Do processed vegetables reduce the socio-economic differences in vegetable purchases? A study in France

Marie Plessz, Séverine Gojard

INRA UR1303 ALISS, Paris, France

Correspondence: Marie Plessz, INRA ALISS, 65 bd Brandebourg, 94205 Ivry sur Seine cedex, Paris, France, tel: +33 1 49 59 69 12, e-mail: marie.plessz@ivry.inra.fr

Background: Vegetable consumption varies highly across households, based on household structure and socio-economic status, but little is known about the share of fresh vs. processed (e.g. frozen or canned) vegetables. Our aim was to compare the social and economic determinants of fresh and processed vegetable consumption. 

Methods: We reviewed detailed data on vegetable purchases for at-home consumption of 2600 French households during 2007. We took into account a wide range of processed vegetables (excluding potatoes) and made a distinction between fresh vegetables, processed vegetables and baby food containing vegetables. We conducted regression analyses to predict consumption of fresh and processed vegetables in kilograms per year and unit values in euros per kilogram. 

Results: About 60% of the vegetables bought by the sample households were fresh. Fresh vegetable consumption increased with the respondent’s income, age and educational level, and with the number of adults but not with the presence of children aged <6 years. The quantity of processed vegetables purchased increased with the household size but was not dependent on age, education or household income, although the richest households spent more per kilogram on processed vegetables. Households with a child aged <6 years also purchased 10 kg of baby foods containing vegetables. 

Conclusion: We found socio-economic inequalities in the quantities of fresh vegetables, in the spending on fresh and processed vegetables but not in the quantities of processed vegetables. This suggests that monitoring the price and nutritional quality of processed vegetables and providing this information to consumers could help them identify nutritious, affordable and convenient foods.

Introduction

The rise in cases of obesity and associated cardiovascular diseases is a major public health issue. Among the measures adopted to improve people’s diets and prevent obesity is an initiative by the World Health Organization and the Food and Agriculture Organization of the United Nations to promote vegetable consumption in most European countries. For instance, the French National Nutrition and Health Program promotes fruit and vegetable consumption mainly through general information campaigns. So far, these campaigns seem to have no effect on the social gradient observed in food consumption—socio-economically disadvantaged far, these campaigns seem to have no effect on the social gradient observed in food consumption—socio-economically disadvantaged families and in other European countries. In most studies, household income seems to be a main determinant of fruit and vegetable consumption. 

Various explanations for differences in diet have been put forward. For instance, the higher price of fruit and vegetables compared with other food items could affect socio-economically disadvantaged households. The necessary preparation time for cooking vegetables can explain some differences between households. Time pressure is frequently mentioned as a barrier to healthy eating, especially for educated women, and this eventually leads to increased difficulties in meeting vegetable consumption guidelines. 

Another barrier to vegetable consumption is a lack of confidence in one’s cooking ability. Some observations suggest that cooking habits have a stronger impact on vegetable consumption rather than fruit consumption. Although fruits can be eaten raw, vegetables may require more preparation. Moreover, low confidence levels regarding the ability to cook vegetables are associated with lower socio-economic status. Hence, disadvantaged households may face multiple constraints related to vegetable consumption, including less money, limited cooking skills and, in some cases, less time dedicated to food preparation. ‘Convenience food’ can be defined as food that ‘transfers the time and activities of preparation from the household manager to the food processor’. It may help households to manage time constraints more effectively. This is especially beneficial in France where female activity and fertility rates are high.

Thus, the development of a wide range of processed foods containing vegetables could alleviate barriers because of cooking time or skills, at least for some households. During the last decades of the 20th century, the decrease in consumption of fresh vegetables by the French was compensated by an increase in consumption of processed vegetables, although at the turn of the century, the intake of fresh vegetables remains four times greater than that of processed ones. Compared with neighbouring countries, French consumption of frozen fruit and vegetables is high.

The consumption of specific food items meant for young children (baby food in jars) has been increasing sharply, with French households ranking second in Europe after the Italians and consuming 2.13 kg per capita of baby food in 1996. To our knowledge the most recent data on the topic. Baby foods containing vegetables are of particular interest, as the precarious exposure to vegetables in infancy can lead to an increase in preferences for vegetables later on. Thus, the consumption of vegetables in the early years may contribute to improved dietary habits in the future. A survey conducted in the USA among disadvantaged families showed that commercial baby food contributed to a better infant diet by ensuring frequency and diversity of vegetable consumption.

