The nutritional and environmental effects of the UK 5-a-day policy

Concetta Castiglione, Mario Mazzocchi
Department of Statistical Sciences, University of Bologna

Abstract
Over the last two decades, food and drink consumption has become a key target of public policy-making in European countries to address a variety of objectives related to the promotion of healthier diets. More recently, policy-makers have also explicitly recognized that food choices have a non-negligible impact on the environment, and a greater emphasis has been placed on promoting more sustainable diets, for example by encouraging consumption of foods produced locally and with environmentally-friendly techniques, or avoiding unnecessary waste at the household level. While consumers are faced with increasingly complex information about healthy and sustainable food choices, there is still a great deal of scientific uncertainty on the potential synergies and trade-offs between those social objectives. Our results show that the effective UK campaign for promoting fruit and vegetables has been effective in increasing fruit consumption, and that it has contributed to a small but relevant reduction of GHGE, although this positive impact has declined over time. The environmental benefits have stemmed from the substitution towards fruit and vegetables from other food choice whose impact in term of GHG was higher. An informed and effective food policy is a key prerequisite to live in a healthier and greener food environment.

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1. Background

During the last years there has been a great deal of attention towards the promotion of healthier food habits (World Health Organization, 2003). A 2010 survey has shown that European countries have implemented more than 100 national-level interventions to encourage the consumption of healthy foods (Capacci et al., 2012). The most common policy action is the provision of information to consumer through social marketing campaigns, especially to promote fruit and vegetable consumption as the 5-a-day program in the UK.

The objective of this work is to update previous evaluations of the UK 5-a-day policy introduced in 2003 and integrate them to consider their impact in terms greenhouse gas emission (GHGE). Other studies have tried to measure the impact of the 5-a-day campaign in terms of F&V intakes (Bremner et al., 2006; Capacci and Mazzocchi, 2011) and they find a small but significant increase, but all of them focus on relatively short periods during the pilot stage or few years after the introduction of the policy. To the best of our knowledge, there is no longer term evaluation of the 5-a-day policy.

In this paper, we explore the impact of the UK 5-a-day campaign using household-level purchase data from 2001 to 2014, i.e. 10 years after the program has been implemented. By considering substitutions across food groups that may be ascribed to the policy, and based on existing estimates of their level of GHGEs, we provide an assessment of some of the environmental effects of the policy.

The paper is structured as follows. Section 2 provides some background on the 5-a-day policy in the UK. The data used for our evaluations are described in Section 3, and the evaluation strategy is discussed in Section 4. Section 5 reports the main findings of the evaluation, and Section 6 draws some conclusions.

2. The 5-a-day case study

Fruit and vegetables are important sources of vitamins, minerals, and dietary fibre. In addition to a high nutrient density, most varieties contain a high proportion of water and are therefore at the same time low in calories. Moreover, high proportions of fruit and vegetables generally imply that other, physiologically less beneficial foods are consumed less often. In addition, a high intake of fruit and vegetables has often been described to be of relevant importance for the prevention of several chronic diseases (Boffetta et al. 2010; Rabenberg et al. 2015).

Despite the known health benefits of fruit and vegetables, population intakes remain low. According to Rooney et al. (2016) one potential contributing factor may be a lack of understanding surrounding recommended intakes.

The "5-a-day" program, that was first launched in the US in 1991 and subsequently embraced by several other countries (Stables et al., 2002), aims at increasing fruit and vegetable (F&V) intakes towards the World Health Organization (WHO) recommendation of 5 portions (or 400 g) per day. In the UK, a 5-a-day campaign was launched at a national level on 25 March 2003. While the policy targets the population at large, the program had specific initiatives for children and elderly people. Capacci and Mazzocchi (2011) evaluated that by 2005-6 the campaign had increased purchases of fruit and vegetables by around 0.3 portions on average, and evaluations in other countries found similar effect sizes. However, according to Rabenberg et al. (2015), fruit and vegetable consumption by children and adolescents is still far from the optimum level and should continue to be encouraged. Rooney et al. (2017) suggest that the 5-a-day F&V message were not well known in the UK population, and that F&V consumption mainly depends on knowledge.

