Journal	British Journal of Nutrition
Title	Aging, retirement and changes in vegetable consumption in France: findings from the prospective GAZEL cohort
Version	Accepted June 12 th 2015
Authors	Marie Plessz ^{1,2} Alice Guéguen ² Marcel Goldberg ^{2,3} Sébastien Czernichow ^{2,3,4} Marie Zins ^{2,3}
Corresponding author	Marie Plessz tel + 33 1 49 59 69 12 fax + 33 1 49 59 69 90 email <u>marie.plessz@ivry.inra.fr</u>
Authors' addresses	¹ UR1303 ALISS Alimentation et sciences sociales, INRA, Ivry sur
	Seine, France
	 ² Inserm, Population-based Epidemiologic Cohorts Unit, UMS 011, Villejuif, France
	³ University of Versailles Saint Quentin, Versailles, France
	⁴ Department of Nutrition, APHP, A. Paré hospital, Boulogne- Billancourt, France
Running title	Aging, retirement and vegetable consumption
Keywords	Aging, vegetable consumption, retirement, multiple imputations, meal place, GAZEL prospective cohort

1 Abstract

The aim of this paper was to describe the change in vegetable consumption with aging and the transition to retirement. Study subjects were the participants in the GAZEL prospective cohort (Gaz and Électricité de France) aged 40-49 years at inclusion in 1989 who retired between 1991 and 2008 (12,942 men and 2,739 women). Four food-frequency questionnaires were completed from 1990 to 2009. We used multiple imputation by chained equations in order to

7 avoid dropping incomplete cases. The odds-ratio for eating vegetables everyday was estimated

8 as a function of aging, retirement status and the place of lunch before retirement through

9 generalized estimating equations. Analyses were stratified by sex and models were adjusted for

10 confounders, including current spousal status. In 1990, 17.7% of men and 31% of women

11 reported eating vegetables daily. The odds of consuming vegetables everyday increased with

12 aging for both men and women. The usual place of lunch was home for less than half the

13 sample before retirement and for almost every respondent after retirement. For those who

14 changed their place of lunch, the association between being retired and the odds of eating

15 vegetables daily was positive and significant. We found that in this cohort, vegetable

16 consumption increased with aging. Retirement had an indirect effect on vegetable consumption

17 mediated by changes in the place of lunch.

18

19 Keywords

20 Aging, vegetable consumption, retirement, multiple imputations, meal place, GAZEL

21 prospective cohort.

22

- Vegetables are a major focus of current nutritional guidelines in developed countries because 23 higher intakes could help protect from a wide range of non-communicable diseases⁽¹⁾. Recent 24 findings suggest that only 12% of the Americans meet the official dietary guideline for 25 vegetables⁽²⁾ and that the British consumed on average 135g/d of vegetables, 100g/d below UK 26 guidelines⁽³⁾. In France vegetable intakes appear to be higher, close to the levels reported in 27 28 Southern European countries⁽⁴⁾, with 55% of the population eating more than 2 servings (160g) daily⁽⁵⁾. Barriers to vegetable consumption include cost, poor nutritional knowledge, and 29 limited cooking time and skills⁽⁶⁻⁸⁾. Although people spend more time in food preparation in 30 France than in many other European countries⁽⁹⁾, these factors are also associated with lower 31 vegetable consumption^(5,10,11). 32
- 33 Cross-sectional surveys suggest a strong association between age and vegetable consumption in France and elsewhere^(5,12-15). However, it remains unclear if age reflects the process of aging, 34 differences across birth cohorts or the impact of specific life-course transitions⁽¹⁶⁻¹⁹⁾ such as 35 retirement. Studies of the transition to retirement have shown its positive impact on health 36 outcomes such as self-rated health⁽²⁰⁾ and sleep⁽²¹⁾, but results are unclear regarding physical 37 activity^(22,23) or alcohol consumption⁽²⁴⁾. In a cohort of 1,200 Finnish civil servants, Helldán et 38 al⁽²⁵⁾ found an increase in healthy food habits in retired women but not in retired men. Food 39 budget tends to decline after retirement⁽²⁶⁾ along with a decline in eating out⁽²⁷⁾ and an increase 40 in time devoted to cooking⁽²⁸⁾. However, adverse effects of retirement were also reported, e.g., 41 people who retired from strenuous jobs were found to gain weight and waist circumference 42 while diminishing their fruit and vegetable intakes⁽²⁹⁾. All these findings suggest that retirement 43 might affect food consumption and especially vegetable consumption but research on this 44 aspect has been very limited by $now^{(30)}$. 45 The aim of the paper was to assess the relative effects of both the aging process and transition 46
- 47 to retirement on the odds of daily vegetable consumption in a cohort with 19 years of follow48 up.
- 49

50 Methods

51 Study design

- 52 The GAZEL cohort study is an occupational cohort composed of 20,625 employees of the
- 53 French national Gas and Electricity Company, born in 1939-48 (men) and 1939-53 (women).
- 54 They were included in 1989 and have been followed up since then. Follow-up includes a
- 55 mailed self-administered questionnaire every year; medical data from the medical department
- 56 of the company; and linkage to the company's human resources database and to the national
- 57 deaths registry, as described in detail elsewhere⁽³¹⁾. The company pays the pensions to the
- 58 retirees and could thus provide mailing addresses to the investigators. For this reason loss to
- 59 follow-up is very low (see Figure 1). A qualitative food frequency questionnaire (FFQ) was
- 60 included in the questionnaire in 1990, 1998, 2004 and 2009⁽³²⁾. The GAZEL study was
- 61 approved by the national commission overseeing ethics in data collection in France
- 62 ("Commission Nationale Informatique et Liberté", CNIL, #105728).

