with age in FV intake from childhood to adolescence as a critical step for planning the timing of interventions to ensure the adequate nutritional quality of young people's diets[12].

Results from longitudinal studies looking into change with age in FV intake have shown decrease in consumption of fruit at different points in the time from childhood to young adulthood, but less clear trends for vegetables. In the context of the US-based Bogalusa Heart Study, Larson et al.[12] observed a decrease in FV intake both in the transition from early to middle adolescence and from middle to late adolescence (approximately the period between 11 and 17 years), while Demory-Luce et al.[13], also using data from a regional US cohort, found a significant decrease in fruit and fruit juice intake, but no change in vegetable intake between the age of 10 years and the mid-twenties. Similarly, using frequency of daily FV intake to approximate children's FV consumption, a study looking at three different age cohorts in a semi-urban area of Sweden found a decrease of fruit intake over two years (8-10, 11-13 and 14-16 years), but a decrease in vegetable intake only for high-socioeconomic groups[14]. A critical assumption in these studies, however, is that cohort and year effects have not influenced the observed trends with age. (Survey) year effects (e.g. the yearly state of the economy) could have accentuated upward or downward trends in the data of these longitudinal samples, while cohort effects could have introduced bias from looking at only one generation over time, i.e. observed patterns with growth would be representative of the studied cohort, but not of older or younger groups[15; 16]. Controlling for both effects using data from different cohorts is therefore important to identify the true development of FV consumption with age[17].

In addition, studies have so far explored the trajectory of intake from the age of 8 to 10 years onwards but little is know about the developmental trajectories of FV intake from earlier ages. FV intake could start to change early, for example, as children go through stages of food neophobia, have greater interaction with peers that can influence their preferences, and are more exposed to food cues in the environment (e.g. food marketing)[18; 19]. If there are negative trends with age in FV intake, it is important to identify which is the earlierst stage at which intake starts to deteriorate in order to intervene more effectively to improve diets later on.

The aim of this study was to investigate how FV intake changes with age from early childhood until late adolescence using robust methods that address critical confounders in previous studies of cohort and year effects. Differences with age were examined separately for males and females to understand if different risk paths for low FV consumption existed in these groups.

2 Method and Data

2.1 Controlling for age, year and cohort effects

Change in FV consumption over time can be modelled as the sum of age, cohort and time effects[1,2](17; 20; 21). Methodologically, an individual's cohort membership is determined through a linear relationship between age and (survey) year, making it hard to separate these effects(21). Approaches to tackle the identification of age, year and cohort effects in linear models combining the three variables involve imposing constraints on one of the effects, some previous assumptions on the shape of the effects, or both(22; 23). Deaton proposed a descriptive age-year-cohort decomposition(15) first applied for the study of economic life-cycle phenomena in which i) given sufficiently large sample sizes, indicator variables are used to describe the three effects, avoiding any *a priori* assumptions around the shape of the effects; ii) year effects are normalized (set to have a zero mean and to be devoid of any trend)(24), leaving only the predictable components of age and cohort as explanation of the patterns in the data[3](22). For estimation purposes (see Online Supplementary Material), the method requires the exclusion of the first category in the set of age and cohort indicator variables, and the first two in the case of the normalized year indicator variables.

2.1.1 Construction of a pseudo-panel

The age-year-cohort decomposition described above requires data on more than one age group (cohorts) at any point in time, with repeated observations over time. A panel data set satisfies these conditions because it follows over time the same study participants that belong to different cohorts. In the case of repeated cross sections, surveys are not designed to follow the same individuals in each survey wave, but they

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[1] It is also possible to attempt to recreate the patterns in the data solely through age effects and a time trend. The time trend acts by shifting the average age-based behaviour with the passing of time(15). This is equivalent to assuming constant cohort effects.

[2] The model used also assumes that the effects of age, cohort and time are not influenced by each other, i.e. there are no interaction (multiplicative) effects. Thus, for example, it is assumed that the developmental processes (the shape of age effects) are not substantially different across cohorts or time ranges, which is usually assumed to be true for short time periods(15, 17, 23).

[3] It is possible to impose the normalization on the cohort effect or the age effect as opposed to the year effect(24). The choice depends on the objective of the research and the underlying assumptions. For example it may be of interest to study the effect of a policy or a shock (year effect) abstracting from the influence of age(16). The interest here is the developmental path of FV consumption, and age is thus retained as fundamental to the analysis.

provide samples from the same cohort over a period of time using the same sampling method, and the average behaviour of the individuals that belong to a cohort can be estimated for each survey period and used to build a pseudo-panel[15; 23; 25]. Changes in these averages can then be used to explore developmental differences of large groups in the population[20; 26]. To account for the skewness of food intake data, cohort medians instead of averages were used[15; 27]. The corresponding equations and a more detailed explanation of the method can be found in the Online Supplementary Material.

2.2 Data

Data on FV intake between the ages of 2 and 23 years was obtained from the pooled 2008/09, 2009/10, 2010/11 and 2011/12 waves of the UK National Diet and Nutrition Survey (NDNS). The NDNS collected FV consumption information, including FV from composite dishes[4], using consecutive 4-day unweighted food diaries from individuals aged 1.5 years and over living in private households. Data collection took place across all months of the year to control for seasonality in food intake, but in the final pooled sample there was a slight over-representation of weekend days[28]. Total sample size was 2,131 observations. Observations were calibrated using the NDNS weighting variable (pooled sample) when calculating the cohort medians. After estimating the medians for each cohort-year cell the total number of observations for the estimation of the age-year-cohort decomposition model was 175 (Table 1.2 in the Online Supplementary Material).

2.3 Measures

The dependent variables were the estimated cohort medians of daily vegetable portions (maximum of 80g/day of pulses and five times the intake of tomato puree g/day); total fruit portions (maximum of 150g/day of fruit juice and 160g/day of fruit smoothies, and three times the intake of dried fruits); fruit portions (total fruit portions minus fruit juice); and total fruit and vegetable portions (including fruit juice). The definitions of portions were those used in the NDNS. Age effects were estimated using twenty two age variables, one for each age between 2 and 23 years. Four year variables (NDNS waves), and 25 cohort dummies[5] were used for year and cohort effects, respectively. The youngest cohort were those aged 2 in 2011/12 and the oldest those aged 23 in 2008/09. Given the age bracket, some cohorts were not observed in some survey waves. Total energy intake from food was measured in MJ/day.

2.4 Estimation strategy

Linear models of FV intake against age, cohort and normalized year effects were calculated including a set of interaction terms between the age indicator variables and sex to capture differences in age effects between boys and girls. Multivariate energy adjustment was done to control for the potential confounding effect of differences with

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[4] Intake from composite dishes takes into account the contribution to the total intake of the food from its use as an ingredient in purchased products or in homemade recipes.

[5] The number of cohorts is given by the formula C = A +T – 1; where C stands for cohorts, A for number of age groups and T for number of years[23].

age in total calorie intake[29] [6]. HC2 robust standard errors were used to account for the estimated nature of the dependent variable and model heteroskedasticity[30; 31]. Stata 13 Statistical Software[32] was used for all analyses.

3 Results

Figure 1 to Figure 3 illustrate for males and females the estimated change with age of total vegetable and fruit portions intake. At each age the graphs plot the change in 80g/day portions compared to intake at 2 years of age. The graphs also show the increase or decrease in consumption in daily portions between adjacent ages. Both pieces of information thus describe the profile of consumption with increasing age. Figure 4 shows the estimated cohort effects on FV intakes, i.e. the increase or decrease in intakes compared to the youngest cohort. Estimates of the model regressions are presented in Tables 1 and in the Online Supplementary Material.