Figure 1 shows the consumption of six goods (fruit, vegetables, beef and lamb, chicken, composite dishes and non-alcoholic drinks) over the period 2001-2014 in the UK based on purchased quantities as measured by the UK household budget surveys. The figure shows that the consumption of fruits and vegetables has increased during the first few years following the program implementation policy, but it has slowly decreased over the following years.

3. Data

The data used in this analysis are derived from the Expenditure and Food Survey (EFS) and the Living Cost Survey (LCS) conducted by the Office for National Statistics (ONS) in the UK, over the period 2001-2014.[1] The EFS has changed from a financial to a calendar year based system in 2006. Our analysis is based on the micro-level (household-level) data, and after combining the 13 surveys into a single data-set, we refer to the calendar years. The resulting sample by year and quarter is displayed in table A1 in the Appendix.

EFS and LCS purchase data are collected from a sample of households using self-reported diaries of all purchases, including food, over a 2-week period (Burgon, 2007). Data are at the household level and include expenditure values and quantities purchased in grams, which are recorded where possible, and otherwise estimated. Food products are classified according to United Nations

[1] From January 2008, the EFS became known as the Living Costs and Food (LCF) module of the Integrated Household Survey (IHS).

Statistical Commission's Classification Of Individual COnsumption by Purpose (COICOP). The EFS and LCS samples are nationally representative and sampling weights are provided for each household in the data-set.
For the purpose of this analysis we consider eighteenth food aggregates[2] and a residual category (Miscellaneous food)[3]. Unit values for each household are computed as the ration between expenditure and purchased quantities. As unit values embody a quality (aggregation) component together with the price dimension, a quality-adjusted estimate of prices is obtained by averaging the unit values by month and geographical area (13 UK government office regions), assuming that households sampled in the same month and same region face the same price.
Finally, total expenditure and income are normalized by the adult-equivalent OECD coefficients (OECD, 2009), to account for economies of scale in household consumption[4]. With the help of equivalence scales each household type in the population is assigned a value in proportion to its needs.

4. Evaluation strategy

We evaluate the five-a-day program in terms of changes in purchased quantities, based on the Almost Ideal Demand System (AIDS, Deaton & Muellbauer, 1980) as the baseline demand model. The evaluation approach relies on quasi-experimental methods (Blundell and Costa Dias, 2009) and on the specification of counterfactual scenarios, so that the policy effect can be disentangled from other changes in consumption induced by changes in prices, incomes or demographic changes.
The UK food demand system is specified as follows:

$$w_{iht} = \alpha_i + \boldsymbol{\tau_i}\, \mathbf{z_h} + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jht} + \beta_i ln\left(\frac{x_{ht}}{P_{ht}}\right) + \varepsilon_{it} \qquad (1)$$

Where:

[2] 1 - Fruit; 2 - Vegetables; 3 - Potatoes; 4 - Cereals; 5 – Beef and lamb; 6 - Chicken; 7 – Pork; 8 - Other meats; 9 - Fish; 10 – Milk and yoghurt; 11 - Butter, cheese & other dairy; 12 - Eggs; 13 – Oils and fats; 14 – Composite dishes; 15 - Alcoholic drinks; 15 - Alcoholic drinks; 16 – Non-alcoholic drinks; 17 – Confectionary; 18 – Crisps and snacks.

[3] Tea; Coffee beans and ground coffee; Instant coffee; Coffee essences; Cocoa and chocolate drinks; Malt drinks & chocolate versions of malted drinks; Fruit teas, instant tea, herbal tea, rosehip tea; Invalid foods, slimming foods and sports foods; Sauces; Takeaway sauces and mayonnnais; Stock cubes and meat & yeast extracts; Salt; Spices and dried herbs; Bisto, gravy granules, stuffing mix, baking powder, yeast.