63 *Population*

We selected individuals satisfying the following criteria: (a) aged 40 to 49y in 1989 (birth years 1939-48); (b) still alive at the end of 2009 (exclusion of 1352 deaths and 349 lost to follow-up); (c) retired after the first FFQ in 1990 and before the last FFQ in 2009; (d) aged 50 to 61 when they retired; (e) never had long-standing illness or disability, according to company records. This last restriction aimed at excluding individuals whose retirement was due to health issues.

69 *Food frequency questionnaire and outcome variable*

70 The qualitative FFQ was designed so as to capture eating habits (rather than nutritional intake).

- 71 Subjects had to report how often they ate foods from various food groups over a typical week,
- from "never" to "daily or almost daily"⁽³³⁾. In 1990, the FFQ included 10 food groups, e.g.,

73 potatoes (fried, mashed...); green vegetables (fresh, canned or frozen...). In 1998 the "green

vegetables" item was replaced by "cooked vegetables as starter, soup or main dish (leeks,

- 75 cabbage, green beans ...)" and "crudités or raw vegetables (green salad, carrots, tomatoes,
- radish, beet...)". The FFQ did not change after 1998.
- 77 The outcome variable was defined as eating vegetables daily (vs less than daily). In accordance
- 78 with French dietary guidelines, we did not include potatoes in the "vegetables" group. We used
- the "green vegetables" item in the 1990 FFQ and the "cooked vegetables" item from the 1998
- 80 to 2009 FFQs, because they appeared to be closest in content and distribution.

81 Exposure variables

82 The variables of interest were age in years and retirement status. For age we used a piecewise

83 linear function with two knots at ages 50 and 61 in order to capture non-linearities. Retirement

84 status was coded using date of retirement as provided by company records.

85 Mediator

The impact of retirement on vegetable consumption could be mediated by a change in the usual place of lunch after retirement. The most frequent place for lunch (home *vs* away from home) was collected in the FFQ. We retained the most frequent place for lunch at the last FFQ before the subject's retirement.

90 Control variables

91 All analyses were stratified by sex.

92 The prevalence of diets followed for health reasons increases with age⁽⁵⁾. We controlled for 93 whether the subject declared a diet prescribed by a doctor at each FFQ. Men living with a 94 partner eat more vegetables^(14,34,35). Changes in spousal status or in the spouse's activity status 95 may act as a confounder of the subject's retirement and were therefore estimated at each FFQ 96 year (no spouse, economically active spouse or inactive spouse).

97 Additionally, we controlled for the birth cohort, coded in two categories (born 1939-43 or

98 1944-48). Educational level was coded in three categories: low (primary school or less, leaving

school before age 12), medium (vocational or technical secondary education) or high

100 (secondary school degree or higher education) $^{(36)}$.

101 Models

102 In a first step, we modelled the outcome as a function of age, retirement status, and the

103 following potential confounders: date of FFQ (1990 versus 1998-2009), current status

104 regarding doctor-prescribed diet, birth cohort, education level and status of the spouse (model

105 1). In a second step, we studied whether a change in the usual place of lunch could mediate the

106 association between retirement status and vegetable consumption. For this purpose, an

107 interaction term between the place of lunch before retirement and retirement status was

108 introduced (model 2).

109 We ran logistic regressions using Generalized Estimating Equations (GEE) with an

110 unstructured correlation matrix, in order to account for the repeated nature of the data.

111 In order to test whether the change in FFQ items affected the results, we estimated model 2

112 excluding the data from year 1990.

113 Treatment of missing data

114 We imputed the non-responses using multiple imputation by chained equations^(37,38). This

technique allows imputing missing information for several variables at a time, through an

116 iterative process (the chained equations). Moreover, running multiple imputations produces

117 between-imputation variance, which accounts for the precision or imprecision of the imputation

118 process.

119 In the GAZEL study, non-response to the annual questionnaire is linked with gender, age,

120 occupational status and retirement status, as well as poor health and unhealthy lifestyle⁽³⁹⁾.

121 These variables had very high response rates because they were collected at inception in 1989

122 or from the company records (occupational status, retirement, age). They are also known

123 predictors of vegetable consumption $^{(5,12-14)}$. In order to account for the (assumed) non-response

124 mechanism, the imputation model included the covariates from the model of interest as well as

125 the following auxiliary variables: self-reported health at inclusion, smoking status at inclusion,

126 occupational status at age 35 (see online supplementary materials for more details). Other

127 auxiliary variables (BMI and alcohol consumption at baseline) were tested and discarded

128 because they did not improve the quality of the imputations while creating colinearity issues.