Total fruit and vegetable intake. No differences were found in the change with age in total FV intake between boys and girls (Figure 1), except the change at 21 years (p = 0.039, table not shown). Results showed that children consumed less FV portions during adolescence: after increasing their intake from early childhood to the age of seven (p = 0.067, boys, Table 1), intakes had droped by the age of 12 ($p < 0.001$, difference with respect to 7 years, boys, Table 1), and changed little during the teenage years. Although differences did not reach statistical significance, during the adolescent years there was a trend in lower intakes of up to one portion compared to intakes at the age of two years (Table 1.3 Supplementary Material). Intakes appeared to recover from the age of 17 to early adulthood, but this increase was not statistically significantly different from zero (p = 0.1634 between 17 and 23 years, boys). Trajectories of FV portions excluding the contribution to total intake from composite dishes were similar, except that the change in age during the young adulthood years presented a slower recovery from the drop during adolescence (Table 1.3 Supplementary Material, graph not shown).

Vegetables intake. Girls' change in vegetables intake with age was also not significantly different from that of boys, except at the age of 23 (p = 0.026, table not shown). For both groups, total vegetable intake changed very little, except after the age of 17, when intake showed growth, albeit not reaching statistical significance and being sustained only for boys (p = 0.186 for intake at 17 compared to 23 years, boys, Table 1). Trends with age in vegetable portions excluding the contribution from composite dishes showed a similar pattern (Figure 2), but without any positive change between the age of 17 and 23 years (p = 0.532, boys, Table 1).

Fruit intake. As with total FV and with vegetables, girls' change in fruit intake differed little from boys', with exceptions at the age of 8 (p = 0.05, fruit excluding juice, table not

[6] This method was preferred over the nutrient density or the regression-adjustment approach given low correlations of FV intake and total energy intake (r = 0.03 for fruit to r= 0.33 for vegetables)[30].

shown) and 17 years ($p = 0.039$, fruit including juice; $p = 0.06$, fruit excluding juice), and with marginally significant differences at 19 ($p = 0.065$, fruit including juice) and 22 years ($p = 0.085$, fruit including juice). In contrast to vegetable intake, changes with age were observed for fruit and fruit juice intake (Figure 3), reflecting the total FV age trends discussed above. Thus, after a brief period of growth until about the age of 7, children started eating less fruit portions as they grew older, (differences between the ages of 7 and 12 years: $p = 0.059$, boys; $p = 0.054$, girls, Table 1). From that point on, girls' intake did not change significantly during adolescence (difference between 12 and 17 years: fruit, $p = 0.716$; fruit including juice, $p = 0.358$), but the trajectory of boys showed further deterioration in total fruit portions consumed with each passing year ($p = 0.013$, fruit including juice $p = 0.029$, Table 1). Notably, there was no real improvement in the intake trajectory after the age of 17 for neither boys nor girls (Table 1). Trends were similar when considering fruit intake excluding composite dishes: by the age of 17 boys were consuming -0.93 ($p = 0.037$, Table 1.3 Online Supplementary Material) portions less than when they were 2 years old, and girls were consuming -0.50 ($p = 0.254$) portions less. During young adulthood, girls' intake recovered slightly, but this change did not reach statistical significance.

Fruit and vegetables intakes across cohorts. Looking at change in FV intake across cohorts (boys and girls combined), results showed variability around the difference across cohorts, but generally, younger cohorts were eating more fruit and fruit juice than older cohorts (but not the oldest cohorts). At the same time, there were no differences between cohorts for vegetable intake. Results were comparable for FV intake from composite dishes (Table 1.4 Supplementary Material).

4 Discussion

The present study explored the trajectory of FV consumption from childhood to young adulthood adding greater understanding of how consumption of these healthy foods can change during youth. The methods applied controlled for year and cohort effects in order to extract the effect of age on intake, while allowing for the use of a large national data set with information for toddlers up to 23 year-olds. Results showed that overall fruit and vegetable consumption started to decrease much earlier than the adolescent years, this trend being driven mainly by drops in fruit intake. Moreover, there was a trend for changes in intake in adolescence of up to a portion less of FV compared to young childhood for both boys and girls, with unclear indication of recovery in itakes during early adulthood. The importance on children's healthy eating of these trends is further highlighted in the context of the intake levels of typical two-year olds. In the last wave of the NDNS (2011/12), the median vegetable intake -including composite dishes- of boys was 0.9 portions per day (approximately 72g/day) and 1.3 portions for girls (100g/day), and median total intake of fruit was 1.9 portions/day (153g/day) for boys and 2 portions for girls (160g/day).

The results for change in fruit intake with age were in line with findings from the studies of Larson et al. and Demory-Luce et al.[12; 13], suggesting common drivers of intakes in these two samples. At the same time, in contrast to the decrease noted in Larson et al., vegetable consumption changed little during childhood and adolescence. This trajectory continued into young adulthood when looking only at the data excluding composite dishes, but even when including vegetable intake from composite dishes, there was little evidence that vegetable consumption increased in young adulthood, presenting a difference to the growth reported in Demory-Luce et al.[13]. Changes in the level of support for fruit and vegetable intake and the greater freedom in food choice exercised by children as they grow older may explain the deterioration in fruit consumption with age. The stark differences between fruit and vegetables may be because vegetables are typically served as part of main meals, and therefore less susceptible to "not being eaten" compared to fruit.

Interestingly, the growth trends found for fruit and vegetables were broadly similar for boys and girls during childhood and adolescence. This may be reflecting shared influences on changes in intake by age across both groups. Males and females did not differ in their vegetable intake in young adulthood, but women appeared to be consuming more fruit than men thanks to the contribution of fruit juice. Both potentially explaining this difference *and* presenting the challenge of improving male's total fruit consumption, may be cultural barriers faced by boys and men for healthy eating. For example, previous research has identified negative perceptions among young men of fruit juices and of fruit more generally as feminine foods[33; 34].

The trends by cohort indicated that the younger cohorts were eating significantly more fruit than older cohorts. Possible explanations for the findings include the English School Fruit and Vegetable Scheme introduced in 2004, which increases the daily availability of FV during school term time to children between four and six years attending state schools[7]; the compulsory nutrient-based standards imposed in primary schools in 2008; and the 2003 launch of the national "5-a-Day" information campaign; all of which may have put younger generations within more positive contexts for FV consumption, both through school environments and through raising parental awareness of the importance of FV intake. Results for fruits mirror the findings of Boddy et al.[35], who detect an increase in fruit intake for large cohorts of 9 to 10 year-olds in Liverpool (UK), although the authors do not control for year effects. There were no significant differences between younger and older cohorts for vegetable consumption. Children and young adults may be more willing or find it easier to increase their fruit and fruit juice consumption in order to improve their diets. These results, in conjunction with the age trajectories, suggest that there is a need for greater efforts to improve vegetable consumption among intiatives to raise young people's FV consumption.