The purpose of this article was to examine whether accounting for the consumption of processed vegetables modified the socio-economic inequalities observed for fresh vegetable consumption in France. More precisely, we asked whether the determinants of the
consumption of processed vegetables were the same as those observed for fresh vegetables. We also studied whether baby food accounted for an important part of vegetable consumption in households with young children, and whether the price paid for fresh or processed vegetables differed according to socio-economic status.

Methods

Data

We used the fruit and vegetable (FV) subpanel from the Kantar Worldpanel data. The respondents recorded, on a weekly basis, all food purchases for at-home consumption throughout the year, independent where shopping was done. The barcode of each purchase was registered using a handheld scanner, as well as the quantity purchased and the associated expenditures. The respondents from the FV-subpanel also recorded manually the information for fresh vegetables and fruit that did not have a barcode. The data did not provide barcodes, but a large set of product attributes.

The sample was stratified by regions and the size of the municipality and, through a quota method, was designed to ensure a better socio-demographic representation. However, some household types, such as single men and households in the highest and lowest income brackets, were underrepresented. There were 4904 households in the FV-subpanel in 2007. Kantar selected only those households who had provided data for at least 44 weeks and corrected outlier entries. This led to a valid sample of 2765 households. We excluded households failing to provide the characteristics used as predictive variables, as well as some outliers (five households whose total vegetable purchases exceeded 450 kg/year). The size of the final sample that we considered was, therefore, 2654.

Definition and measurement of the outcome variables

Definitions

The data allowed us to measure consumption of fresh and processed vegetables separately. Vegetables did not include potatoes or pulses, such as lentils, according to the definition used in other French surveys on food consumption. Fresh vegetables (FV) were easily found in the product database. Processed vegetables (PV) included fresh-cut ('minimally processed') vegetables; raw or cooked vegetables, frozen, in cans or jars; composite foods, such as soups (dehydrated, frozen or in cans or jars) and ready-to-eat dishes. Among composite foods, we retained those containing at least one portion of vegetable according to the ingredients appearing in the product’s sale name. We discarded systematically items, such as pizzas, pies or ketchup, according to the most usual nutritional definition of vegetables in France. We determined that baby foods containing vegetables (BV) could be added to processed vegetables as long as some vegetables appeared among the ingredients specified in the product’s sale name. We subsequently compared two outcome variables: processed vegetables without baby food (PV) and processed vegetables including baby food (PV + BV).

Measurement

The weight of each item was indicated in the database. These weights included the peels for raw vegetables and every ingredient in the composite foods, including non-vegetables. However, composite foods represented only 5% of the total quantities purchased by the sample population. For dehydrated products, we used the weight of the product as if water had been added according to the recipe. We calculated the sum of the weights of the items bought, measured in kilograms per year. Unit values (spending per kilogram) were calculated as the total sum spent for vegetables divided by their total weight (euros per kilogram).

Predictive variables and covariates

Predictive variables

In the sample, the respondent was the person in charge of household food purchases. Male respondents were a minority, and they lived mostly in single-adult households. Besides, we know that single men and women in France exhibit different preferences for food consumption. Therefore, for single-adult households, we distinguished between men and women. In other cases, we calculated the number of adults. We also computed the number of children aged <6 and ≥6 years. These age groups have been designed to capture the effect of having young children in the household without generating confounding effects with the age of the respondent. The ages of respondents were also included. A household’s socio-economic status was measured based on household self-reported income per capita (four categories) and the respondent’s highest educational level.

Covariates

We controlled for two phenomena that could affect purchases for at-home consumption: home production and eating out or feeding extra people regularly. The dummy variable ‘Veg_garden’ was used to indicate that the household had a garden where vegetables were cultivated. We also computed the continuous variable ‘At_home:’ the average number of people eating lunch or dinner during a regular week was divided by the number of household members. We have displayed descriptive statistics for categorical variables in Table 1 and for continuous variables in Table 2.

