Appetite 165 (2021) 105283

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Explaining inequalities in fruit and vegetable intake in Europe: The role of capabilities, opportunities and motivations

Daniela Craveiro [a,b,*], Sibila Marques [a], Iva Zvěřinová [c], Vojtěch Máca [c], Milan Ščasný [c], Aline Chiabai [d], Cristina Suarez [e], Pablo Martinez-Juarez [e,f], Silvestre García de Jalón [d,g], Sonia Quiroga [e], Timothy Taylor [h]

[a] Instituto Universitário de Lisboa (ISCTE-IUL), CIS-IUL, Lisbon, Portugal
[b] Lisbon School of Economics and Management, CSG/SOCIUS-ISEG, Universidade de Lisboa, Lisbon, Portugal
[c] Environment Centre, Charles University, Prague, Czech Republic
[d] Basque Centre for Climate Change, BC3, Leioa, Spain
[e] Department of Economics, Universidad de Alcalá, Alcalá, Spain
[f] Department of Communication and Media Studies, University Carlos III of Madrid, Madrid, Spain
[g] Department of Agricultural Economics, Statistics and Business Management, Universidad Politécnica de Madrid, Madrid, Spain
[h] European Centre for Environment and Human Health, University of Exeter Medical School, Exeter, United Kingdom

ARTICLE INFO

Keywords:
Fruits and vegetables
Inequality
Education
Health
Diet

ABSTRACT

People who do not eat enough fruit and vegetables (F&V) have incremental health risks. Most Europeans do not comply with health recommendations relating to F&V consumption and this is especially true for those with lower-level education, which reinforces structural inequalities in health and wellbeing among Europeans. This study investigated the role of key behavioural triggers – capabilities, opportunities and motivation (in the COM-B model) – as pathways for educational differentials in F&V intake in Europe. A cross-sectional survey-based study was conducted in five European countries differing widely in their consumption habits, wealth, and climatic conditions. A structural equation model was designed to study how capabilities (diet perceived knowledge, health purchase criteria), opportunities (financial availability, social norms), and motivations (health value, habits strength) affect educational inequalities in the intake of F&V (5 portions a day) as mediators. Multi-group comparisons assessed country differences. People with higher levels of education were more likely to eat the recommended diet, i.e., at least 5 portions of F&V a day. Countries in the sample vary significantly in the percentage of people complying with the recommendation, but not significantly in terms of relative education differentials. The educational gap in the intake of F&V is mainly explained by education differentials in financial availability, diet knowledge, and habits in inserting F&V in main meals. Policies targeting dietary inequalities should address behavioural triggers affecting dietary intake, for example by subsidising F&V, developing targeted dietary awareness campaigns, or by intervening in mass catering contexts to facilitate the implementation of healthy habits.

1. Introduction

The consumption of sufficient quantities of fruit and vegetables (F&V) is an important component of a healthy diet, recognised by experts, health professionals and citizens across Europe (e.g., Ridder, Kroese, Evers, Adriaanse, & Gillebaart, 2017). The connection between improved F&V intake and a number of health outcomes is well known, such as the reduction of non-communicable diseases (NCDs) including cardiovascular diseases and cancer (WHO, 2019). The consumption of F&V, when complemented with a diet low in fat, salt and sugar, may also contribute to a reduction in the risk of obesity, which is an additional risk factor for NCDs.

The World Health Organization (WHO) attributed 3.9 million deaths worldwide to insufficient F&V intake in 2017 (WHO, 2019). Despite this evidence, people in countries all over Europe do not on average eat the recommended amount of F&V that would ensure a health protection effect. According to the European Health Interview Survey (EHIS; 2013–2015), only 14.1% of European adults consume 5 portions of F&V

* Corresponding author.
E-mail address: daniela.craveiro@iscte-iul.pt (D. Craveiro).

https://doi.org/10.1016/j.appet.2021.105283
Received 5 March 2020; Received in revised form 20 April 2021; Accepted 22 April 2021
Available online 12 May 2021

per day (400 g assuming 80 g per portion), as recommended by the WHO and FAO (2005), which forms the basis of most national guidelines in EU Member States (EUROSTAT, 2018). The percentage of the actual consumption varies across countries and varies consistently across educational and socioeconomic groups.

Several reviews of the literature have reported the inverse association between socioeconomic status and fruit and vegetable intake. Less educated, lower income or lower occupational status individuals tend to have a lower consumption of F&V and less healthy diets (e.g., Darmon & Drewnowski, 2008; Giskes, Avendaño, Brug, & Kunst, 2010; Kamphuis et al., 2006; Ridder et al., 2017; Roos, Johansson, Kasmel, Klumbiené, & Prättälä, 2001). The trend is reported in almost all EU-28 countries, with only a few exceptions (EUROSTAT, 2018).

Behavioural disparities in health such as dietary choices underline different exposures and vulnerabilities to health risks between different social groups contributing to these health inequalities. This can be framed under the Theory of Fundamental Causes, according to which social conditions are the main determinants of health-relevant actions in keeping with the access to resources that increase the scope for engaging in health-enhancing or health-protective behaviours (Phelan, Link, & Tehranifar, 2010). We identified from the literature some of these resources by consulting previous studies on explanatory variables for inequalities in F&V intake.

A lack of access to F&V, be it in terms of financial or physical barriers, has been advanced as an explanation for inequalities in diets. Even though healthy diets can be achieved on a low budget in some settings (e.g. Tharrey, Perignon, Dubois, Gaigi, & Darmon, 2019), research findings based on normalized international data suggest that, on average, following a healthier diet pattern with higher intakes of F&V (such as the Mediterranean-type diet) is more expensive than opting for a less healthy diet pattern (Rao, Afshin, Singh, & Mozaffarian, 2013). There is also evidence that residents from lower-income neighbourhoods have less access to healthier options and higher exposure to unhealthy food outlets (e.g. Andreyeva, Long, & Brownell, 2010; Black, Moon, & Baird, 2014; Giskes et al., 2010). Perceptions of availability and affordability (e.g. Ball et al., 2006), food expenditure (Pechey & Monsivais, 2016) and diet costs (Aggarwal, Monsivais, Cook, & Drewnowski, 2011) have been identified as relevant mediators for socioeconomic differences in fruit and vegetable consumption.