129 We imputed the missing data separately for men and women. This allowed the imputation

130 model to be fully compatible with the specifications of the model of interest. It also warranted

that, if the non-response mechanism or the sample size made the imputation less precise for

132 women, this would not affect the results for men. We generated 50 completed datasets, ran the

133 GEE on these files and combined the results using Rubin's rules⁽⁴⁰⁾, which take into account the

134 variability in estimates and standard errors between the imputed datasets⁽³⁸⁾. We also ran model

135 2 on the complete cases only (model 3). We carried out all statistical analyses with Stata

136 version 12 (commands mi impute chained and mi estimate: gee). Results were

137 reported as odds-ratios with 95% confidence intervals.

139 **Results**

140 Study population

141 Figure 1 provides a flowchart for the selection of participants in the study. The population 142 included 12,942 men and 2,739 women. Descriptive statistics and number of missing values for 143 men and women are presented in Table 1 (baseline characteristics) and Table 2 (time-varying 144 variables). Because the company has specific rules on retirement, retirement occurred on average at age 55. The average year of retirement was 1999 for men and 2000 for women. In 145 146 the cohort, a higher proportion of women ate vegetables every day over the whole follow-up 147 period, had a low educational level and were single (p < 0.001). Among the available cases 148 (respondents who completed the questionnaires in a given year), between 1990 and 2009, the 149 daily consumption of vegetable increased from 17.7% to 33.4% for men and from 31% to 55.3% for women. The proportion of individuals without a spouse increased for both sexes. 150 151 Crude associations between the repeated measurements of vegetable consumption appear in the 152 online supplementary material.

153 Missing values and imputation

Only 4,332 men and 855 women had no missing values (complete cases). The number of missing outcomes went up after 1990 (Table 2). Figure 2 displays the proportion of subjects who declared they ate vegetables everyday according to year of measurement for both sexes, among the complete cases (listwise deletion), the available cases (pairwise deletion) and after imputation (50 completed datasets). The proportion of positive outcomes is lower after imputation than among the complete cases and the gap gets wider over time although confidence intervals overlap.

161 Aging and retirement

Table 3 reports the odds-ratios of daily consumption of vegetables. Model 1 showed the
evolution of vegetable consumption as subjects grew older and retired, based on the imputed
data. The odds of eating vegetables daily increased steadily by 6% per year of age for men
(95% CI 5%,7%), and 7% for women (95% CI 4%,10%) until age 61. After age 61 the increase
was smaller but remained statistically significant.

167 Model 1 also showed that being retired had a positive and significant effect on the odds of

- 168 eating vegetables every day for men, but the effect was not significant for women. For men,
- 169 retiring was equivalent to being three years older in terms of vegetable consumption.

170 Place of lunch before retirement

- 171 Based on the available cases of our sample (pairwise deletion), at the last FFQ before
- 172 retirement the most frequent place for lunch was away from home for 53.7% of men and 69.9%
- 173 of women (Table 1). After retirement only 1.5% of the respondents had most lunches away
- 174 from home, implying that most of those who used to lunch out started to lunch at home.
- 175 Model 2 in Table 3 shows that before retirement, men who had most of their lunches at home
- 176 ate vegetables significantly more often than those who had lunch away from home (OR= 1.28,
- 177 95% CI 1.18,1.39). The difference was smaller and not significant for women (OR= 1.16).
- 178 After retirement, there was no significant difference between the subjects who used to have
- 179 lunch away from home when working and those who did not.
- 180 Indeed, for men who had lunch mostly away from home before retirement, the effect of
- retirement was positive and statistically significant (OR=1.31, 95% CI 1.17, 1.46). For these
- 182 men, getting retired increased the chances of daily vegetable consumption in the same
- 183 proportions as being five years older. By contrast, those who had lunch mostly at home when
- 184 working increased only slightly and non-significantly their vegetable intake upon retirement
- 185 (before retirement OR= 1.28 versus after retirement: 1.38). The same is true for women: those
- 186 who used to lunch out increased their vegetable consumption after retirement (OR= 1.21) while
- 187 for the others the odds-ratios before and after retirement were very close (1.16 versus 1.22).
- 188 Figure 3 displays the results of model 2 as predicted probabilities of eating vegetables daily if
- 189 the subjects had retired at age 56. In terms of probabilities of eating vegetables daily, the gap
- 190 between men and women grew larger over time. The transition to retirement implied no change
- 191 for those who had lunch at home at the end of their active life. There was a positive change for
- 192 those who had lunch away from home prior to retirement, so that after retirement the two
- 193 groups did not differ in their vegetable consumption.

194 Robustness checks

In order to assess the impact of the imputation process on the results we ran Model 2 on the complete cases only (Model 3 in Table 3). Changes in estimate values were modest and nonsignificant for men. Some coefficients varied more markedly for women, possibly due to the smaller number of complete cases.

In 1990 the question on vegetables was about "green vegetables" while later on, the item was
"cooked vegetables". We tested whether this change affected the estimates by running model 2

- 201 on the imputed data after excluding the 1990 FFQ, and found very similar results (online
- 202 supplementary material).