Table 1 Distribution of the categorical variables for the population included in the regression analyses

<table>
<thead>
<tr>
<th>Variable</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td></td>
</tr>
<tr>
<td>One male</td>
<td>238 (8.97)</td>
</tr>
<tr>
<td>One female</td>
<td>599 (22.57)</td>
</tr>
<tr>
<td>Two adults</td>
<td>1680 (63.3)</td>
</tr>
<tr>
<td>Three or more</td>
<td>137 (5.16)</td>
</tr>
<tr>
<td>Children aged &lt;6 years</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>2288 (86.21)</td>
</tr>
<tr>
<td>One</td>
<td>257 (9.68)</td>
</tr>
<tr>
<td>Two or more</td>
<td>109 (4.11)</td>
</tr>
<tr>
<td>Children (6–25 years old)</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>1767 (66.58)</td>
</tr>
<tr>
<td>One</td>
<td>370 (13.94)</td>
</tr>
<tr>
<td>Two</td>
<td>350 (13.19)</td>
</tr>
<tr>
<td>Three or more</td>
<td>167 (6.29)</td>
</tr>
<tr>
<td>Veg_garden</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1592 (59.98)</td>
</tr>
<tr>
<td>Yes</td>
<td>1062 (40.02)</td>
</tr>
<tr>
<td>Respondent age, years</td>
<td></td>
</tr>
<tr>
<td>20–29</td>
<td>166 (6.25)</td>
</tr>
<tr>
<td>30–39</td>
<td>606 (22.83)</td>
</tr>
<tr>
<td>40–49</td>
<td>529 (19.93)</td>
</tr>
<tr>
<td>50–59</td>
<td>479 (18.05)</td>
</tr>
<tr>
<td>60–69</td>
<td>430 (16.2)</td>
</tr>
<tr>
<td>≥70</td>
<td>444 (16.73)</td>
</tr>
<tr>
<td>Household income class</td>
<td></td>
</tr>
<tr>
<td>I (15% poorest)</td>
<td>348 (13.11)</td>
</tr>
<tr>
<td>II (next 40%)</td>
<td>1168 (44.01)</td>
</tr>
<tr>
<td>III (next 30%)</td>
<td>768 (28.94)</td>
</tr>
<tr>
<td>IV (15% richest)</td>
<td>370 (13.94)</td>
</tr>
<tr>
<td>Respondent educational level</td>
<td></td>
</tr>
<tr>
<td>Lower secondary</td>
<td>1190 (44.84)</td>
</tr>
<tr>
<td>Upper secondary</td>
<td>646 (24.34)</td>
</tr>
<tr>
<td>Tertiary (maximum 2 years)</td>
<td>445 (16.77)</td>
</tr>
<tr>
<td>Tertiary (at least 3 years)</td>
<td>373 (14.05)</td>
</tr>
</tbody>
</table>
Using Stata 11, we ran linear regressions predicting the quantities of vegetables of any kind (FV + PV + BV). We then fitted separate models for fresh (FV), processed vegetables (PV) and processed vegetables including baby food (PV + BV). Table 3 displays the results (unstandardized coefficients and standard errors) of these regressions in kilograms per year. Table 4 displays the same model for unit values of fresh vegetables (FV) and processed vegetables including baby food (PV + BV), in euros per kilogram.

Results

In France in 2007, a household’s average vegetable consumption was 114 kg/year. Fresh vegetables represented 61% of these purchases (Table 2), with almost 70 kg/year. Table 3 shows that the quantities of vegetables of all kinds (FV + PV + BV) and of fresh vegetables (FV) depended on the household and on the respondent’s characteristics in similar ways.

Common trends: household size and structure

Household size and structure affected the patterns of purchasing vegetables logically. As the number of household members increased, the amount of vegetables purchased also increased, although the number of children had a smaller effect than the number of adults. In single-adult households, however, we confirmed that men bought significantly less fresh vegetables and slightly less processed vegetables than women did.

Fresh vegetable consumption

Age was a strong determinant of fresh vegetable consumption. We noted, for example, that a married respondent aged >60 years...
and without children typically bought 52 kg more fresh vegetables than a respondent in his/her twenties ($P = 0.000$). This may be not only because of ageing but also because of a cohort effect. Indeed, some studies in France assert that the youngest cohorts tend to buy less fresh fruit and vegetables and more convenience foods, even though other authors have shown that this cohort effect may hold for some fresh vegetables and not for others.

The results of this study also indicated that fresh vegetables purchases differed according to socio-economic position. Respondents bought more fresh vegetables for their household if their income placed them among the richest (+14 kg/year, $P = 0.001$), and if they had at least a bachelor’s degree (+10 kg/year, $P = 0.003$).