A range of other factors may also influence dietary inequalities. For example, in a multilevel study with a sample of Australian women, socio-economic differences in F&V intake were shown to be partially mediated by perceived social support and nutritional knowledge (Ball, Crawford, & Mishra, 2006). These factors have also explained educational differences in diet quality among first-time mothers in the same country (McLeod, Campbell, & Hesketh, 2011). Attention to health when buying food, and organic food consumption (i.e. attitudes about healthy eating) partially explained educational differences in fruit and vegetable intake in a regional subsample of an epidemiological study in France (Lê et al., 2013). The indirect effect of education on F&V consumption was also found to be mediated through control beliefs (self-efficacy and health locus of control), in a sample of 45-year-old women residing in the city of Bergen, Norway (Leganger & Kraft, 2003). Other psychosocial factors, such as perceived health status, perceived life control and social cohesion, were found to be contributing to education differences in vegetable consumption in a sample of residents of the city of Utrecht in the Netherlands (Mulder, De Bruin, Schreurs, Van Ameijden, & Van Woerkum, 2011).

Research has reported important differences across countries and regions in Europe (Boylan et al., 2010; Hall, Moore, Harper, & Lynch, 2009; Naska et al., 2000; Pechey et al., 2013; Roos et al., 2001). Roos and collaborators concluded, based on a meta-analysis, that those in southern European countries tend to eat more F&V than those in northern and central European countries and that there are lower socioeconomic disparities in consumption levels (Roos et al., 2001).

More recent data, however, present a less coherent pattern. The daily consumption of F&V vary greatly across EU-28 countries. Relying on data from the European Health Interview Survey (EHIS; 2014–2015), we can observe that among the countries with higher consumption profile – United Kingdom, Ireland, Denmark, Netherlands and Portugal – 20–30% of the population eat at least five portions a day. This figure is less than 8% among countries with the lowest consumption, such as Romania, Bulgaria, Croatia, Greece, Austria, or Slovenia (EUROSTAT, 2018). Surprisingly, the countries with higher percentages of people reporting eating at least 5 portions of F&V a day are those with the largest educational gaps (EUROSTAT, 2018).

Cultural patterns and the availability of F&V at the national level are some of the possible explanations for this complex pattern (e.g. Hall et al., 2009; Naska et al., 2000). Cross-country differences in dietary inequalities suggest different pathways between socioeconomic status and food consumption.

Many interventions to promote F&V intake have been proposed, but if the mechanisms by which socioeconomic factors influence dietary patterns are not understood there is a risk that actions may accentuate these differences and reinforce the disadvantage of the most economically vulnerable groups (McGill et al., 2015; Rekhy & McConchie, 2014). It is therefore important to explore the pathways and understand the factors that account for socioeconomic differences in dietary behaviours in order to be able to reduce those inequalities or minimize the degree to which they influence health.

Taking into consideration the multiplicity of factors discussed in the literature, approaches require broad models on human behaviour for a comprehensive view on how these dimensions may operate. The COM-B model (Capability, Opportunity, Motivation and Behaviour) is particularly tailored for such an exercise as a comprehensive and coherent understanding of behavioural determinants (Michie, Van Stralen, & West, 2011). This model affirms how behaviour (B) requires the interaction of three distinct factors: capability (C), the physical and psychological capacities to engage in behaviours; opportunity (O), that covers the possibilities prevailing in the physical and social context; and motivation (M), or the internal processes that trigger behaviours (Michie et al., 2011).

Previous studies that address indirect effects of socioeconomic variables on the intake of F&V tend to focus on specific dimensions, instead of exploring the interplay of multiple pathways. They test mediations using coefficient comparisons, considered to be a weak analytical strategy for establishing mediation (Claassen, Klein, Bratanova, Claes, & Corneille, 2019). Finally, these studies do not assess country level specificities nor do they employ a common framework that would allow for mapping the diverse relevant theoretical pathways.

In this paper, we attempt to address all these gaps. This paper examines the associations between education and F&V intake, drawing on a survey implemented in five European countries. We aim to explore the multiple drivers of inequalities, drawing on the COM-B framework to explore the factors that mediate the impact of education on intake using path analysis, probing the statistical significance of each indirect path. We also explore the potential that the mediation effects differ between countries.

Relying on recent literature reviews on determinants of F&V intake and healthy eating, we select the key attributes involved in capability, opportunity and motivation determinants for diet change, and intake of F&V in particular. Concerning the capability to eat healthily or to eat enough F&V, research highlights the role of cognitive factors, such as knowledge and beliefs, and the volitional factors related to self-regulatory skills (e.g., Godinho, Carvalho, & Lima, 2014). To address this dimension, we include indicators related to health food purchase criteria and self-assessments of diet healthiness.

In terms of opportunities, material and social environments emerge as important dimensions to behavioural changes, shaping the opportunities for healthier diets (Bowen, Barrington, & Beresford, 2015; Giskes et al., 2010; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). Material environments concern the multiple settings where people eat or

acquire food; financial and physical accessibility to healthy food rank as key features in these micro-contexts (e.g., Black et al., 2014; Giskes et al., 2010). Social environments relate to the interactions among people that influence behaviour through social factors and social cues, such as social norms (Ajzen, 2011). To address the opportunities dimension, we include indicators related to financial availability (material opportunity) and social norms about healthy eating (social opportunity).

Regarding motivation (M), the authors refer to the importance of reflexive motivation processes and automatic motivation processes (Michie et al., 2011). Reflexive motivation involves what people consciously want, decide and/or plan to do. This dimension has been explored extensively in the literature on diet change within the scope of the Theory of Planned Behaviour, anchored in the notion of intentions (e.g., Canova and Manganelli, 2016; Kothe et al., 2012). In a broader way, reflexive motivation regarding eating healthy can also be addressed through peoples' personal values, that is, on the end states or behaviours perceived as good and desirable (e.g. Verplanken & Holland, 2002; Verplanken & Roy, 2016). As regards automatic motivation processes, research has demonstrated the empirical value of habits for predicting eating behaviours (e.g., van't Riet, Sijtsema, Dagevos, & de Bruijn, 2011). This duality of motivational triggers for eating healthily is included in our study with the model considering the relative importance of health as a personal value (reflexive) and the strength of habits (automatic) of eating F&V at main meals.