The differences with age in FV intake described in this study are generalizable to the UK child population because they represent changes with children's development after controlling for time and cohort differences. However, a number of limitations to the study are of note. Change in intake was explored in terms of daily 80g portions, which refer to daily portion recommendations for adults and children older than 11 years[36], as currently there are no child-specific portion size recommendations in place in the UK. However, the derived portions were not used to discuss adequacy of intake in young age groups, solely to depict change with age. Sensitivity analyses using data in grams[7] showed that for vegetable portions and for fruit excluding juice portions, the age trends in grams and in portions were identical and data in portions represented just another way of depicting change with age. When including fruit juice, age trends in grams and in portions were very similar, with only sharper increases in total fruit intake at the ages of 7, and 10 to 12 years (results not shown). Sample sizes for the cohort estimates were relatively small because of the NDNS sample sizes for the age groups of interest, introducing less precision in the cohort-year cell means. The use of robust standard errors given the estimated nature of the dependent variable partly accounted for this greater uncertainty, yet the large standard errors impose cautious interpretations in some cases, particularly for the young adulthood years. The size of the sample may also have contributed to the more accentuated shifts in intake between ages, depicted graphically in Figures 1 to 3. Statistical tests of significance were carried out to check the relevance of upward or downward shifts between ages to avoid over-interpreting results. The age at which children acquire experiences with food may be important to the preferences and eating habits they form[37], but the simplifying assumption was made that the developmental trajectory would not change from generation to generation (absence of interactions). This assumption is commonly applied for studies covering just a few number of years[15; 17; 23] as it is expected that generational change does not occur over short periods of time. Finally, the dietary assessment method of the NDNS was 4-day unweighted food records. Although this method is less burdensome on participants,

[7] Constraining for maximum amounts of fruit juice, smoothies and pulses and multipliying the amount of dried fruit and tomato puree by the respective factors.

therefore improving compliance, reporting of portion-sizes is subject to imprecisions that can induce upward or downward biases in intake estimates, such as in the case of fibre and energy intake, respectively[38]. Moreover, data collection for the NDNS took place across all months of the year to control for seasonality in food intake, but in the final pooled sample there was a slight over-representation of weekend days[28], possibly resulting in lower estimated intakes of FV because diets tend to be less healthy during these days.

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7 Authorship

V.A. reviewed the literature, prepared and analysed the data and wrote the first draft. L.B., O.K. and W.T. provided conceptual contributions and statistical advice. All authors shared in the writing.

8 Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

9 Conflict Of Interest

The authors declare that they have no conflict of interests.

10 References

1. Prynne CJ, Mishra GD, O'Connell MA *et al.* (2006) Fruit and vegetable intakes and bone mineral status: a cross-sectional study in 5 age and sex cohorts. *The American Journal of Clinical Nutrition* **83**, 1420-1428.
2. Dauchet L, Amouyel P, Dallongeville J (2009) Fruits, vegetables and coronary heart disease. *Nature Reviews Cardiology* **6**, 599-608.
3. Maynard M, Gunnell D, Emmett P *et al.* (2003) Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort. *Journal of Epidemiology and Community Health* **57**, 218-225.
4. Bradlee ML, Singer MR, Qureshi MM *et al.* (2010) Food group intake and central obesity among children and adolescents in the Third National Health and Nutrition Examination Survey (NHANES III). *Public Health Nutrition* **13**, 797-805.
5. Kim SA, Moore LV, Galuska D *et al.* (2014) Vital signs: fruit and vegetable intake among children—United States, 2003–2010. *MMWR Morb Mortal Wkly Rep* **63**, 671-676.
6. Yngve A, Wolf A, Poortvliet E *et al.* (2005) Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: the Pro Children Cross-sectional Survey. *Annals of Nutrition and Metabolism* **49**, 236-245.
7. Jotangia D (2009) Chapter 14: children's fruit and vegetable consumption. In *The Health Survey for England 2008 Volume 1: physical activity and fitness* [R Craig, J Mindell and V Hirani, editors]. Leeds: The NHS Information Centre.
8. Holman DM, White MC (2011) Dietary behaviors related to cancer prevention among pre-adolescents and adolescents: the gap between recommendations and reality. *Nutrition Journal* **10**, 1-8.
9. Cullen KW, Zakeri I (2004) Fruits, vegetables, milk, and sweetened beverages consumption and access to a la carte/snack bar meals at school. *American Journal of Public Health* **94**, 463-467.
10. Hackett A, Gibbon M, Sratton G *et al.* (2001) Dietary intake of 9 -10-year-old and 11-12-year-old children in Liverpool. *Public Health Nutrition* **5**, 449-455.
11. Marks J, Barnett LM, Allender S (2015) Change of School in Early Adolescence and Adverse Obesity-Related Dietary Behavior: A Longitudinal Cohort Study, Victoria, Australia, 2013–2014. *Preventing chronic disease* **12**.
12. Larson NI, Neumark-Sztainer D, Hannan PJ *et al.* (2007) Trends in adolescent fruit and vegetable consumption, 1999–2004: project EAT. *American Journal of Preventive Medicine* **32**, 147-150.
13. Demory-Luce D, Morales M, Nicklas T *et al.* (2004) Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. *Journal of the American Dietetic Association* **104**, 1684-1691.
14. Elinder L, Heinemans N, Zeebari Z *et al.* (2014) Longitudinal changes in health behaviours and body weight among Swedish school children - associations with age, gender and parental education - the SCIP school cohort. *BMC Public Health* **14**, 640.
15. Deaton A (2000) *The analysis of household surveys: a microeconometric approach to development policy. 3rd Edition.* Baltimore: The John Hopkins University Press.
16. Wooldridge JM (2006) *Introductory econometrics, a modern approach*. 3rd. ed. Mason, Ohio: Thomsom South-Western.
17. Collins LM, Sayer A (2000) Modeling growth and change processes. Design, measurement and analysis for research in social psychology. In *Handbook of research methods in social and personality psychology*, pp. 478-495 [HT Reis and CM Judd, editors]. New York: Cambridge University Press.

18. Hill AJ (2002) Developmental issues in attitudes to food and diet. *Proceedings of the Nutrition Society* **61**, 259-266.
19. Thomas J (1991) Food choices and preferences of schoolchildren. *Proceedings of the Nutrition Society* **50**, 49-57.
20. Elder Jr G (1998) The life course as developmental theory. *Child Development* **69**, 1-12.
21. Masche JG, van Dulmen MHM (2004) Advances in disentangling age, cohort, and time effects: no quadrature of the circle, but a help. *Developmental Review* **24**, 322-342.
22. Attanasio OP, Jappelli T (2001) Intertemporal choice and the cross-sectional variance of marginal utility. *The Review of Economics and Statistics* **83**, 14-27.
23. McKenzie DJ (2006) Disentangling age, cohort and time effects in the additive model. *Oxford Bulletin of Economics and Statistics* **68**, 473-495.
24. Block SA, Keiss L, Webb P (2002) *Did Indonesia's crises of 1997/98 affect child nutrition? A cohort decomposition analysis of national Nutrition Surveillance data*. vol. Discussion Paper 5. The Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy: Boston. Boston.
25. Browning M, Deaton AS (1985) A Profitable approach to labor supply and commodity demands over the life-cycle. *Econometrica* **53**, 503-544.
26. Baranowski T, Cullen K, Basen-Engquist K *et al.* (1997) Transitions out of high school: time of increased cancer risk? *Preventive Medicine* **26**, 694-703.
27. Scientific Advisory Committee on Nutrition (2011) *Dietary reference values for energy.* London: The Stationary Office.
28. Nelson MC, Story M, Larson NI *et al.* (2008) Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity* **16**, 2205-2211.
29. Willett WC, Howe GR, Kushi LH (1997) Adjustment for total energy intake in epidemiologic studies. *The American Journal of Clinical Nutrition* **65**, 1220S-1228S.
30. Angrist JD, Pischke J-S (2008) *Mostly harmless econometrics: an empiricist's companion*: Princeton university press.
31. Lewis JB, Linzer DA (2005) Estimating regression models in which the dependent variable is based on estimates. *Political Analysis* **13**, 345-364.
32. StataCorp (2013) Stata Statistical Software: Release 13. College Station, TX: StataCorp. LP.
33. Krølner R, Rasmussen M, Brug J *et al.* (2011) Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part II: qualitative studies. *International Journal of Behavioral Nutrition and Physical Activity* **8**, 112.
34. Herbert G, Butler L, Kennedy O *et al.* (2010) Young UK adults and the 5 A DAY campaign: perceived benefits and barriers of eating more fruits and vegetables. *International Journal of Consumer Studies* **34**, 657-664.
35. Boddy LM, Abayomi J, Johnson B *et al.* (2014) Ten-year changes in positive and negative marker food, fruit, vegetables, and salad intake in 9–10 year olds: SportsLinx 2000–2001 to 2010–2011. *Journal of Human Nutrition and Dietetics* **27**, 236-241.
36. Bates B, Lennox A, Prentice A *et al.* (2014) *National Diet and Nutrition Survey. Results from Years 1-4 (combined) of the Rolling Programme (2008/2009 – 2011/12).* London: Public Health England.
37. Skinner JD, Carruth BR, Bounds W *et al.* (2002) Children's food preferences: a longitudinal analysis. *Journal of the American Dietetic Association* **102**, 1638-1647.
38. Tabacchi G, Amodio E, Di Pasquale M *et al.* (2014) Validation and reproducibility of dietary assessment methods in adolescents: a systematic literature review. *Public Health Nutrition* **17**, 2700-2714.