[4] The OECD equivalence scale assigns a weight equal to 1 to the first household member has a weight of 1, and 0.7 to each additional adult, whereas every children weights 0.5.

$\mathbf{z_h}$ is a vector of household characteristics to capture the variation in expenditure shares across households which can be explained by heterogeneity in the household socio-demographic characteristics;
p_{jht} is the price for the j-th food faced by household h at time t.;
x_{ht} is the total food budget spent by household h at time t
P_{ht} is the AIDS non-linear price index for household h at time t
The set of demographic variables in our model (all referring to the household reference person) are: age in years, age at which education was completed, marital status and job status (working, retired, unemployed). Per-capita household income is used as an instrument for total food expenditure to overcome endogeneity issues.
To evaluate the 5-a-day campaign, since no natural treatment or control group can be identified, and the whole UK population is 'treated' by the promotion program, we adopt an AIDS model-based counterfactual as in Capacci and Mazzocchi (2011). Assuming that the ultimate effect of the policy is to change consumer preferences, we estimate a baseline demand model prior to the policy intervention and a post-intervention model afterwards. The policy effect is given by the difference in the post-policy predictions obtained using the post-policy model parameters and the pre-policy model parameters.
More specifically, we estimate an AIDS model on the sample preceding to the policy (ModBEFORE - 2001-2003) and after the policy (ModAFTER - 2004-2014), then we predict the consumption after the policy using ModBEFORE parameters 2004-2014 and we predict consumption after the policy using ModAFTER parameters 2004-2014. The difference between the two predictions is the policy impact.
The final step of our analysis is to convert the estimated quantities in environmental impact, to do so we apply coefficients from Hoolohan et al. (2013) to estimate the effects of these policies in terms of greenhouse gas emissions (GHGE). In each food categories we have weighted the Hoolohan et al. (2013) estimated coefficient for the purchased quantities. We then translated the policy outcome (purchased quantities *Q*) into GHGE, based on the average impact *(Q × AVG)*. The resulted GHGE coefficients are reported in Table 1. Animal products have the highest environmental impact, especially Beef & Lamb, Other meats, Butter, cheese & other dairy, and Pork. On the other side, Potatoes, Crisps & snacks and Non-alcoholic drink have the lowest GHGE coefficients.

5. Results

Estimates from equation (1) are reported in Tables 2-4. The second column of each table indicates the policy impact on the quantity, whilst the following column shows the environmental impact.
Table 2 show the 5-a-day policy and the environmental impacts on the whole period after the policy (2003-2014), Table 3 shows both impact on the period 2003-2008, whilst Table 4 takes into account the period 2009-2014.
Our estimates suggest that the 5-a-day campaign has had a positive impact on the consumption of fruit, vegetables, eggs, oil and fats, and alcoholic drinks, while inducing a reduction in the consumption of meats, and other foods ceteris paribus. The resulting environmental effect is an average reduction of GHGE. In this case, there seems to be a consistency between the policy objective and the environmental effects. However, what is important is that all the positive effects in terms of both the increase of health food and, consequently, the reduction of GHGE emission are strong over the period following the introduction of the policy (2004-2009) but they become smaller afterwards (2009-2014). According to our estimates, the positive effects on fruit consumption are higher in the years following the policy introduction, whereas consumption of vegetables increases later in the sample.

6. Summary and discussion

In this work we have evaluated the 5-a-day campaign over a longer period (2003-2014) relative to previous evaluations, and we have translated the outcomes in terms of purchased quantities in environmental impacts as measured by GHGEs, based on the coefficients provided in Hoolohan et al. (2013) allowing for substitutions across food groups. Our results show that the promotion campaign of F&V has been effective especially in the short term (between 2004 and 2009), and that it has contributed to a small but significant reduction of GHGEs, although this positive impact has declined over time. The environmental benefits have stemmed from the substitution towards F&V from other foods whose impact in term of GHG was higher.
However, this consistency in outcomes is not necessarily generalizable to other food policies, and substitutions should be evaluated on a case-by-case basis.
An informed and effective food policy is a key prerequisite to live in a healthier and greener food environment.