Our main research hypothesis is that capabilities, opportunities and motivations to eat healthy food partially explain educational differentials in F&V intake.

The socioeconomic position encapsulates the relative position of the individual on a continuum of variables that describe the key structural domains of social stratification, such as education, income, occupation, and wealth (Krieger, Williams, & Moss, 1997; Lahema, 2010). In this study, we focus on different socioeconomic segments based on different levels of educational attainment. This choice stems from two key reasons: relevance and convenience. Education is one of the stronger predictors of health behaviours, such as diet or exercise (e.g., Brunello, Fort, Schneeweis, & Winter-Ebmer, 2016; Park, Cho, & Moore, 2018). Additionally, education level has clearly been identified as one of the most relevant mechanisms in the social stratification of health inequality in Europe, determining occupational class, employment prospects, income, and wealth (Phelan et al., 2010). The use of education as a proxy for socioeconomic position is also convenient given the relative ease of data collection and comparison across different international countries due to established protocols (e.g., the International Standard Classification of Education).

The contribution of COM-B factors to education related inequalities in diets are examined in a unique data sample gathered by our own survey carried out in five European countries that differ significantly in current lifestyles and diets as well as their respective educational endowments.

2. Material and methods

2.1. Data

Data come from a survey conducted in five countries – the Czech Republic, Latvia, Portugal, Spain, and in the United Kingdom – compiling different political and socio-economic contexts and ensuring a broad European perspective on different subjects (Zvěřinová, Ščasný, & Máca, 2018). This survey was conducted in 2019 as part of the Horizon 2020 funded INHERIT project (inherit.eu).

The country subsamples were selected using quota sampling from online access panels and are representative of national populations aged 18–65 years in terms of gender, age, region, and education (EUROSTAT, 2017). All participants gave their informed consent. The study obtained ethics approval in each country where data were collected: ethical Committee from Rsu (Riga, Latvia, 1/21.12.2017), University of Exeter Medical School (Exeter, United Kingdom, RG/CB/CA249); Instituto Universitário de Lisboa (Lisbon, Portugal, 24/2017); University of Alcalá (Alcalá, Spain, CEI/HU/2018/02); Charles University Environment Center (Czech Republic, Prague, 4/2017). The dataset analysed in this paper includes 7582 valid responses. Table 1 presents an overview of the sample in the different countries.

2.2. Measures

The INHERIT household survey was developed to examine attitudes, preferences and behaviours related to consuming, moving and living (Zvěřinová et al., 2018). A set of variables was selected to test the relevance of capabilities, opportunities and motivations to explain differences in F&V intake across individuals with differing levels of education. The indicators were selected based on criteria of theoretical soundness and empirical validation (internal consistency of scales, regression assumption studies).

2.2.1. Capabilities

People are able to increase their fruit intake or opt for healthier diets if they have the skills and knowledge to do so (Rimal, Moon, Balasubramanian, & Miljkovic, 2011). In our survey, two indicators are considered to address these dimensions: (i) concern to own health as an important criteria to buy food (*health purchase criteria*); and (ii) the self-perceived healthiness of the personal diet (*perceived diet knowledge)*, assessed on a 7 points Likert scale ("How healthy or unhealthy do you think your current food consumption is on a scale from 1, very unhealthy, to 7, very healthy?").

2.2.2. Opportunities

Material and social environments shape opportunities to follow a healthy diet with enough fruits and vegetables (Bowen et al., 2015; Giskes et al., 2010; Story et al., 2008). Generally, more educated people tend to have the financial resources to live and work in settings with better access to healthier options (e.g., Black et al., 2014; Giskes et al., 2010). Therefore, in our model we use *financial availability* to measure material environments, in terms of household income.[1]

The description of social environment applies a *social norms* measure. The survey included a three-item scale following the standard wording on normative beliefs recommended by Ajzen (1985, pp. 11–39). The scale is designed to capture contextual understandings on what people believe they are expected to do.[2] We consider this as a measure of *social* norms – as opposed to *descriptive* norms, thus, as how people believe others behave (Ham, Jeger, & Ivkovic, 2015). As preliminary analyses (in terms of item correlation and internal consistency) did not validate the combination of the three items into a single score (Supplementary material, Table A3), we selected the indicator with the highest face validity ("People who are important to me would disapprove/approve of my eating of a healthy diet most of the time").

2.2.3. Motivation

The motivation to eat is influenced by reflexive and automatic motivational processes (e.g. Wood and Rünger, 2016).

For the reflexive motivational trigger, we applied the role of personal values. It is plausible to assume that people who value their personal

[1] Midpoints from 12 income brackets shown in the questionnaire divided by the square root of the size of the household, converted to Purchasing Power Standards and then square rooted (with this last mathematical calculation performed to account for the non-linear association between education and financial availability).

[2] In the Theory of Planned Behaviour, "*subjective* norms" are measured by the strength of "normative beliefs" weighted by the strength of individual motivation to comply with them (Ajzen, 1985).

Table 1
Sample description by country.

	CZ		ES		LV		PT		UK		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Age group												
18–34 years old	587	31.5	504	31.6	328	34.3	495	40.6	591	30.4	2505	33.0
35–49 years old	709	38.0	654	41.0	352	36.8	455	37.3	659	33.9	2829	37.3
50–65 years old	570	30.5	437	27.4	276	28.9	270	22.1	695	35.7	2248	29.6
Gender												
Female	947	50.8	805	50.5	515	53.9	593	48.6	1073	55.2	3933	51.9
Male	919	49.2	790	49.5	439	45.9	626	51.3	870	44.7	3644	48.1
Other	0	0.0	0	0.0	2	0.2	1	0.1	2	0.1	5	0.1
Marital status												
No partner	584	31.3	571	35.8	318	33.3	495	40.6	836	43.0	2804	37.0
With partner	1282	68.7	1024	64.2	638	66.7	725	59.4	1109	57.0	4778	63.0
Education attainment												
Primary/lower secondary	799	42.8	387	24.3	94	9.8	349	28.6	474	24.4	2103	27.7
Secondary education	692	37.1	539	33.8	498	52.1	479	39.3	685	35.2	2893	38.2
Tertiary	375	20.1	669	41.9	364	38.1	392	32.1	786	40.4	2586	34.1
Total	1866	100.0	1595	100.0	956	100.0	1220	100.0	1945	100.0	7582	100.0