11 Tables

Table 1. Tests of differences at selected ages in consumption of fruit and vegetable portions for males and females

		Including composite dishes		Excluding composite dishes	
		Boys	Girls	Boys	Girls
Total Fruit and vegetable portions					
3 vs 7	F(1,105)	3.43	0.05	1.38	0.01
	p value	0.067	0.822	0.242	0.936
7 vs 12	F(1,105)	13.38	1.76	9.46	0.72
	p value	0.000	0.187	0.003	0.399
12 vs 17	F(1,105)	0.07	<0.01	1.55	0.74
	p value	0.797	0.955	0.216	0.393
17 vs 23	F(1,105)	1.97	0.06	0.65	<0.01
	p value	0.163	0.815	0.423	0.944
Vegetable portions					
3 vs 7	F(1,105)	1.56	0.05	3.11	1.10
	p value	0.214	0.823	0.081	0.296
7 vs 12	F(1,105)	0.04	0.04	2.65	0.02
	p value	0.834	0.843	0.106	0.888
12 vs 17	F(1,105)	1.04	0.58	<0.01	0.77
	p value	0.310	0.448	0.971	0.383
17 vs 23	F(1,105)	1.77	0.01	0.39	0.45
	p value	0.186	0.924	0.532	0.504
Fruit portions[a]					
3 vs 7	F(1,105)	1.59	1.23	1.85	1.00
	p value	0.211	0.269	0.177	0.321
7 vs 12	F(1,105)	2.25	1.74	3.2	1.94
	p value	0.137	0.191	0.076	0.167
12 vs 17	F(1,105)	4.88	0.85	6.12	0.90
	p value	0.029	0.358	0.015	0.345
17 vs 23	F(1,105)	0.81	0.03	1.26	0.04
	p value	0.371	0.868	0.265	0.840
Fruit portions[b]					
3 vs 7	F(1,105)	0.29	0.29	0.16	<0.01
	p value	0.590	0.594	0.686	0.967
7 vs 12	F(1,105)	3.65	3.79	4.17	2.89
	p value	0.059	0.054	0.044	0.092
12 vs 17	F(1,105)	6.45	0.13	9.54	0.68
	p value	0.013	0.716	0.003	0.412
17 vs 23	F(1,105)	1.73	0.53	1.45	0.47
	p value	0.191	0.470	0.232	0.495

[a]Fruit including fruit juice. [b]Fruit excluding fruit juice. Age coefficients from the regressions of FV on age dummies, controlling for cohort effects, normalized year effects and total energy intake from food. Models with interaction effects between the age dummies and sex with the corresponding reference category for each model (boys and girls, respectively). *p*-value from a Wald F-tests for the equality of the age coefficient estimated from the regressions of fruit and vegetable intakes on age. Data from year 1 to year 4 of the rolling program of the National Diet and Nutrition Survey

12 Figures

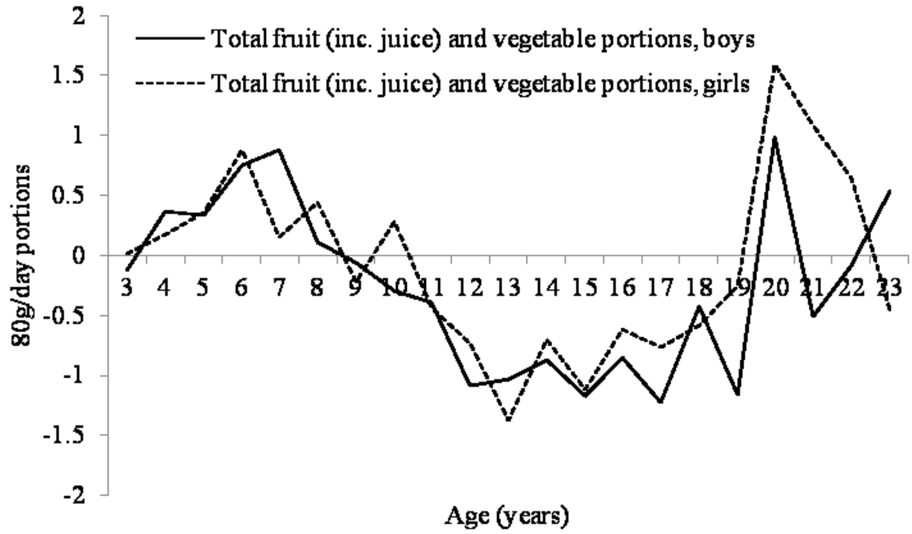
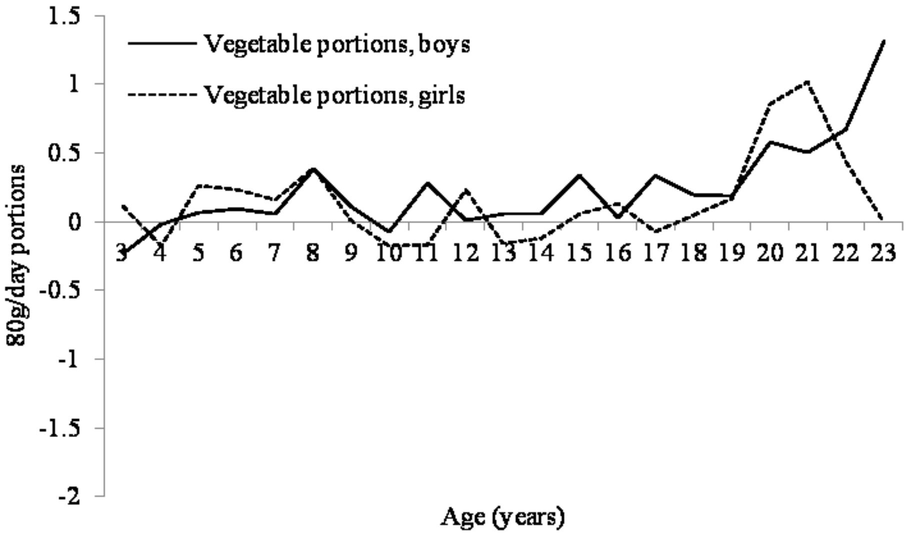


Fig. 1 Change with age of fruit and vegetable intake, boys and girls.
At each age the graph indicates the average difference in the amount consumed compared to that of a 2 year-old and the change in intake between adjacent ages. Change with age are the coefficients from the regressions of FV on age dummies, controlling for cohort effects, normalized year effects and total energy intake from food. Models by sex from the interaction effects between the age dummies and sex with the corresponding reference category for each model (boys and girls, respectively). Pooled NDNS year 1 to year 4 waves. Fruit and vegetables intake including contribution from composite dishes.