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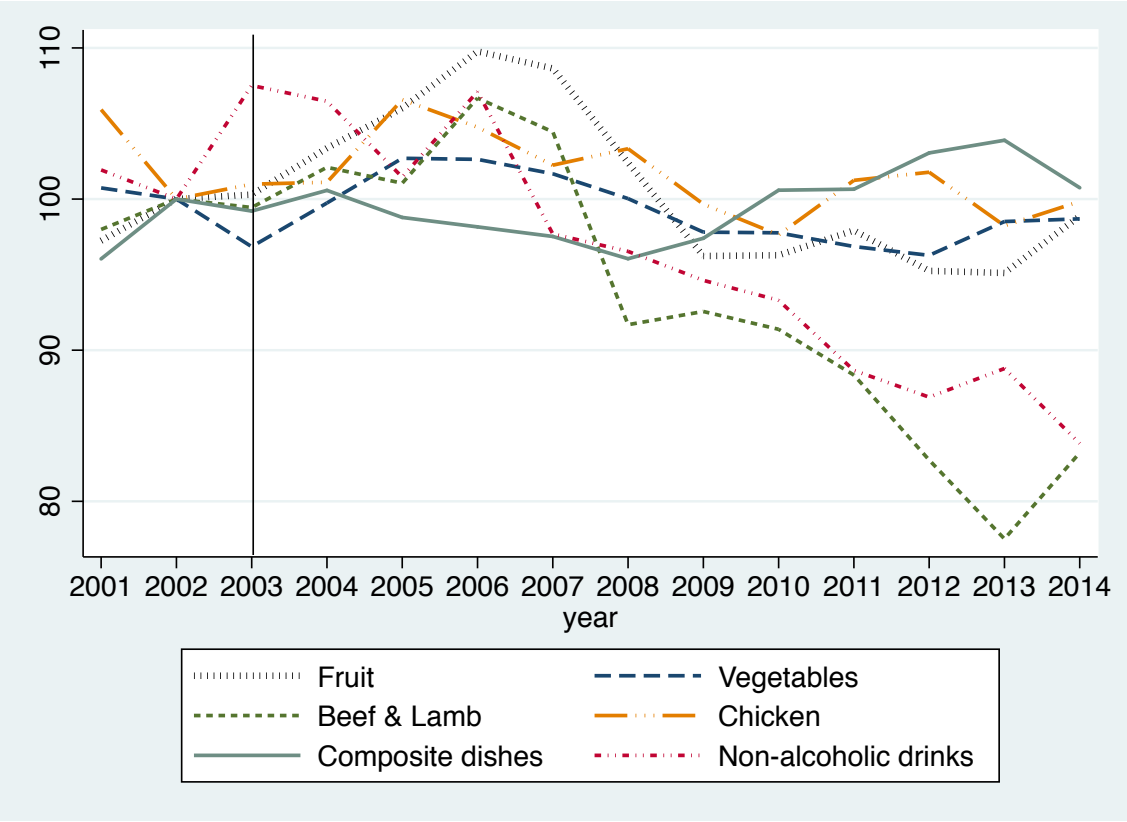
Appendix A – Figures

Figure 1: Weighted quantities consumption over the period 2001-2014 (2002=100)



Appendix B- Tables

Table 1: GHGE coefficient for food category (Kg CO2/Kg)

Product	GHGE
1. Fruit	1.406
2. Vegetables	2.870
3. Potatoes	0.338
4. Cereals	1.882
5. Beef & Lamb	22.484
6. Chicken	4.050
7. Pork	10.290
8. Other meats	12.770
9. Fish	2.931
10. Milk & yoghurt	3.270
11. Butter, cheese & other dairy	11.588
12. Eggs	4.900
13. Oils & fats	2.563
14. Composite dishes	5.490
15. Alcoholic drinks	1.803
16. Non-alcoholic drinks	0.898
17. Confectionary	3.752
18. Crisps & snacks	0.297
19. Miscellaneous food	1.004