Notes. Czech Republic (CZ), Spain (ES), Latvia (LV), Portugal (PT), United Kingdom (UK). Frequency (N) and percentage (%) by sample.

health tend to have a greater intention to opt for healthier diet options, such as eating F&V in main meals. An indicator of Schwartz scale (e.g., Schwartz, 1992) concerning the importance attributed to health as a personal value was included in the model (*health value*, evaluated on a 8-point Likert scale: from −1, opposed to my values, to 7, of supreme importance).[3] To minimize the interference of differences in rating styles the value score was centred by the individuals' average score on the full scale.

The motivation to eat F&V is also influenced by automatic triggers, such as habits. Habits are generated by contextualized-learned behaviours; when a habit is established, situational cues are able to trigger the behaviour, without any conscious decision to do so (e.g. Gardner, 2015). The strength of the habit of eating F&V is measured with an adapted short version of the Self-Report Habit Index (Gardner, Abraham, Lally, & de Bruijn, 2012), considering the consumption of F&V and in main meals on weekdays. The *habit strength* score results from the average of six items, assessed on an agreement scale to three sentences concerning the lunch and dinner situation ("Eating fruit or vegetables at lunch/-dinner time on weekdays is something that …. I do without thinking; … is natural for me to do; … I do automatically"). The scale demonstrated a good level of internal consistency (Cronbach's Alpha = 0.914; Supplementary material, Table A2).

2.2.4. Education

The educational inequalities in F&V intake are explored in this article to contribute to the understanding of pathways to decrease health inequalities in Europe. Based on the International Standard Classification of Education (ISCE), country specific variables for highest level of educational attainment were categorized in three levels: up to low secondary education (primary/low secondary education), secondary education, and tertiary education.

2.2.5. F&V intake

A Self-Reported short-form Food Frequency Questionnaire was included in the survey to collect information on diets (Cleghorn et al., 2016 adapted by Zvěřinová et al., 2018). Respondents were asked to indicate how often they consume F&V separately on a scale of 9 frequency categories (see Figure A1 in Appendix). The daily portions of

[3] Single item usage of the health item receives support from preliminary psychometric assessments of the scale that failed to frame the health item clearly in one specific factor (basic human values), being relatively less compliant than other items with the structure of Schwartz' human values scale (Schwartz, 1992).

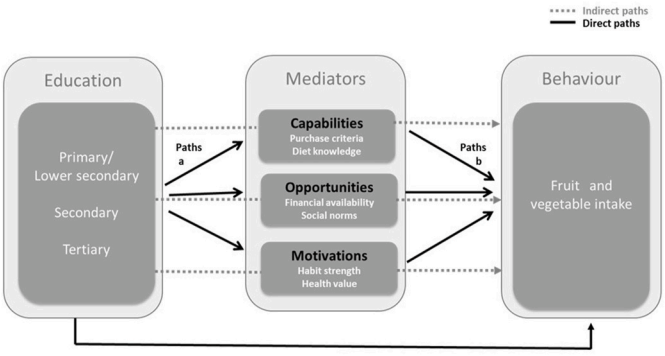

Fig. 1. Representation of indirect and indirect effects of education on fruit and vegetable intake.

F&V were estimated using the conversion key made available by Cleghorn et al. (2016). After summing the variables, responses were coded into a dichotomous variable showing compliance or not with the standard of 5 portions or more a day (0 = less than 5 portions a day; 1 = 5 or more portions a day).

2.3. Analyses

A structural equation model was designed to study the contribution of capabilities (diet perceived knowledge, health purchase criteria), opportunities (financial availability, social norms), and motivations (health value, habits strength) to educational inequalities in the intake F&V (5 portions a day) as mediators. These hypotheses are theoretically grounded (COM-B model) and were specified before data treatment.

The mediated effects of education on fruit and vegetable intake through differences in capabilities, opportunities and motivations (indirect paths) are estimated based on the direct effects of educational variables on each mediator variable (Paths a) and each mediator and the dependent variables (Paths b), as presented in Fig. 1.

Regression coefficients and overall fit of the model were estimated using the Lavaan package in *R* (Rosseel et al., 2019), based on robust estimations. The model included regression paths between education variables (introduced in the model as two dummy variables) and each mediator, and from each mediator variable to F&V intake, with a total of 7 regressions and 12 bivariate correlations, with pair-wise comparisons among the scale level mediators, to take into account all relevant effects. All regression paths include a set of controls (gender, age group, marital status, country). Due to the existence of exogenous dichotomous

variables, model parameters were estimated using diagonally weighted least squares, but the full weight matrix is used to compute robust standard errors and mean- and variance-adjusted test statistics. The estimation of the indirect effects was computed based on MacKinnon and Dwyer (1993), adapting the product of coefficients approach to models with dichotomous outcomes.

Multigroup comparisons were conducted to assess whether the regression pathways under study significantly vary across country samples. The multigroup modelling relies on a version of the model without the country control variables and it is based on the comparison of the overall fit between "free" (all parameters are allowed to differ between groups) and "constrained" models (regression parameters are fixed to be equal across groups).

Preliminary analysis included the study of bi-variate associations between educational attainment and the variables in the model (Table 2), the overall significance of the regressions that compose the model (Table 3), and the study of the key linear regression models based on residuals analysis (Supplementary material, Table A3, Figure A2).

3. Results

The results show that, drawing on the full sample, the association between educational attainment and F&V intake is similar to that in previous studies - higher educated groups are shown to be more likely to eat the recommended amount of F&V ($\chi^2_{(2)} = 184.654$, $p < .01$). Overall, 22% of the pooled sample said that they ate at least 5 portions a day; 17 and 18% Czech and Spanish respondents, respectively, 21% Latvian and Portuguese respondents, and 32% of British respondents. However, the share of respondents who eat the recommended portions of F&V (or more) vary greatly across education levels. This percentage is lower among the least educated (11–15% and 23% in UK) and higher among the most educated respondents (Tertiary education, 25–29% and 41% in UK). While countries vary in the percentage of people that say that they eat more than 5 portions of F&V a day (from 17% in Czech Republic to 32% in the United Kingdom), the educational differentials are consistent across samples (Fig. 2).