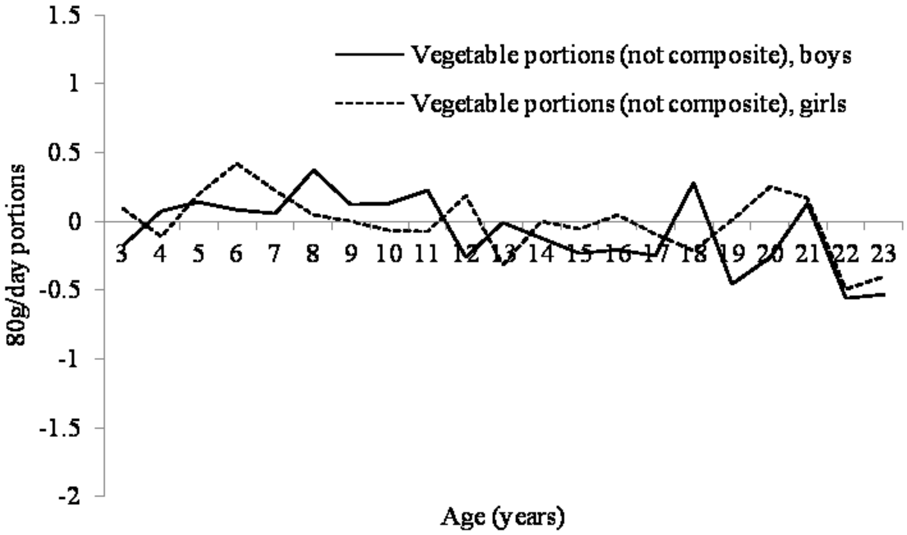
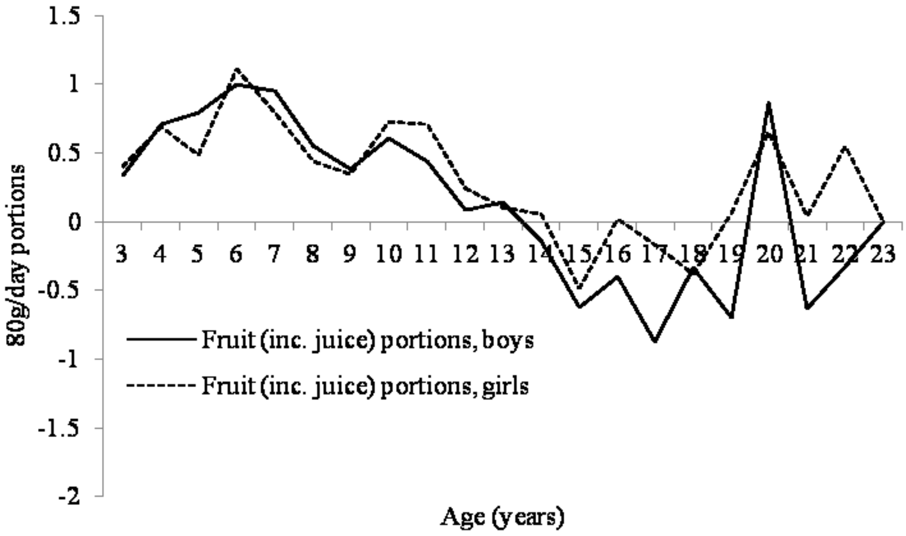


Fig. 2 Increase or decrease in vegetable intake with age, boys and girls
Vegetable portions included a maximum of 80g per day of pulses and five times the intake of tomato puree. At each age the graph indicates the average difference in the amount consumed compared to that of a 2 year-old and the change in intake between adjacent ages. Change with age are the coefficients from the regressions of FV on age dummies, controlling for cohort effects, normalized year effects and total energy intake from food. Models by sex from the interaction effects between the age dummies and sex with the corresponding reference category for each model (boys and girls, respectively). Pooled NDNS year 1 to year 4 waves.



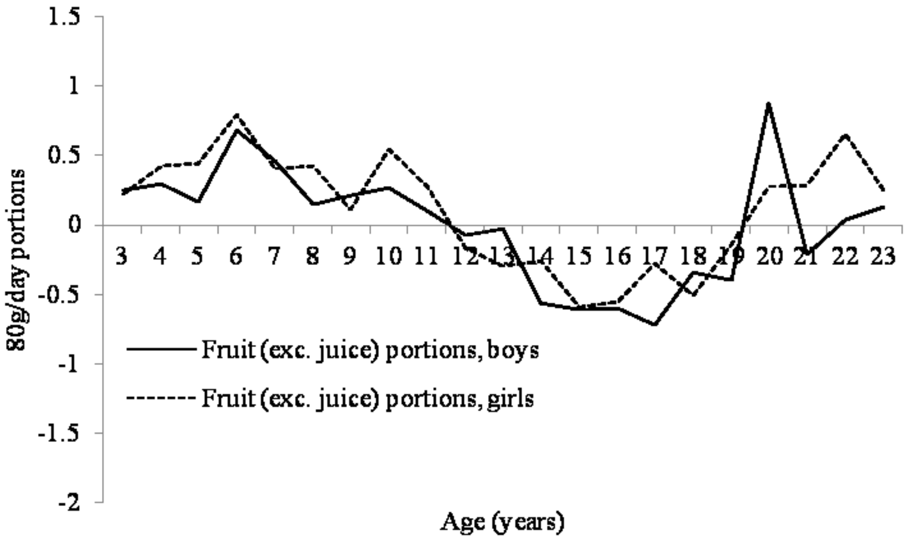


Fig. 3 Increase or decrease with age of fruit intake, boys and girls
Total fruit portions included a maximum of 150g/day of fruit juice and 160g/day of fruit smoothies, and three times the intake of dried fruits. At each age the graph indicates the average difference in the amount consumed compared to that of a 2 year-old and the change in intake between adjacent ages. Change with age are the coefficients from the regressions of FV on age dummies, controlling for cohort effects, normalized year effects and total energy intake from food. Models by sex from the interaction effects between the age dummies and sex with the corresponding reference category for each model (boys and girls, respectively). Pooled NDNS year 1 to year 4 waves. Fruit intake including contribution from composite dishes.