203 Discussion

204 We used four FFQ over 19 years of follow-up to assess the evolution of vegetable consumption 205 between ages 42 and 70, as subjects aged and retired. Our results show that for both men and 206 women, the process of aging was associated with gradually increasing odds of eating 207 vegetables every day. The increase in vegetable consumption observed upon the transition to 208 retirement appeared to be mediated by the place of lunch before retirement. These results hold 209 after imputing non-responses and taking into account the main potential confounders. Age is associated with increased vegetable consumption in cross-sectional studies^(5,12-14). Our 210 211 study suggests that as a given birth cohort grows older, its members tend to eat vegetables more 212 often. This aging effect remains positive and significant after controlling for retirement status, 213 but also for current spousal status, current dieting prescription status, and birth cohort. The 214 aging effect is relatively stable over time, at least from 42 to 61 years of age, and may decline 215 slightly afterwards. 216 Retirement is a major life-course transition between midlife and old age. While the association 217 between transition to retirement and changes in health-related behaviour, such as alcohol 218 drinking and physical activity, have been studied before, there are only a few studies on changes in food intake^(25,30,41). In this cohort study, retiring was associated with increased 219 220 vegetable consumption in those respondents whose meal environment changed upon retirement. This is consistent with the life-course perspective on food consumption⁽¹⁶⁻¹⁹⁾. 221 Food eaten away from home seems less healthy than food eaten at home $^{(42,43)}$. Evidence is less 222 clear on the nutritional quality of meals taken at work, e.g. in staff or university canteens⁽⁴⁴⁻⁴⁶⁾. 223 In France a nationally representative survey including a 7-day food diary found that 26% of the 224 lunches eaten by adults were taken away from home⁽⁴⁷⁾. For the US a similar figure (25%) was 225 found in the NHANES survey 2003-2004⁽⁴²⁾. In our study, those who had lunch away from 226 227 home while working ate vegetables less often, but vegetable consumption after retirement did 228 not differ according to the place of lunch before retirement. 229 This result may be related to the impact of the spouse on male respondents' food habits. In the 230 GAZEL study, men's BMI depended more on the spouse's social status than on the respondent's occupational category⁽⁴⁸⁾. In the present study, the presence of a spouse was 231 232 associated with higher odds of eating vegetables every day for males. Women's vegetable

consumption was higher than men's and less affected by the presence of a spouse. This may be

- linked to the fact that women have better nutritional knowledge⁽⁸⁾ and do most of the cooking in
- European countries⁽⁴⁹⁾.

236 Our hypothesis was that getting retired may have a causal effect on vegetable consumption, 237 through changes in the place of lunch. In order to move from the measurement of an 238 association to the identification of a causal pathway, we have taken several precautions. A 239 reverse causality path from vegetable consumption to retirement was unlikely. We controlled 240 for several sources of confusion besides aging. A poor health condition during active life could 241 lead both to retiring earlier than expected and to adopting healthier eating habits, including 242 higher vegetable consumption. We therefore excluded from the study population all individuals 243 who had a long-standing illness or disability, according to the company records, and we 244 controlled for current dieting prescription status. It is also necessary to separate the subject's 245 retirement from his or her spouse's retirement: we controlled for the presence and the activity 246 status of the spouse at each FFQ date. Additionally we controlled for birth cohort, education 247 level and changes in the questionnaire.

248 Another potential source of confusion is the period of observation. Over 60% of the subjects 249 retired between 1998 and 2004. In 2001 France launched nutrition information campaigns 250 including the message to eat "five fruits and vegetables a day". According to cross-sectional surveys, the share of the adult population aware of this nutritional guideline (2.5% in 2002) 251 increased 11-fold between 2002 and 2008⁽⁵⁾. However, based on the 24-hour recalls included in 252 the same surveys, the level of vegetable consumption had not changed much: the share of the 253 254 French population who ate five fruit and vegetable servings a day was estimated at 10.2% in 2002 and 13% in $2008^{(5,50)}$. Confusion between the measured effect of aging and the impact of 255 256 nutrition information campaigns during the observation period might play a role, but it is very 257 unlikely that it would explain all the aging and retirement effects.

258 An important limitation regarding the interpretation of the results is the population included in 259 the survey. Respondents were all employees of a large, state-owned French company. While 260 their social background was diverse (over 80% entered the firm as blue-collar or clerical workers⁽³¹⁾), the subjects' risk of being laid-off was virtually null and their income did not drop 261 262 substantially after retirement. It is therefore likely that the impact of retirement would be lower 263 in a population exposed to unemployment or having less protective retirement status. Similarly, 264 it would be unwise to extend our conclusion to other age-groups or birth cohorts than those 265 included in this survey. Indeed, it appears that in the GAZEL cohort, the subjects born after 1943 had a higher BMI⁽³⁶⁾ and lower alcohol consumption⁽²⁴⁾. Other studies in France suggest 266 267 differences in lifestyle and food consumption across birth cohorts born after the Second World War^(51,52). Additionally, in the GAZEL cohort, men are far more numerous than women. While 268 269 the results seemed robust for men, for women it was sometimes unclear whether the estimates