All indicators selected to describe capabilities, opportunities and motivations to eat healthier increase significantly with the levels of education, with the exception of the health value score variable ($p > .05$) (Table 2).

The path analysis was modelled to test the predicted mediation effects between education and F&V intake (details in the Supplementary material). The overall significance of each regression path was tested previously, assessing fitness differences between the estimated models and respective intercept-only model.

No severe infringements of the regression assumptions were observed (Supplementary material, Table A3; Figure A2). All estimated models provide a better fit than the intercept-only models.

Fitness measures indicated a good overall fit to the data (CFI = 0.989, TLI = 0.921; RSMEA = 0.042, IC90%[0.031–0.053], p = .882; SRMR = 0.14). The model with mediation paths provides a better fit than the model with no mediation paths ($\Delta\chi^2_{(12)} = 918.12$, $p < .001$).[4] The estimated coefficients of the direct paths are presented in Table 3. Higher educational attainment levels (secondary and tertiary education in relation to lower secondary) are positively correlated to capabilities (Diet knowledge, Health purchase criteria), opportunities (Financial availability, Social norms), and motivations (Habits strength, Health value score) to eat healthy food, controlling for country, gender, age group and marital status ($p < .001$). Capabilities, opportunities and motivation variables are shown to be positively correlated with the likelihood of eating at least 5 portions of F&V a day ($p < .001$).

[4] Model omitting paths a (education to mediation variables) and paths b (mediation variables to dependent variable): CFI = 722, TLI = 0.611, RSMEA = 0.092, IC90%[0.087-0.097], p = .000, SRMR = 0.014).

Estimated coefficients of the indirect paths are presented in Table 4. All estimated indirect effects are considered statistically significant ($p < .001$). Thanks to the standardization process, the coefficients are comparable and provide information on which pathways present higher correlations with the consumption of F&V. According to these calculations, the education-related advantages in F&V intake in the five European countries are mostly related to financial availability. Higher educated people may have more income available to make healthier diet choices than less educated people, making it easier to access and opt for higher intakes of F&V.

The second and third strongest indirect effects concerns habits and diet knowledge, respectively. Those with higher levels of education are more likely to include F&V in main meals as a habit. They also have increased understanding of healthier diets.

Using health as a criteria when purchasing food, valuing health as a personal value and perceiving social support when opting for healthier diets also significantly contribute to explaining educational inequalities in diets ($p < .05$).

A set of multigroup comparisons by country were conducted (Table 5). Comparing the overall fit between constrained and free models, we find a substantial increase in the overall model fit, suggesting differences across country groups in the regression coefficients ($\Delta\chi^2_{(172)} = 187$, $p < .01$). The systematic comparisons between free and partially constrained models suggest that the relationships in different countries may be considered broadly consistent, though a few factors may be more or less responsible for preference heterogeneity in consumption of F&V across the countries.

Country samples differ only in the effect of education variables on the health value. Regression coefficients by country were consulted to understand this result (details in the Supplementary material, Table A5). Concerning the health value score, the correlation between education variables and health value scores is found to be positive in the Czech Republic (Secondary education: B = 0.28, SE = 0.06, $p < .01$; Tertiary education: B = 0.44, SE = 0.08, $p < .01$), Latvia (Secondary education: B = 0.38, SE = 0.14, $p < .01$; Tertiary education: B = 0.54, SE = 0.14, $p < .01$) and Portugal (Secondary education: B = 0.09, SE = 0.07, $p > .05$; Tertiary education: B = 0.17, SE = 0.08, $p < .05$). The same was not true in the UK and Spain, where health concerns appear to be equal across educational levels, whilst being more socially stratified (and relevant to inequality) across Latvia and the Czech Republic.

Countries do not vary significantly in the regression coefficients concerning the direct impact of education on diets. Education inequalities in F&V intake do not significantly vary across countries ($\Delta\chi^2_{(8)} = 6.564$, p = . 5843). Countries do not differ either in the influence of capability, motivation, and opportunity variables in the chances of eating 5 portions a day (Table 5.).

4. Discussion

The results give further evidence of low intake of F&V in Europe. The majority of people (78%) from five European countries stated that they ate less than the recommended 5 portions of F&V a day. Additionally, the intake of F&V significantly varies according to education level. Tertiary and secondary educated people are more likely to eat the recommended 5 portions in the overall sample and in each country sample. These results are similar to those found in the literature (e.g. Darmon & Drewnowski, 2008; Giskes et al., 2010; Kamphuis et al., 2006; Ridder et al., 2017; Roos et al., 2001), signalling relevant health risks among the general population, and especially among those less educated.

By exploring the multiple theoretical pathways that may potentially be involved in the explanation of educational inequalities in diet, it is possible to highlight key factors related to this behavioural pattern. The most relevant pathways identified in our study concern the three triggers for behaviour change as proposed in the COM-B model (Michie et al., 2011): opportunity (financial availability), motivation (habits) and capability (healthy diet knowledge). This theoretical divide appears

Table 2
Capabilities, opportunities and motivation variables by education level.

			Lower secondary		Secondary		Tertiary		Total	
			N	%	N	%	N	%	N	%
Capability	Purchase criteria	No	1492	70.9	1905	65.8	1572	60.8	4969	65.5
		Yes	611	29.1	988	34.2	1014	39.2	2613	34.5
			M	SD	M	SD	M	SD	M	SD
	Diet knowledge		4.33 [a]	1.24	4.46 [a,b]	1.17	4.72 [a,b]	1.15	4.52	1.19
Opportunity	Financial availability		39.6 [c]	10.5	42.3[c,d]	11.4	47.2 [c,d]	12.4	43.2	11.9
	Social norms		5.70 [e]	1.36	5.75 [f]	1.31	5.87 [e,f]	1.20	5.78	1.29
Motivations	Habit strength		4.49 [g]	1.70	4.61 [g,h]	1.63	4.82 [g,h]	1.59	4.65	1.64
	Health value score		1.17	1.26	1.20	1.19	1.21	1.16	1.19	1.20

Notes. Frequency (N) and relative percentage (%). Mean (M) and standard deviation (SD). Health purchase criteria and Education ($\chi^2_{(2)} = 53.181$, $p < .01$). Pair-wise comparisons (Bonferroni correction) a, b, c, d, e, f, g, h: $p < .05$.