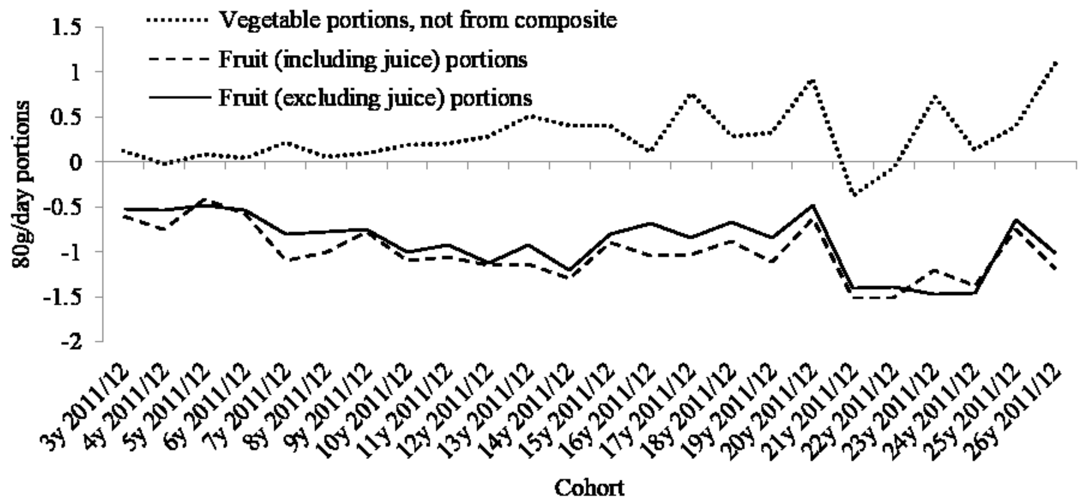


Fig. 4 Change in fruit and vegetable consumption from older to younger cohorts
Total fruit portions included a maximum of 150g/day of fruit juice and 160g/day of fruit smoothies, and three times the intake of dried fruits. Vegetable portions included a maximum of 80g per day of pulses and five times the intake of tomato puree. At each cohort the graph indicates the average difference in the amount consumed compared to the youngest cohort (children aged 2 in 2011/12), and the change in intake between contiguous cohorts. Change across cohorts are the coefficients from the regressions of FV on cohort effects, controlling for age effects, normalized year effects and total energy intake from food. Pooled NDNS year 1 to year 4 waves. Fruit and vegetables intake including contribution from composite dishes.

13 Supplementary material

13.1 Age-year-cohort decomposition

Following McKenzie[(1)], individuals are observed over an age range comprising *j* age groups, over *k* periods. A cohort is defined as the same group of individuals observed on successive occasions, where individuals are observed based on their age in a specific period. Cohorts are thus indexed with the subscript *(j-k +1)*. The individual's *i* age, cohort and year effects on the dependent variable of interest are then written as

$$FV_{i,c(j-k+1),aj,tk} = b + \alpha_{c(j-k+1)} + \beta_{aj} + \rho_{tk} + \mu \qquad (1)$$

where FV stands for fruits and vegetables, a_j refers to age group j, t_k to time period k and $c_{(j-k+1)}$ to cohort (j-k+1), b is a constant and μ is an error term. Theoretical and empirical results can serve to guide the functional form imposed on the age, time and cohort effects [(2)]. However, it is possible to avoid any *a priori* functional forms for the three effects when sample size is sufficiently large through the use of dummy variables[(3)]. It is further assumed that there are no interaction effects between age, cohort and time variables[(3)]. Thus Equation (1) is estimated through matrices of age, year and cohort dummies. The cohort dummies are defined as cohort-year pairs: for each survey year there are *j* cohorts observed. All the matrices therefore have *j* times the number of surveys as lines, and, respectively, the number of age groups, the number of years and the number of cohorts as columns.

One column is dropped out of each matrix to avoid perfect collinearity given the constant term in (1). As it stands, however, the model is unable to attribute any estimates specifically to age, year or cohort effects as there exists a linear relationship among these variables due to the fact that cohort membership is determined through age and survey year. An approach used previously to address this problem is to make the year effects orthogonal to a time trend, i.e. lacking in trend or predictable pattern, and averaging to zero over the long run [(4; 5)]. Following Deaton [(3)], the normalization that achieves both conditions is given by:

$$d_t^* = d_t - [(t-1)d_2 - (t-2)d_1] \qquad (2)$$

where d is the dummy variable for survey year, and where t = 1, …, 4. The choice of the normalization of the year effect assumes that age and cohort effects explain the trends on the data [(5)].

13.1.1 References

1. McKenzie DJ (2006) Disentangling age, cohort and time effects in the additive model. *Oxford Bulletin of Economics and Statistics* **68**, 473-495.
2. Attanasio OP, Jappelli T (2001) Intertemporal choice and the cross-sectional variance of marginal utility. *The Review of Economics and Statistics* **83**, 14-27.
3. Deaton A (2000) *The analysis of household surveys: a microeconometric approach to development policy. 3rd Edition.* Baltimore: The John Hopkins University Press.
4. Aristei D, Perali F, Pieroni L (2005) *Cohort analysis of alcohol consumption: a double hurdle approach*. *ChilD Working Papers*. Centre for Household, Income, Labour Demographic Economics.
5. Block SA, Keiss L, Webb P (2002) *Did Indonesia's crises of 1997/98 affect child nutrition? A cohort decomposition analysis of national Nutrition Surveillance data*. vol. Discussion Paper 5. The Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy: Boston. Boston.

13.2 Number of individuals in each cohort in each survey year used to calculate the median fruit and vegetable consumption behaviour of the individuals that belong to each cohort. Weighted counts.

	Survey wave			
Cohort number	**1**	**2**	**3**	**4**
1				11
2			12	11
3		14	15	11
4	18	14	8	16
5	14	10	12	8
6	13	11	15	9
7	16	14	12	13
8	11	9	9	11
9	17	9	12	10
10	13	10	13	14
11	18	11	11	9
12	11	14	13	14
13	11	10	13	14
14	10	18	12	10
15	13	12	13	15
16	15	11	13	14
17	12	15	12	6
18	16	18	16	8
19	15	11	6	12
20	12	14	17	18
21	26	9	17	16
22	10	10	13	8
23	24	16	12	
24	9	23		
25	14			

The age range under study is 2 to 23 years. The youngest cohort was aged 2 in the 4th wave of the survey (20011/12), the last survey included; the oldest cohort was aged 23 in the first survey wave included (2008/09). Cohort 9 was 7 years in the first survey year, cohort 10 was 8 years in that same survey wave, and so on until the last cohort.