- were non-significant because the associations were weaker or because the sample size reducedthe power of the tests.
- 272 Measures of vegetables (or fruit) intake are sensitive to survey designs and definitions. For 273 example, the French official dietary guideline of five fruits and vegetables a day is met by only 13% of the French population⁽⁵⁾, but around 45% of the French have intakes $>400g/d^{(5,53,54)}$. In 274 275 2008, 86% of the French respondents (aged 12-75) to a nutritional survey had eaten vegetables at least once during the 24-hour recall⁽⁵⁾. In contrast, in our occupational cohort, in 2009 one 276 out of three men and 55% of the women reported that they usually ate (cooked) vegetables 277 278 every day. Rather than food intake, our short, qualitative and self-administered FFQ captured 279 food habits, namely, whether a food group is usually consumed on a daily basis. Misreporting 280 is possible, but measurement error induces bias in a longitudinal analysis only if it is time-281 dependent. In our case, the FFQ did not change from 1998 to 2009. The FFQ changed between 282 1990 and 1998 but our robustness check showed that this did not affect our results.
- Measurement error should therefore not be a concern in this study. Finally, since we do not control for total food intake or BMI, it is possible that the subjects increased their consumption of unhealthy foods along with their vegetable consumption. While our results indicate that vegetable consumption complied more and more with nutritional guidelines as subjects grew older, it remains to be shown whether their whole diet became healthier.
- 288 Major strengths of our study were a large sample and a long follow-up period, with very low 289 attrition: more than 16,000 subjects were followed up over 19 years, with four repeated 290 questionnaires on their food habits. To our knowledge, there is no comparable study on 291 vegetable consumption and aging. Moreover, due to the initial recruitment of people aged over 292 40 in a large, state-owned company, virtually every subject had a continuous work history in 293 the company and had retired during the survey period. Multiple imputation of missing values 294 prevented loss of power and reduced bias due to non-response. We were also able to address 295 several potential sources of confusion.
- In developed countries, people aged 60 years and more represent nearly 23% of the population. They face a life expectancy of 23 years at age 60⁽⁵⁵⁾ with an increasing risk of nutrition-related chronic diseases. While population aging is a major public health concern for industrialized societies, our results also suggest that aging and retiring may have a positive effect on vegetable intake among older adults. This supports the idea that dietary interventions at the time of retirement may make an effective and sustainable⁽⁵⁶⁾ contribution to healthy aging.

302

303 Acknowledgements

- 304 We thank EDF-GDF and the Population-based Epidemiologic Cohorts Unit (UMS 011
- 305 INSERM/UVSQ) for their contribution to building and providing the GAZEL database. We are
- 306 grateful to Dr. Séverine Gojard (INRA ALISS), Éléonore Herquelot (INSERM UMS 011) and
- 307 Diane Cyr (INSERM UMS 011) for their support and comments.

308 Affiliations

- 309 UR1303 ALISS Alimentation et sciences sociales, INRA, Ivry sur Seine, France (Marie Plessz)
- 310 Inserm, Population-based Epidemiologic Cohorts Unit, UMS 011, Villejuif, France (Marie
- 311 Plessz, Alice Guéguen, Marcel Goldberg, Sébastien Czernichow, Marie Zins)
- 312 Versailles St-Quentin University, UMS 011, F-94807, Villejuif, France (Marcel Goldberg,
- 313 Sébastien Czernichow, Marie Zins)
- 314 Department of Nutrition, APHP, A. Paré hospital, Boulogne-Billancourt, France (Sébastien
 315 Czernichow)
- 316 Authors' contributions
- 317 MP, MG, MZ, and SC designed the research. MP and AG analysed the data. MP wrote the
- 318 paper. MZ and MG provided detailed information on the data. All authors revised the text and
- 319 approved the final draft.
- 320 Financial support
- 321 None
- 322 Conflicts of interest
- 323 The authors declare no conflict of interest.

References

- 1. World Health Organization (2003) *WHO fruit and vegetable promotion initiative a meeting report.* Geneva: World Health Organization.
- 2. Krebs-Smith SM, Guenther PM, Subar AF *et al.* (2010) Americans do not meet federal dietary recommendations. *J Nutr* **140**, 1832-1838.
- Maguire ER, Monsivais P (2015) Socio-economic dietary inequalities in uk adults: An updated picture of key food groups and nutrients from national surveillance data. *Br J Nutr* 113, 181-189.
- Orfanos P, Naska A, Trichopoulos D *et al.* (2007) Eating out of home and its correlates in 10 european countries. The European prospective investigation into cancer and nutrition (EPIC) study. *Public Health Nutr* 10, 1515-1525.
- 5. Escalon H, Bossard C, Beck F (editors) (2009) *Baromètre santé nutrition 2008*. Saint-Denis: INPES.
- Welch N, McNaughton SA, Hunter W *et al.* (2009) Is the perception of time pressure a barrier to healthy eating and physical activity among women? *Public Health Nutr* 12, 888-895.
- Crawford D, Ball K, Mishra G *et al.* (2007) Which food-related behaviours are associated with healthier intakes of fruits and vegetables among women? *Public Health Nutr* 10, 256-265.
- Baker AH, Wardle J (2003) Sex differences in fruit and vegetable intake in older adults. *Appetite* 40, 269-275.
- Warde A, Cheng S-L, Olsen W *et al.* (2007) Changes in the practice of eating. *Acta Sociologica* 50, 363-385.
- 10. Plessz M, Gojard S (2015) Fresh is best? Social position, cooking, and vegetable consumption in France. *Sociology* **49**, 172–190.
- 11. Bertail P, Caillavet F (2008) Fruit and vegetable consumption patterns: A segmentation approach. *American Journal of Agricultural Economics* **90**, 827-842.
- 12. Lindström M, Hanson BS, Wirfält E *et al.* (2001) Socioeconomic differences in the consumption of vegetables, fruit and fruit juices. *Eur J Public Health* **11**, 51-59.
- Roos G, Johansson L, Kasmel A *et al.* (2001) Disparities in vegetable and fruit consumption: European cases from the north to the south. *Public Health Nutr* 4, 35-43.
- 14. Plessz M, Gojard S (2013) Do processed vegetables reduce the socio-economic differences in vegetable purchases? A study in France. *Eur J Public Health* **23**, 747-752.