Table 3
Estimated regression coefficients included in the path-model.

Path		Independent variable	Dependent variable	Coefficient	Standard Error
Direct path		Secondary education	5 portions a day	0.138***	0.043
		Tertiary education		0.340***	0.045
Paths a		Secondary education	Purchase criteria	0.175***	0.039
		Tertiary education		0.279***	0.040
		Secondary education	Diet knowledge	0.141***	0.033
		Tertiary education		0.351***	0.035
		Secondary education	Financial availability	3.648***	0.324
		Tertiary education		8.039***	0.326
		Secondary education	Social norms	0.123***	0.036
		Tertiary education		0.206***	0.039
		Secondary education	Habit strength	0.190***	0.046
		Tertiary education		0.357***	0.048
		Secondary education	Health value score	0.157***	0.033
		Tertiary education		0.248***	0.035
Paths b	Capability	Purchase criteria	5 portions a day	0.104***	0.022
		Diet knowledge	5 portions a day	0.179***	0.015
	Opportunity	Financial availability	5 portions a day	0.005***	0.001
		Social norms	5 portions a day	0.042***	0.013
	Motivation	Habit strength	5 portions a day	0.189***	0.010
		Health value score	5 portions a day	0.045***	0.014

Notes. All regressions paths include a set of 8 control variables: gender (male as reference category), age group dummies (50+ years old as reference category), marital status (no partner as reference category), and country dummies (PT as reference category). ***$p < .001$.

to be relevant not only for understanding behaviour change patterns but also understanding behavioural inequalities.

The Theory of Fundamental Causes puts forward a key theoretical framework for health inequalities (Phelan et al., 2010). Within this scope, the concept of flexible resources is crucial. This idea encapsulates how privileged socioeconomic positions correlate with access to multiple resources that facilitate healthier options (Phelan et al., 2010). This foresees the relative importance of particular resources as depending on the specific historical and geographical context even though these advantages persist over time (Phelan et al., 2010). Our approach allows for the comparison of the relative relevance of such resources (or pathways) and provides some clues on the priorities for intervention among European adult populations.

The results suggest that to be more efficient, the design of interventions to decrease diet-related social inequalities and consequent increased health risks should address the different behavioural triggers.

The educational inequalities in F&V intake in the five European countries are mostly related to financial situation. As expected, more highly educated groups have more disposable income than less educated people, which partially explains a higher intake of F&V. In the health inequalities literature, the differentials between social groups in terms of material resources have been identified as relevant pathways for inequalities for decades (e.g., Phelan et al., 2010). People with lower education levels get less qualified jobs, ensuring lower incomes, and therefore restrictions in the food expenditure budget, or a higher exposure to food insecurity risk. Thus, subsidies for F&V could be more helpful for less educated and low-income people. There is a good evidence from plenty of other studies that healthy food subsidies are effective in triggering consumption change (for systematic reviews see Andreyeva et al., 2010; Thow, Downs, & Jan 2014) and may improve the

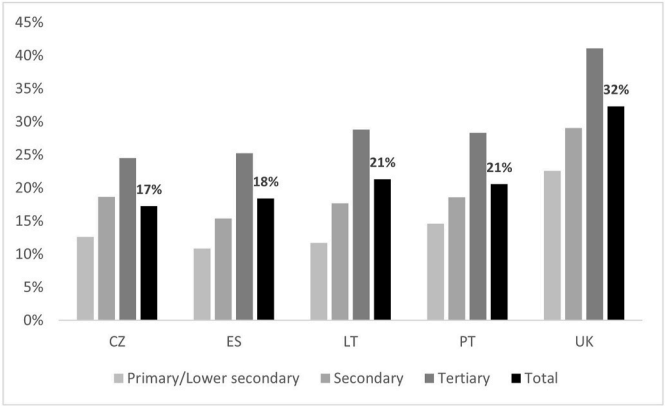

Fig. 2. Percentage of people that declare eating at least 5 portions of fruit and vegetables a day by country and education.
Notes. Czech Republic (CZ), Spain (ES), Latvia (LV), Portugal (PT), United Kingdom (UK).

Table 4
Estimated indirect effects of education on fruits and vegetables intake (5 portions a day) through each mediator in the path-model.

Education variables	Mediators		Coefficient	Sobel(Z)
Secondary education	Capability	Purchase criteria	.004	3.254**
Tertiary education			.006	5.049***
Secondary education		Diet knowledge	.014	3.509***
Tertiary education			.033	8.297***
Secondary education	Opportunity	Financial availability	.051	10.920***
Tertiary education			.056	22.046 ***
Secondary education		Social norms	.003	2.175*
Tertiary education			.005	3.467***
Secondary education	Motivation	Habit strength	.027	3.850***
Tertiary education			.049	4.452***
Secondary education		Health value score	.004	3.105***
Tertiary education			.006	4.705***

Notes. All regressions paths include a set of 8 control variables: gender (male as reference category), age group variables (50+ years old as reference category), marital status (no partner as reference category), and country dummies (PT as reference category). For education variables Primary/Lower secondary education is the reference category. *p < .05, **p < .01, ***p < .001. Standardized indirect effects were calculated as a product of coefficients (Path a) and (Path b), made comparable following MacKinnon and Dwyer (1993).

Table 5
Multigroup comparison (by country sample).