Table 2: 5-a-day impact on purchased quantities and GHGE (Kg/hh/month), 2003-2014

Food	Coeff.	St. Err.	Impact
Fruit	1.324***	0.098	1.861
Vegetables	0.642***	0.089	1.843
Potatoes	-0.421***	0.063	-0.142
Cereals	-0.224***	0.021	-0.422
Beef & Lamb	-0.085***	0.025	-1.916
Chicken	-0.0002	0.018	-0.001
Pork	-0.236***	0.014	-2.430
Other meats	-0.080***	0.021	-1.020
Fish	0.120***	0.007	0.352
Milk & yoghurt	-0.219***	0.080	-0.717
Butter, cheese & other dairy	0.008	0.007	0.095
Eggs	0.014***	0.004	0.067
Oils & fats	0.018***	0.005	0.047
Composite dishes	-0.120***	0.014	-0.657
Alcoholic drinks	0.591***	0.016	1.065
Non-alcoholic drinks	-0.249***	0.033	-0.224
Confectionary	-0.782***	0.023	-2.934
Crisps & snacks	-0.078***	0.008	-0.023
Miscellaneous food	-0.093***	0.003	-0.093
Total	**0.129**		**-5.250**

*** p<0.01; ** p<0.05; * p<0.1

Table 3: 5-a-day impact on purchased quantities and GHGE (Kg/hh/month). Years 2003-2008

Food	Coeff.	St. Err.	Impact
Fruit	1.370***	0.039	1.926
Vegetables	0.443***	0.022	1.273
Potatoes	-1.039***	0.022	-0.351
Cereals	-1.018***	0.031	-1.916
Beef & Lamb	0.077***	0.017	1.728
Chicken	0.069***	0.009	0.278
Pork	-0.098***	0.007	-1.004
Other meats	-0.034***	0.007	-0.433
Fish	0.152***	0.004	0.445
Milk & yoghurt	-1.710***	0.078	-5.592
Butter, cheese & other dairy	-0.109***	0.005	-1.264
Eggs	-0.122***	0.007	-0.598
Oils & fats	-0.037***	0.004	-0.095
Composite dishes	0.095***	0.025	0.521
Alcoholic drinks	0.973***	0.023	1.754
Non-alcoholic drinks	0.0004	0.031	0.000
Confectionary	-0.906***	0.012	-3.401
Crisps & snacks	-0.094***	0.006	-0.028
Miscellaneous food	-0.140***	0.008	-0.141
Total	**-2.128**		**-6.899**

*** p<0.01; ** p<0.05; * p<0.1

Table 4: 5-a-day impact on purchased quantities and GHGE (Kg/hh/month). Years 2009-2014

Food	Coeff.	St. Err.	Impact
Fruit	0.985***	0.097	1.385
Vegetables	0.579***	0.021	1.661
Potatoes	0.357***	0.089	0.121
Cereals	0.555***	0.025	1.044
Beef & Lamb	-0.193***	0.018	-4.335
Chicken	0.003	0.014	0.014
Pork	-0.319***	0.021	-3.280
Other meats	-0.047**	0.007	-0.606
Fish	0.063***	0.079	0.185
Milk & yoghurt	0.583***	0.007	1.906
Butter, cheese & other dairy	0.093***	0.004	1.075
Eggs	0.133	0.005	0.653
Oils & fats	0.119***	0.014	0.304
Composite dishes	-0.276***	0.015	-1.514
Alcoholic drinks	0.130***	0.033	0.235
Non-alcoholic drinks	-0.599***	0.022	-0.538
Confectionary	-0.595***	0.008	-2.231
Crisps & snacks	-0.036***	0.003	-0.011
Miscellaneous food	-0.021***	0.061	-0.021
Total	**1.515**		**-3.953**

*** p<0.01; ** p<0.05; * p<0.1