- Dubuisson C, Lioret S, Touvier M *et al.* (2010) Trends in food and nutritional intakes of French adults from 1999 to 2007: Results from the INCA surveys. *Br J Nutr* 103, 1035-1048.
- Devine CM, Connors M, Bisogni CA *et al.* (1998) Life-course influences on fruit and vegetable trajectories: Qualitative analysis of food choices. *Journal of Nutrition Education* **30**, 361-370.
- 17. Bisogni CA, Jastran M, Shen L *et al.* (2005) A biographical study of food choice capacity: Standards, circumstances, and food management skills. *J Nutr Educ Behav* **37**, 284-291.
- Furst T, Connors M, Bisogni CA *et al.* (1996) Food choice: A conceptual model of the process. *Appetite* 26, 247-266.
- Plessz M, Dubuisson-Quellier S, Gojard S *et al.* (2014) How consumption prescriptions change food practices. Assessing the role of household resources and life course events. *Journal of Consumer Culture* Online first February 4, 2014.
- 20. Westerlund H, Kivimäki M, Singh-Manoux A *et al.* (2009) Self-rated health before and after retirement in France (GAZEL): A cohort study. *Lancet* **374**, 1889-1896.
- 21. Vahtera J, Westerlund H, Hall M *et al.* (2009) Effect of retirement on sleep disturbances: The GAZEL prospective cohort study. *Sleep* **32**, 1459-1466.
- 22. Sjösten N, Kivimäki M, Singh-Manoux A *et al.* (2012) Change in physical activity and weight in relation to retirement: The French GAZEL cohort study. *BMJ Open* **2**, e000522.
- Slingerland AS, van Lenthe FJ, Jukema JW *et al.* (2007) Aging, retirement, and changes in physical activity: Prospective cohort findings from the globe study. *Am J Epidemiol* 165, 1356-1363.
- 24. Zins M, Guéguen A, Kivimaki M *et al.* (2011) Effect of retirement on alcohol consumption: Longitudinal evidence from the French gazel cohort study. *PLoS ONE* **6**, e26531.
- 25. Helldán A, Lallukka T, Rahkonen O *et al.* (2012) Changes in healthy food habits after transition to old age retirement. *Eur J Public Health* **22**, 582-586.
- 26. Hurd MD, Rohwedder S (2006) *Some answers to the retirement-consumption puzzle*. National Bureau of Economic Research.
- 27. Chung S, Popkin BM, Domino ME *et al.* (2007) Effect of retirement on eating out and weight change: An analysis of gender differences. *Obesity* **15**, 1053-1060.
- 28. Stancanelli E, Soest AV (2012) Retirement and home production: A regression discontinuity approach. *Am Econ Rev* **102**, 600-605.

- Nooyens AC, Visscher TL, Schuit JA *et al.* (2005) Effects of retirement on lifestyle in relation to changes in weight and waist circumference in dutch men: A prospective study. *Public Health Nutr* 8, 1266-1274.
- 30. Zantinge EM, van den Berg M, Smit HtA *et al.* (2014) Retirement and a healthy lifestyle: Opportunity or pitfall? A narrative review of the literature. *Eur J Public Health* **24**, 433-439.
- 31. Goldberg M, Leclerc A, Bonenfant Sb *et al.* (2007) Cohort profile: The GAZEL cohort study. *Int J Epidemiol* **36**, 32-39.
- 32. Le Port As, Gueguen A, Kesse-Guyot E *et al.* (2012) Association between dietary patterns and depressive symptoms over time: A 10-year follow-up study of the GAZEL cohort. *PLoS ONE* 7, e51593.
- 33. Goldberg M, Zins M (2015) The gazel cohort: 20 000 volunteers for medical research. Questionnaires. <u>http://www.gazel.inserm.fr/en/documentation/questionnaires.html</u> (accessed 01/19/2015).
- 34. Kamphuis CBM, Giskes K, Bruijn G-jD *et al.* (2006) Environmental determinants of fruit and vegetable consumption among adults : A systematic review. *Br J Nutr*, 620-635.
- 35. Bove CF, Sobal J, Rauschenbach BS (2003) Food choices among newly married couples: Convergence, conflict, individualism, and projects. *Appetite* **40**, 25-41.
- 36. Dugravot A, Sabia S, Stringhini S *et al.* (2010) Do socioeconomic factors shape weight and obesity trajectories over the transition from midlife to old age? Results from the French GAZEL cohort study. *Am J Clin Nutr* **92**, 16-23.
- 37. White IR, Royston P, Wood AM (2011) Multiple imputation using chained equations: Issues and guidance for practice. *Stat Med* 30, 377-399.
- 38. Sterne J, A. C., White IR, Carlin JB *et al.* (2009) Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *Br Med J* **338**, b2393
- 39. Goldberg M, Chastang JFo, Zins M *et al.* (2006) Health problems were the strongest predictors of attrition during follow-up of the GAZEL cohort. *J Clin Epidemiol* **59**, 1213-1221.
- 40. Rubin DB (1987) *Multiple imputation for nonresponse in surveys*. vol. 307. New York: Wiley.
- 41. Akbaraly TN, Brunner EJ (2008) Socio-demographic influences on trends of fish consumption during later adult life in the whitehall II study. *Br J Nutr* **100**, 1116-1127.
- 42. Mancino L, Todd J, Lin B-H (2009) Separating what we eat from where: Measuring the effect of food away from home on diet quality. *Food Policy* **34**, 557-562.