	χ2	DF	Δχ2	DF (Δχ2)	p
Unconstrained model	59.970	15			
Constrained models:					
All regression coefficients equal by country	692.69	187	333.68***	172	0.000
Education regression coefficients on intake equal by country	62.856	23	6.5638	8	0.5843
Education regression coefficients on Purchase criteria equal by country	72.728	23	6.0852	8	0.6377
Education regression coefficients on Diet knowledge equal by country	86.900	23	9.9424	8	0.2691
Education regression coefficients on Social norms equal by country	83.185	23	8.9313	8	0.3481
Education regression coefficients on Habit strength equal by country	70.074	23	8.1198	8	0.4219
Education regression coefficients on Health value score equal by country	91.373	23	16.323*	8	0.0380
Education regression coefficients on Financial availability equal by country	84.607	23	13.717	8	0.0895
Purchase criteria regression coefficients on intake equal by country	63.793	19	3.410	4	0.492
Diet knowledge regression coefficients on intake equal by country	62.987	19	3.056	4	0.548
Social norms regression coefficients on intake equal by country	63.063	19	2.902	4	0.574
Habit strength regression coefficients on intake equal by country	65.933	19	5.379	4	0.251
Health value score regression coefficients on intake equal by country	72.112	19	7.497	4	0.112
Financial availability regression coefficients on intake equal by country	61.323	19	2.8507	4	0.583

*p < .05, **p < .01, ***p < .001.

diets of people of lower socioeconomic status (McGill et al., 2015). Nevertheless, we would stress that our model does not predict linear correlations between either education and income or between income and F&V consumption. In our sample, the increase in income translates into greater F&V consumption growth all the while the level of income increases. The efficacy of healthy food subsidies may be constrained (counterintuitively) among more deprived people.

Studies on consumer stratification and profiling have signalled such a complex interplay. Low F&V intake profiles are socially heterogeneous (e.g., Bertail & Caillavet, 2008; Raaijmakers, Sijtsema, Labrie, & Snoek, 2018). In addition, studies have also reported profiles of lower-income consumers with medium and high F&V consumption (e.g. Raaijmakers et al., 2018) or with profiles of lower-income consumers who are particularly insensitive to economic incentives (e.g. Bertail & Caillavet, 2008). Lower financial availability may be more relevant for F&V access in some social groups than others. Most studies (ours included) do not consider, for example, the role of subsistence farming or family's budgeting strategies in the access to and domestic availability of fresh food among lower income groups. This may confound the results while also providing clues for intervention (e.g. Tharrey et al., 2019). Therefore, this requires the consideration of multiple strategies to ensure positive results across the income spectrum.

Habit strength is the second most influential factor that explains educational inequalities in F&V intake. More highly educated people are better able to combine the consumption of F&V in a main meal. To promote better diet habits among the less educated it is important to intervene in the contexts where people consume their main meals in order to establish the inclusion of F&V as a default choice (Gardner, 2015). This resonates with the "nudge" approach that intervenes in the contextual features surrounding habits in order to steer human behaviour towards better options (e.g. Thaler & Sunstein, 2008; Evans & Stanovich, 2013; Vecchio & Cavallo, 2019). Our data suggest that the automatic route in the decision-making process in meals contributes to the disadvantage of people with lower educational resources. Therefore, interventions where people make decisions related to diets, may prioritize targeting lower socioeconomic class neighbourhoods. These can include, for example, interventions in school canteens, such as including soup and fruit in all lunch menus; presenting fruit bowls in waiting rooms, meeting rooms, or lunchrooms in schools, social and municipal services; or even visually promote the consumption of F&V where people eat or buy food. Fostering schemes for bundle buy of healthy foods with vouchers (Vecchio & Cavallo, 2019), or regular subscriptions of F&V baskets (Bell et al., 2019), for example, may also ensure that people buy enough fresh F&V to have in their household and so rely less on intentional decision making.

Additionally, interventions should also target the dietary knowledge of people. In our study, the assessment of the healthiness of personal diet served as an indicator of healthy diet knowledge. Less educated people self-assessed as being less knowledgeable as to how to eat healthily which partially explained their lower fruit and vegetable intake. This therefore leads to the recommendation for the tailoring of information campaigns to populations with lower educational resources.

F&V intake promotion campaigns should make clear the advantages of this behaviour and possible action plans based on realistic scenarios

for the target populations (for example, disclosing strategies on how to obtain healthy diets on limited budgets; portraying people eating F&V in workplace settings linked to lower qualified jobs or on typical commuting routes).

Promotional campaigns should be long-term, and require (1) inter sectorial collaboration (industry, retail, NGOs, state, city, etc.), (2) action across the multiple dimensions of behaviour change, (3) clear messages, (4) interactive approaches; and (5) cultural targeting (Rekhy & McConchie, 2014). The accumulated evidence on campaign efficacy should guide and direct the development of these initiatives (e.g., Kothe, Mullan, & Butow, 2012; Rekhy & McConchie, 2014; Ungar, Sieverding, & Stadnitski, 2013).

Educational differences in F&V intakes emerge as very consistent across the countries selected in this study. Despite the national variability in the percentages of people that eat at least five portions of F&V a day, the educational gap in diets are of similar magnitude across samples. These findings do not align with the consulted literature (e.g. EUROSTAT, 2018), possibly due to methodological differences in the assessment of F&V intakes and the social gradient in such intakes.

Overall, our data collected in 2019 suggest a higher consumption of F&V than the 2014 EHIS. In this EHIS, information on F&V intake stems from the frequency of consumption, and correspondingly asking respondents only to specify the number of portions when a person declared eating more than once a day. The data sets are therefore not directly comparable. Additionally, in our study, education differentials are assessed while maintaining gender, age groups, and marital status as constants. These dimensions influence dietary intake and are added to the regression models as controls to return a better understanding of educational inequalities independently of other important factors. One part of the national differences in education differentials may arise from compositional differences in the populations. Future research should address this hypothesis with multilevel models in order to identify and explain country effects on diets.

As in any such case, there are limitations in the approaches deployed in this paper. First, we apply a self-reported short form of food frequency questionnaire (FFQ) to estimate F&V intake. The short form of FFQ we adapted was validated against an extensive FFQ for the UK (Cleghorn et al., 2016). The diet quality of participants is therefore roughly assessed and not based on energy or nutrition intake. Research suggests that the estimate of energy and nutrient intake based on self-reported FFQ experiences bias from multiple factors (Watanabe et al., 2019) – including education, our key variable. Future research should assess whether key explanatory dimensions contributing to education differentials in F&V intakes differ when diets are assessed with other methods.