13.3 Estimates of age effects on consumption of fruit and vegetable portions for males and females

	Including composite dishes															
	Total Fruit and vegetable portions				Vegetable portions				Fruit portions[a]				Fruit portions[b]			
	Male		Female		Male		Female		Male		Female		Male		Female	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
2 years	(base)															
3 years	-0.12	(0.25)	0.02	(0.25)	-0.23	(0.20)	0.11	(0.15)	0.34	(0.34)	0.40*	(0.20)	0.25	(0.22)	0.23	(0.24)
4 years	0.37	(0.40)	0.18	(0.56)	-0.02	(0.17)	-0.18	(0.14)	0.71*	(0.33)	0.68	(0.50)	0.30	(0.24)	0.43	(0.29)
5 years	0.34	(0.40)	0.36	(0.45)	0.07	(0.20)	0.27	(0.18)	0.79	(0.50)	0.49	(0.38)	0.17	(0.31)	0.44	(0.34)
6 years	0.75	(0.50)	0.88	(0.55)	0.09	(0.29)	0.23	(0.21)	1.00*	(0.44)	1.12*	(0.51)	0.68+	(0.39)	0.79*	(0.33)
7 years	0.88	(0.55)	0.16	(0.63)	0.06	(0.22)	0.16	(0.22)	0.95*	(0.45)	0.79*	(0.40)	0.46	(0.36)	0.41	(0.34)
8 years	0.11	(0.62)	0.43	(0.67)	0.38	(0.30)	0.39	(0.32)	0.55	(0.46)	0.44	(0.45)	0.15	(0.34)	0.43	(0.32)
9 years	-0.06	(0.60)	-0.23	(0.58)	0.11	(0.27)	0.01	(0.24)	0.38	(0.52)	0.35	(0.51)	0.21	(0.35)	0.11	(0.36)
10 years	-0.29	(0.72)	0.29	(0.63)	-0.07	(0.27)	-0.17	(0.31)	0.61	(0.57)	0.73	(0.51)	0.27	(0.40)	0.55	(0.34)
11 years	-0.39	(0.75)	-0.43	(0.81)	0.28	(0.37)	-0.17	(0.28)	0.44	(0.62)	0.71	(0.62)	0.10	(0.41)	0.29	(0.40)
12 years	-1.08	(0.73)	-0.73	(0.72)	0.01	(0.33)	0.23	(0.38)	0.09	(0.64)	0.24	(0.56)	-0.07	(0.39)	-0.17	(0.37)
13 years	-1.03	(0.81)	-1.37+	(0.73)	0.06	(0.32)	-0.17	(0.35)	0.14	(0.67)	0.10	(0.59)	-0.03	(0.45)	-0.30	(0.40)
14 years	-0.87	(0.77)	-0.71	(0.73)	0.06	(0.36)	-0.11	(0.31)	-0.14	(0.63)	0.07	(0.63)	-0.56	(0.41)	-0.26	(0.42)
15 years	-1.17	(0.85)	-1.12	(0.93)	0.34	(0.41)	0.06	(0.48)	-0.62	(0.62)	-0.48	(0.65)	-0.61	(0.42)	-0.59	(0.45)
16 years	-0.85	(0.84)	-0.62	(0.88)	0.03	(0.42)	0.13	(0.43)	-0.40	(0.62)	0.02	(0.63)	-0.60	(0.42)	-0.55	(0.45)
17 years	-1.22	(0.87)	-0.77	(0.82)	0.34	(0.42)	-0.07	(0.38)	-0.87	(0.66)	-0.16	(0.66)	-0.72	(0.45)	-0.28	(0.45)
18 years	-0.42	(0.96)	-0.58	(1.03)	0.20	(0.50)	0.05	(0.53)	-0.33	(0.74)	-0.38	(0.70)	-0.34	(0.67)	-0.51	(0.51)
19 years	-1.16	(1.09)	-0.25	(1.20)	0.19	(0.61)	0.17	(0.51)	-0.70	(0.74)	0.07	(0.78)	-0.40	(0.53)	-0.13	(0.61)
20 years	0.99	(1.61)	1.61	(1.24)	0.58	(0.74)	0.86	(0.56)	0.87	(1.31)	0.65	(1.09)	0.88	(1.06)	0.28	(0.75)
21 years	-0.51	(1.22)	1.09	(1.37)	0.50	(0.62)	1.02+	(0.60)	-0.63	(0.89)	0.04	(1.07)	-0.21	(0.66)	0.29	(0.82)
22 years	-0.08	(1.46)	0.65	(1.41)	0.67	(1.04)	0.43	(0.64)	-0.32	(0.98)	0.55	(1.05)	0.04	(0.70)	0.65	(0.83)
23 years	0.54	(1.50)	-0.45	(1.57)	1.32	(0.84)	-0.01	(0.70)	0.00	(1.12)	-0.01	(1.10)	0.13	(0.75)	0.25	(0.86)
N	175		175		175		175		175		175		175		175	
F	2.30		2.30		6.22		6.22		10.08		10.08		8.29		8.29	
$Adj.R^2$	0.23		0.23		0.39		0.39		0.26		0.26		0.37		0.37	
	Excluding composite dishes															
	Total Fruit and vegetable portions				Vegetable portions				Fruit portions[a]				Fruit portions[b]			
	Male		Female		Male		Female		Male		Female		Male		Female	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
2 years	(base)															

3 years	0.10	(0.45)	0.36	(0.25)	-0.17*	(0.07)	0.10*	(0.05)	0.34	(0.35)	0.42*	(0.19)	0.24	(0.21)	0.24	(0.23)
4 years	0.79**	(0.28)	0.49	(0.52)	0.08	(0.07)	-0.10	(0.07)	0.54+	(0.32)	0.70	(0.45)	0.29	(0.25)	0.37	(0.28)
5 years	0.45	(0.41)	0.52	(0.53)	0.14	(0.11)	0.20**	(0.07)	0.77	(0.49)	0.55	(0.35)	0.20	(0.30)	0.43	(0.31)
6 years	0.51	(0.47)	0.96+	(0.54)	0.09	(0.17)	0.42**	(0.12)	0.85+	(0.46)	1.08*	(0.54)	0.56	(0.39)	0.69+	(0.35)
7 years	0.80	(0.56)	0.32	(0.56)	0.06	(0.13)	0.23*	(0.11)	0.99*	(0.45)	0.78+	(0.40)	0.39	(0.35)	0.26	(0.32)
8 years	0.28	(0.60)	0.37	(0.54)	0.38*	(0.15)	0.05	(0.15)	0.52	(0.43)	0.47	(0.43)	0.07	(0.35)	0.37	(0.32)
9 years	0.30	(0.56)	-0.01	(0.57)	0.12	(0.15)	0.00	(0.13)	0.28	(0.49)	0.34	(0.54)	0.18	(0.35)	0.10	(0.37)
10 years	0.15	(0.64)	0.47	(0.60)	0.13	(0.15)	-0.07	(0.20)	0.59	(0.53)	0.69	(0.53)	0.18	(0.40)	0.46	(0.34)
11 years	0.20	(0.69)	0.31	(0.78)	0.23	(0.25)	-0.07	(0.19)	0.54	(0.60)	0.66	(0.60)	0.04	(0.39)	0.14	(0.39)
12 years	-0.74	(0.65)	-0.14	(0.62)	-0.26	(0.22)	0.19	(0.26)	0.10	(0.59)	0.22	(0.53)	-0.17	(0.40)	-0.26	(0.37)
13 years	-0.62	(0.72)	-0.84	(0.71)	-0.01	(0.21)	-0.31	(0.21)	0.12	(0.64)	0.08	(0.57)	-0.19	(0.43)	-0.40	(0.39)
14 years	-0.80	(0.72)	-0.74	(0.68)	-0.12	(0.25)	-0.00	(0.20)	-0.02	(0.64)	0.06	(0.61)	-0.66	(0.41)	-0.44	(0.41)
15 years	-1.43+	(0.75)	-1.07	(0.72)	-0.23	(0.26)	-0.04	(0.23)	-0.56	(0.61)	-0.51	(0.62)	-0.78+	(0.41)	-0.82+	(0.42)
16 years	-0.90	(0.71)	-0.71	(0.86)	-0.20	(0.24)	0.05	(0.30)	-0.48	(0.61)	-0.09	(0.62)	-0.79+	(0.41)	-0.74+	(0.43)
17 years	-1.55+	(0.88)	-0.54	(0.74)	-0.25	(0.38)	-0.09	(0.29)	-0.85	(0.63)	-0.14	(0.62)	-0.93*	(0.44)	-0.50	(0.43)
18 years	-0.54	(0.87)	-0.89	(0.80)	0.28	(0.31)	-0.22	(0.32)	-0.28	(0.74)	-0.43	(0.65)	-0.62	(0.65)	-0.72	(0.49)
19 years	-1.49+	(0.88)	-0.39	(0.97)	-0.45	(0.38)	0.01	(0.44)	-0.49	(0.68)	0.02	(0.77)	-0.54	(0.50)	-0.40	(0.58)
20 years	0.32	(1.56)	0.57	(1.36)	-0.26	(0.49)	0.26	(0.47)	0.91	(1.21)	0.68	(1.01)	0.74	(1.07)	0.04	(0.73)
21 years	-0.44	(1.17)	0.04	(1.34)	0.13	(0.49)	0.18	(0.46)	-0.52	(0.84)	0.15	(1.00)	-0.42	(0.64)	0.10	(0.82)
22 years	-1.24	(1.27)	-0.15	(1.34)	-0.56	(0.51)	-0.49	(0.55)	-0.32	(0.91)	0.66	(1.01)	-0.18	(0.69)	0.53	(0.84)
23 years	-0.38	(1.57)	-0.63	(1.40)	-0.53	(0.49)	-0.40	(0.51)	0.17	(1.07)	0.04	(1.07)	-0.16	(0.72)	0.02	(0.88)
N	175		175		175		175		175		175		175		175	
F	2.30		2.30		6.22		6.22		10.08		10.08		8.29		8.29	
Adj.R^2	0.23		0.23		0.39		0.39		0.26		0.26		0.37		0.37	

Estimates controlling for cohort effects, normalized year effects and total energy intake from food. Models with interaction effects between the age dummies and sex with the corresponding reference category for each model (boys and girls, respectively). SE = HC2 robust standard errors. Data from year 1 to year 4 of the rolling program of the National Diet and Nutrition Survey.