**Processed vegetable purchases (excluding baby food)**

Based on the findings from model PV in Table 3, age, education and income did not affect processed vegetable consumption. This suggested that processed vegetables consumption was relatively even across social classes and age groups when we controlled for the size and structure of the household. For this reason, we concluded that processed vegetable consumption did not alter the socio-economic differences in quantities of vegetable purchased.

**Baby food**

Households with one or more children aged <6 years ($n=366$) bought, on average, 12.3 kg/year of ready-prepared baby food containing vegetables (95% confidence interval 10.187–14.378). This represented 19.6% of the processed vegetables and 10% of the total amount of vegetables (PV + BV) purchased by those households. In the models without baby food, the presence of a child aged <6 years added a small amount of vegetables to total household purchases; the coefficient was not significant for fresh vegetables (not even with two or more young children) and one child added 6 kg/year ($P=0.004$) of processed vegetables.

We explored the dietary role of baby food containing vegetables by comparing the models processed vegetables and PV + BV. When we included baby food (PV + BV), households with children aged <6 years reported a significantly higher vegetable consumption, demonstrating that one child aged <6 years added 16 kg ($P=0.000$), whereas two or more increased the household’s consumption by 23 kg per year ($P=0.000$), compared with a childless couple. The other coefficients of the regression were not significantly affected. Thus, baby food seemed to be an important source of vegetables for young children in France, but it did not affect the socio-economic gradient of vegetable consumption.

**Social position and prices paid**

If social class does not affect the quantities of processed food purchased by the household, differences may appear in the amount spent on these products. For instance, Carrigan et al. suggest that shoppers assess the quality of convenience foods through brands and prices. Table 4 shows the regression results for the unit values in fresh (FV) and processed food (baby food included, PV + BV) in euros per kilogram.

The richest and most educated respondents bought more expensive fresh and processed vegetables. The strongest coefficient was the effect of income class IV (the top 15% of income distribution) on PV + BV (0.87, $P=0.000$). It was almost three times as high as for fresh vegetables (0.30, $P=0.000$). This led us to conclude that there was a socio-economic gradient evident in the quantities of fresh vegetables purchased; for processed vegetables, however, the price paid for a given product quantity was strongly linked to household socio-economic status.

**Discussion**

In France, fresh vegetables constituted ~60% of the quantities of vegetables bought to homes in 2007. They remained, therefore, the dominant form of vegetable purchases in France. We showed that the buying behaviour regarding fresh vegetables depended primarily on the age of the respondent. We suggested that this might be the result of a mix of cohort and lifecycle effects. The propensity to purchase fresh vegetables also depended on the socio-economic status of the household (i.e. income and education). We also noted that the presence of young children had no significant effect on fresh vegetable consumption.

The findings of this study indicated that processed vegetable consumption in France did not depend on the respondent’s age, education or income. It seemed relatively even across age groups, socio-economic levels and household structures. Processed vegetables, therefore, neither reduce nor increase inequalities in total vegetable consumption, except in households with young children, where significantly more vegetables were purchased because of the consumption of vegetable-based baby food.

The purchase of processed vegetables was, nonetheless, linked to socio-economic status, as we have shown when we examined the expenses rather than the quantities. Unit values varied markedly across income categories for processed food and less markedly for fresh vegetables, whereas educational level had a significant but moderate impact on spending for both types of vegetables.

The major strength of this article is that it precisely separated vegetables that were bought as fresh produce from those bought as processed foods including composite foods. The determinants of each seemed to have little in common, except for the expected
effect of the size and structure of the household and the gender in single-adult households. Their link to socio-economic status, in particular, contrasted sharply.

The main restriction to the interpretation of the results comes from the fact that we used household purchase data. These are conceptually different from individual intakes. First, we do not know how food is shared among household members. Second, all the items purchased are not always entirely eaten. Some food is thrown away, but more importantly, we used the total weight of each item, thus including the peels for fresh vegetables, and other ingredients in processed vegetables (in ready-to-eat dishes containing vegetables). This should be only a minor problem because composite foods, defined this way, represented only 5% of the amount of processed vegetables.