- 43. Guthrie JF, Lin B-H, Frazao E (2002) Role of food prepared away from home in the american diet, 1977-78 versus 1994-96: Changes and consequences. *J Nutr Educ Behav* 34, 140-150.
- 44. Kjollesdal MR, Holmboe-Ottesen G, Wandel M (2011) Frequent use of staff canteens is associated with unhealthy dietary habits and obesity in a norwegian adult population. *Public Health Nutr* 14, 133-141.
- 45. Lachat CK, Huybregts LF, Roberfroid DA *et al.* (2009) Nutritional profile of foods offered and consumed in a belgian university canteen. *Public Health Nutr* **12**, 122-128.
- 46. Roos E, Sarlio-Lähteenkorva S, Lallukka T (2004) Having lunch at a staff canteen is associated with recommended food habits. *Public Health Nutr* **7**, 53-61.
- 47. Lafay L (editor) (2009) Étude individuelle nationale des consommations alimentaires : 2006-2007 (INCA 2). Paris: AFSSA.
- 48. Ribet C, Lang T, Zins M *et al.* (2001) Do cardiovascular risk factors in men depend on their spouses' occupational category? *Eur J Epidemiol* **17**, 347-356.
- 49. Tai T-o, Treas J (2013) Housework task hierarchies in 32 countries. *European Sociological Review* **29**, 780-791.
- 50. Guilbert P, Perrin-Escalon H (editors) (2002) *Baromètre santé nutrition 2002*. Paris: INPES.
- Chauvel L, Schröder M (2014) Generational inequalities and welfare regimes. *Soc Forces* Advance access, sot156.
- 52. Hébel P, Recours F (2007) Effets d'âge et de générations : Transformation du modèle alimentaire. *Cahiers de nutrition et de diététique* **42**, 297-303.
- 53. Castetbon K, Vernay M, Malon A *et al.* (2009) Dietary intake, physical activity and nutritional status in adults: The French nutrition and health survey (ENNS, 2006–2007). *Br J Nutr* 102, 733-743.
- 54. Lioret S, Dubuisson C, Dufour A *et al.* (2010) Trends in food intake in French children from 1999 to 2007: Results from the INCA (étude individuelle nationale des consommations alimentaires) dietary surveys. *Br J Nutr* 103, 585-601.
- 55. United Nations Organization (2001) World population ageing 1950-2050. New York: UN.
- 56. Lara J, Hobbs N, Moynihan PJ *et al.* (2014) Effectiveness of dietary interventions among adults of retirement age: A systematic review and meta-analysis of randomized controlled trials. *BMC Med* 12, 60.

Tables

	Me	en	Women			
	Column % ^a	N missing	Column % ^a	N missing		
Educational level ^d		238		85		
Low	18.9		31.9			
Medium	53.4		51.9			
High	27.7		16.2			
Birth cohort		0		0		
1939-1943	41.4		40.1			
1944-1948	58.6		59.9			
Usual place of lunch before retireme	ent ^{b, d}	2,947		772		
Out	53.7		69.9			
Home	46.3		30.1			
Age in 1990 ^c	45.9 (2.8)	0	45.9 (2.9)	0		
Year of retirement ^{c, e}	1999.3 (3.6)	0	1999.9 (3.7)	0		
Age at the time of retirement ^{c, e}	54.9(2.4)	0	55.5 (2.7)	0		

Table 1. Baseline characteristics: descriptive statistics and number of missing values in men (n=12,942) and women (n=2,739) in the GAZEL cohort, France 1989-2009.

Abbreviations: FFQ, food frequency questionnaire; SD, standard deviation.

^a Column percentages based on available cases (pairwise deletion).

- ^b Measured at the last FFQ before retirement.
- ^c Continuous variables are expressed as mean (standard deviation in parentheses).
- ^d Difference between men and women statistically significant (chi² test: p<0.001).
- ^e Difference between men and women statistically significant (t-test: p<0.001).

		Μ	len	Women					
	1990	1998	2004	2009	1990	1998	2004	2009	
Outcome : daily consumption	n of vegetables	b							
Yes (%)	17.7	19.9	28.6	33.4	31.0	36.1	50.8	55.3	
N missing	1,616	3,235	3,050	3,282	372	810	709	750	
Spouse ^b (column %)									
No spouse	6.4	7.7	9.0	10.5	21.7	24.9	26.5	29.7	
Spouse works	52.5	46.3	28.1	13.0	72.5	43.7	15.4	4.4	
Spouse inactive	41.1	46.0	62.9	76.5	5.7	31.4	58.2	65.9	
N missing	1,555	3,239	2,941	3,216	361	816	702	738	
Diet prescribed by a doctor									
Yes (%)	15.8	8.0	8.6	6.9	16.3	8.3	9.6	6.6	
N missing	1,794	5,443	4,003	5,117	454	1,203	890	1,136	

Table 2. Sample characteristics: descriptive statistics^a and number of missing values for the variables with repeated measurements for men (n=12,942) and women (n=2,739) in the GAZEL cohort, France 1989-2009.