[a]Including fruit juice [b]Excluding fruit juice * Significant at the 0.05 level, + Significant at the 0.10 level.

13.4 Change in intake of fruit and vegetable portions across cohorts

	Composite dishes								Not from composite dishes							
	Total Fruit and vegetable portions		Vegetable portions		Fruit portions[a]		Fruit portions[b]		Total Fruit and vegetable portions		Vegetable portions		Fruit portions[a]		Fruit portions[b]	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
cohort 1	(base)															
cohort 2	-0.00	(0.28)	0.12	(0.27)	-0.61+	(0.32)	-0.52+	(0.27)	-0.65	(0.49)	0.15	(0.13)	-0.59+	(0.35)	-0.44+	(0.24)
cohort 3	-0.33	(0.35)	-0.03	(0.24)	-0.75**	(0.23)	-0.54*	(0.22)	-0.83*	(0.34)	0.11	(0.13)	-0.74**	(0.25)	-0.51**	(0.16)
cohort 4	0.05	(0.29)	0.08	(0.23)	-0.42+	(0.23)	-0.48*	(0.20)	-0.39	(0.33)	0.18	(0.13)	-0.39+	(0.23)	-0.39*	(0.17)
cohort 5	0.04	(0.39)	0.04	(0.26)	-0.58+	(0.33)	-0.54*	(0.27)	-0.57	(0.40)	0.10	(0.14)	-0.49	(0.33)	-0.41+	(0.23)
cohort 6	-0.29	(0.47)	0.22	(0.26)	-1.10**	(0.39)	-0.80*	(0.32)	-0.56	(0.46)	0.17	(0.15)	-1.04*	(0.41)	-0.62*	(0.29)
cohort 7	-0.20	(0.48)	0.06	(0.28)	-1.00*	(0.40)	-0.78*	(0.31)	-0.55	(0.53)	0.12	(0.16)	-0.96*	(0.41)	-0.79**	(0.27)
cohort 8	-0.13	(0.58)	0.09	(0.29)	-0.78+	(0.46)	-0.75*	(0.36)	-0.13	(0.55)	0.12	(0.17)	-0.65	(0.46)	-0.57	(0.36)
cohort 9	-0.35	(0.59)	0.19	(0.29)	-1.10*	(0.44)	-1.01**	(0.35)	-0.58	(0.57)	0.11	(0.17)	-1.04*	(0.45)	-0.86*	(0.33)
cohort 10	0.10	(0.70)	0.20	(0.35)	-1.06*	(0.49)	-0.92*	(0.36)	-0.42	(0.60)	0.15	(0.19)	-0.99*	(0.48)	-0.82*	(0.34)
cohort 11	-0.10	(0.67)	0.29	(0.34)	-1.15*	(0.52)	-1.13**	(0.37)	-0.73	(0.61)	0.22	(0.21)	-1.06*	(0.51)	-0.94**	(0.35)
cohort 12	0.39	(0.81)	0.51	(0.35)	-1.14+	(0.62)	-0.93*	(0.43)	-0.28	(0.73)	0.35	(0.23)	-1.05+	(0.60)	-0.71+	(0.41)
cohort 13	0.06	(0.77)	0.41	(0.40)	-1.30*	(0.61)	-1.20**	(0.42)	-0.60	(0.69)	0.28	(0.24)	-1.36*	(0.58)	-0.93*	(0.40)
cohort 14	0.29	(0.79)	0.41	(0.38)	-0.90	(0.62)	-0.80+	(0.43)	-0.12	(0.72)	0.25	(0.27)	-0.88	(0.60)	-0.53	(0.41)
cohort 15	0.22	(0.82)	0.11	(0.42)	-1.04+	(0.62)	-0.68	(0.44)	-0.05	(0.74)	0.13	(0.26)	-0.89	(0.61)	-0.35	(0.42)
cohort 16	0.60	(0.88)	0.76	(0.47)	-1.03	(0.66)	-0.84+	(0.47)	-0.17	(0.77)	0.39	(0.28)	-0.91	(0.64)	-0.50	(0.45)
cohort 17	0.34	(0.93)	0.29	(0.49)	-0.89	(0.67)	-0.67	(0.49)	-0.27	(0.83)	0.35	(0.33)	-0.92	(0.66)	-0.40	(0.47)
cohort 18	0.15	(0.95)	0.32	(0.49)	-1.11	(0.70)	-0.84	(0.53)	-0.33	(0.85)	0.30	(0.34)	-1.03	(0.67)	-0.54	(0.50)
cohort 19	0.97	(1.00)	0.92+	(0.53)	-0.63	(0.76)	-0.49	(0.59)	-0.40	(0.93)	0.18	(0.37)	-0.68	(0.75)	-0.13	(0.58)
cohort 20	-1.53	(1.19)	-0.37	(0.60)	-1.51+	(0.88)	-1.40+	(0.71)	-1.04	(1.07)	0.17	(0.40)	-1.45+	(0.84)	-1.08	(0.70)
cohort 21	-1.26	(1.25)	-0.06	(0.61)	-1.51	(0.98)	-1.39+	(0.79)	-0.99	(1.20)	0.33	(0.47)	-1.41	(0.93)	-1.06	(0.77)
cohort 22	-0.07	(1.46)	0.72	(0.67)	-1.20	(1.13)	-1.47+	(0.82)	-0.50	(1.43)	0.79	(0.52)	-1.31	(1.04)	-1.16	(0.81)
cohort 23	-0.60	(1.44)	0.14	(0.81)	-1.38	(1.02)	-1.46+	(0.77)	-0.66	(1.30)	0.37	(0.48)	-1.28	(0.96)	-1.13	(0.75)
cohort 24	-0.26	(1.57)	0.39	(0.72)	-0.75	(1.13)	-0.65	(0.89)	0.07	(1.41)	1.01+	(0.53)	-0.91	(1.08)	-0.57	(0.91)
cohort 25	0.46	(1.58)	1.11	(0.78)	-1.19	(1.16)	-1.02	(0.88)	-1.04	(1.97)	0.56	(0.62)	-1.49	(1.33)	-1.00	(0.94)
N	175		175		175		175		175		175		175		175	
F	2.30		6.22		10.08		8.29		3.59		3.24		7.59		21.15	
r2_a	0.23		0.39		0.26		0.37		0.11		0.10		0.28		0.34	

Estimates controlling for age effects, normalized year effects and total energy intake from food. SE = HC2 robust standard errors. Data from year 1 to year 4 of the rolling program of the National Diet and Nutrition Survey. [a]Including fruit juice [b]Excluding fruit juice *Significant at the 0.05 level, +Significant at the 0.10 level