Another important limitation is that we do not have any information on meals taken outside the home. However, in France, at-home meals remain important compared with European countries. Although in most countries, time devoted to eating at home declined during the past decades, it remained constant in France.28,29

We should, therefore, be cautious in the interpretation and use of these results in terms of discussing individual access to healthy food. Despite all these caveats, our findings about social determinants of vegetable consumption were consistent with conclusions drawn from other surveys on food intakes in France.22,30

Finally, we have not taken into account the respondent’s occupational status. Indeed, being in employment has an impact on the time available for shopping and cooking. However, occupational status is highly correlated with the respondent’s age: in the sample, a great majority (85%) of people aged <60 years in the sample were employed. We then ran a separate analysis on people aged <60 years, including whether they had an occupation. This showed that people in employment, although they buy less fresh vegetables, do not buy more processed ones (see Supplementary Material). Moreover, the socio-economic inequalities in vegetables consumption remained unchanged.

Our results suggest that three directions may be explored to promote vegetable consumption. First, encouraging fresh vegetable consumption is important, as they still constitute more than half of the quantities purchased in France. However, our results suggest that the strongest determinants of fresh vegetable consumption can be considered as exogenous constraints on the household’s daily life: age, income, educational level and household structure. Processed vegetables should, therefore, not be neglected, especially because their consumption does not depend on the household socio-economic status. However, the price paid for these foods is higher and differs more according to the household social position than for fresh foods, which may reveal a higher heterogeneity within processed vegetables than within fresh ones. In the frame of the French National Nutrition and Health Program 2 (2006–10), some major food companies have signed nutrition improvement charters with the State.31 They have committed to improve the nutritional quality of their processed foods, but their commitments rarely apply, as they still constitute more than half of the quantities purchased in France.32,33

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Conflicts of interest: None declared.

Key points
- In France, ~60% of the vegetables purchased for homes were fresh. Fresh vegetable consumption increased with income as well as with the head of household’s age and education level. Single men purchased low quantities of fresh vegetables.
- Income affected the unit values of processed vegetables purchased. Quantities of processed vegetables were independent from the respondent’s age, education and income. Processed foods did not reduce nor increase socio-economic inequalities in vegetable consumption.
- Baby food containing vegetables contributed significantly to vegetable consumption in households with young children, but did not change the economic gradient in the total quantities of vegetables purchased. Fresh vegetable consumption did not increase with the presence of children aged <6 years.
- This suggests that surveys measuring vegetable intakes as well as public policies aiming at promoting vegetable consumption should not neglect the contribution and the specificities of processed foods.

References
Access to excess: how do adolescents deal with unhealthy foods in their environment?

Emely de Vet1, John B. F. de Wit2,3, Aleks Luszczynska4,5, F. Marijn Stok1, Tania Gaspar6, Michelle Pratti2, Jane Wardle1, Denise T. D. de Ridder1

1 Clinical and Health Psychology, Utrecht University, Utrecht, The Netherlands
2 Social and Organizational Psychology, Utrecht University, Utrecht, The Netherlands
3 National Centre in HIV Social Research, University of New South Wales, Kensington, Sydney, Australia
4 Trauma, Health, and Hazards Center, University of Colorado, CO, USA
5 Warsaw School of Social Sciences and Humanities, Warsaw, Poland
6 Instituto de Psicologia e Ciências da Educação (IPCE), Universidade Lusíada de Lisboa
7 Department of Epidemiology and Public Health, Health Behaviour Research Centre, University College London, London, UK

Correspondence: Emely de Vet, Clinical and Health Psychology, Utrecht University, P.O. Box 80140, 3508 TC Utrecht, The Netherlands, tel: +31 (0) 30 253 9250, fax: +31 (0) 30 253 4718, e-mail: e.devet@uu.nl

Purpose: Easy access to unhealthy foods is believed to contribute to the current overweight epidemic. It remains unclear, however, how access to unhealthy foods is related to self-regulation of food intake. This study tests the hypothesis that using self-regulation strategies buffers the negative influences of easy access to unhealthy foods. Methods: Cross-sectional survey data from 2764 adolescents aged 10–17 years from four European countries (The Netherlands, UK, Poland and Portugal) about use of self-regulation strategies, access to unhealthy foods and intake of unhealthy foods (sweet and salty snacks and sugar-sweetened beverages) were used. Results: Both access to unhealthy foods and use of self-regulation strategies were independently, but in opposing directions, related to intake of unhealthy foods. Easy access to unhealthy food products was associated with higher consumption, but this effect could be attenuated by use of self-regulation strategies to facilitate healthy eating even when the food environment tempts one to do otherwise. Conclusions: Health promotion policy and programs should not only address the food environment but could also teach young people better strategies to deal with it.