^a Column percentages based on available cases (pairwise deletion).

^b Difference between men and women statistically significant each year (chi² test: p<0.001).

CI).

	Men						Women					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	OR	CI										
Age: slope 42-50	1.06	1.04, 1.08	1.06	1.03, 1.08	1.08	1.05, 1.11	1.08	1.04, 1.11	1.07	1.04, 1.11	1.1	1.05, 1.17
Age: slope 50-61	1.06	1.05, 1.07	1.06	1.05, 1.07	1.07	1.05, 1.09	1.07	1.04, 1.10	1.07	1.04, 1.10	1.09	1.05, 1.13
Age: slope 61-70	1.03	1.02, 1.05	1.03	1.02, 1.05	1.03	1.01, 1.04	1.04	1.01, 1.06	1.04	1.01, 1.06	1.03	1.00, 1.07
Retired	1.19	1.08, 1.31					1.16	0.97, 1.39				
Not retired & lunches at home ^a			1.28	1.18, 1.39	1.32	1.16, 1.49			1.16	0.99, 1.35	1.31	1.01, 1.70
Retired & lunched out ^a			1.31	1.17, 1.46	1.25	1.07, 1.46			1.21	1.01, 1.46	1.18	0.89, 1.56
Retired & lunched at home ^a			1.38	1.23, 1.54	1.31	1.10, 1.56			1.22	0.97, 1.53	1.27	0.90, 1.81
FFQ 1990 (ref: years 1998-2009)	1.42	1.26, 1.59	1.41	1.26, 1.58	1.46	1.23, 1.74	1.44	1.16, 1.78	1.43	1.16, 1.77	1.56	1.13, 2.16
Diet prescribed by a doctor	1.29	1.19, 1.41	1.29	1.19, 1.41	1.33	1.18, 1.49	1.7	1.46, 1.99	1.7	1.46, 1.99	1.59	1.27, 2.00
Born 1944-48 (ref: 1939-43)	1.12	1.04, 1.19	1.12	1.05, 1.19	1.11	1.00, 1.23	1.3	1.13, 1.48	1.3	1.13, 1.49	1.58	1.26, 1.97
Education:	1.15	1.06, 1.25	1.15	1.06, 1.25	1.14	1.01, 1.29	1.09	0.95, 1.24	1.09	0.96, 1.24	1.02	0.82, 1.27

Table 3. Multivariate models for daily vegetable consumption, men and women in the GAZEL cohort, France 1989-2009 (odds-ratios with 95%

medium (ref: low)												
Education: high	1.21	1.11, 1.32	1.22	1.12, 1.33	1.14	0.99, 1.31	1.42	1.19, 1.69	1.43	1.20, 1.70	1.39	1.04, 1.85
Spouse works (ref: no spouse)	1.35	1.21, 1.50	1.35	1.21, 1.50	1.43	1.20, 1.69	1.03	0.89, 1.18	1.02	0.89, 1.17	1.15	0.91, 1.46
Spouse inactive	1.62	1.47, 1.79	1.6	1.45, 1.77	1.74	1.48, 2.06	1.25	1.09, 1.43	1.25	1.09, 1.43	1.26	1.02, 1.56
N. of observations	51768		51768		17328		10956		10956		3420	
N. of subjects	12942		12942		4332		2739		2739		855	

Abbreviations: FFQ, food frequency questionnaire. GEE, Generalized Estimating Equations.

Logistic regressions using Generalized estimating equations.

Model 1: controls + age + retirement status. Completed data (50 imputations).

Model 2: controls + age + interaction between retirement status and usual place of lunch before retirement. Completed data (50 imputations). Model 3: same as Model 2 on complete cases (listwise deletion: subjects with zero missing value).

^a Lunch : the most frequent place of lunch declared at the last FFQ before retirement. Reference category: not retired and lunches out

Figure legends

Figure 1

Flowchart describing the selection of the study population from the GAZEL cohort, France 1989-2009.

^a Lost to follow-up: subjects asked not to be contacted again or stopped being employed by EDF-GDF before they retired.

Figure 2

Proportion of subjects eating vegetables daily according to sex and year of measurement among complete cases (listwsise deletion, white), available cases (pairwise deletion, light grey) and after imputation (dark grey) in the GAZEL cohort, France 1989-2009, with 95% CI.

Figure 3

Predicted probabilities of consuming vegetables daily for men and women according to age, retirement status and usual place of lunch before retirement in the GAZEL cohort, France 1989-2009.

Predicted probabilities of eating vegetables everyday in the GAZEL cohort study are based on model 2 (imputed data) assuming that retirement occurred at age 56 years adjusted for educational level, (high versus low), current doctor-prescribed dieting status (no versus yes), current marital status (no versus yes), FFQ 1998 or later.

Solid line: predicted probability for people having most lunches away from home before retirement.

Shaded area: 95% confidence interval for the solid line.

Dashed line: before retirement, alternative prediction for a person who had most lunches at home.

Abbreviations: FFQ, food frequency questionnaire. GEE: Generalized Estimating Equations.

Figures

Figure 1