The operationalization of the dimensions of capability, opportunities and motivation to eat healthily was also constrained by data availability.

The study relied on analysis of a multi-thematic survey that did not include detailed measures for all the concepts involved even though the questionnaire was heavily reliant on indicators tested by previous research and subject to empirical validation by a pilot study. Most measures relied on single items, challenging content validity (potentially not capturing the construct) and reliability assessments (no internal consistency measures) (e.g., Fisher, Matthews, & Gibbons, 2016). This is particularly challenging in the measurement of abstract constructs that potentially hold multiple meanings (e.g. Fisher et al., 2016) – for example, our measure of health score value relies on a single item even though we may assume health means different things to different people (e.g., Raaijmakers et al., 2018) or our measure of social norms that strives to capture global beliefs about the people that are most relevant to them (e.g. Ajzen, 2011; Ham et al., 2015).

The broadness of our scope may compromise the depth of the analysis but nevertheless it can be used to inform future research by highlighting the main dimensions contributing to the educational differentials and is worthy of further exploration. For example, this approach may support future comparative analysis of the different behaviour models that the COM-B model aims to compile.

Additionally, even though the survey samples are designed to collect country representative samples of adult populations, the survey samples did not include people without Internet access with data collection through web-based questionnaires administered by online access panels. Although the Internet coverage is high in all these counties (The internet is available in 95% of British, 86% of Czech and Spanish, 82% of Latvian, 79% of Portuguese households EUROSTAT, 2019), the results are to be understood with caution and making generalizations about the national differences should be done only with reservations.

5. Conclusion

The study examined the educational inequalities in F&V intake in order to contribute to the understanding of pathways to decrease health inequalities in Europe. Building on the COM-B framework (Michie et al., 2011), the association between education and F&V intake is shown to be related to capability, motivation, and opportunity differentials. The most educated people have an increased likelihood of consuming at least 5 portions of F&V a day. The educational gap is mainly explained by factors such as financial availability, diet knowledge and habits in inserting F&V into main meals.

Public health policies need to pay special attention to support less educated people to increase their F&V intake. This can be achieved by targeting key triggers for behaviour change, by combining subsidies for F&V, targeting awareness campaigns and nudge approaches to enable less educated people to change their diets.

Ethical statement

The study resorts to survey data collected by online panel sampling. All participants gave their informed consent.

The study obtained ethics approval in each country where data was collected: ethical Committee from Rsu (Riga, Latvia, 1/21.12.2017), University of Exeter Medical School (Exeter, United Kingdom, RG/CB/CA249); Instituto Universitário de Lisboa (Lisbon, Portugal, 24/2017); University of Alcalá (Alcalá, Spain, CEI/HU/2018/02); Charles University Environment Center (Czech Republic, Prague, 4/2017).

Author contributions

Conceptualization: D.C. & S.M.; Data curation: All authors under I.Z., V.M., & M. Š. supervision; Formal analysis: D.C. & S.M; Methodology: D.C. & S.M; Supervision: S.M.; Writing - original draft: DC; Writing - review & editing: D.C., S.M., I.Z., V.M., M. Š., A.C., C·S., P.M.J., S.G.J., S.Q. and T.T.

Acknowledgements

This work was supported by the European Union's Horizon 2020 research and innovation, by funding of the INHERIT project (www.inherit.eu), coordinated by EuroHealthNet (Grant Agreement No. 667364). The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results. All authors had full access to the data reported in the manuscript. Declarations of interest: none.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2021.105283.

References

Aggarwal, A., Monsivais, P., Cook, A. J., & Drewnowski, A. (2011). Does diet cost mediate the relation between socioeconomic position and diet quality? *European*

Journal of Clinical Nutrition, 65(9), 1059–1066. https://doi.org/10.1038/ejcn.2011.72
Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl, & J. Beckman (Eds.), *Action-control: Springer series in social psychology*. Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-69746-3_2.
Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology and Health, 26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995
Andreyeva, T., Long, M. W., & Brownell, K. D. (2010). The impact of food prices on consumption: A systematic review of research on the price elasticity of demand for food. *American Journal of Public Health, 100*(2), 216–222.
Ball, K., Crawford, D., & Mishra, G. (2006). Socio-economic inequalities in women's fruit and vegetable intakes: A multilevel study of individual, social and environmental mediators. *Public Health Nutrition, 9*(5), 623–630. https://doi.org/10.1079/PHN2005897
Bell, R., Khan, M., Romeo-Velilla, M., Stegeman, I., Godfrey, A., Taylor, T., et al. (2019). Ten lessons for good practice for the INHERIT triple win: Health, equity, and environmental sustainability. *International Journal of Environmental Research and Public Health, 16*(22), 4546. https://doi.org/10.3390/ijerph16224546
Bertail, P., & Caillavet, F. (2008). Fruit and vegetable consumption patterns: A segmentation approach. *American Journal of Agricultural Economics, 90*(3), 827–842. https://doi.org/10.1111/j.1467-8276.2008.01138.x
Black, C., Moon, G., & Baird, J. (2014). Dietary inequalities: What is the evidence for the effect of the neighbourhood food environment? *Health & Place, 27*, 229–242. https://doi.org/10.1016/j.healthplace.2013.09.015
Bowen, D. J., Barrington, W. E., & Beresford, S. A. A. (2015). Identifying the effects of environmental and policy change interventions on healthy eating. *Annual Review of Public Health, 18*(36), 289–306. https://doi.org/10.1146/annurev-publhealth-032013-182516
Boylan, S., Lallukka, T., Lahelma, E., Pikhart, H., Malyutina, S., Pajak, A., et al. (2010). Socio-economic circumstances and food habits in Eastern, Central and Western European populations. *Public Health Nutrition, 14*(4), 1–10. https://doi.org/10.1017/S1368980010002570
Brunello, G., Fort, M., Schneeweis, N., & Winter-Ebmer, R. (2016). The causal effect of education on health: What is the role of health behaviors? *Health Economics* (Vol. 25, (3), 314–336. https://doi.org/10.1002/hec.3141
Canova, L., & Manganelli, A. (2016). Fruit and vegetable consumption as snacks among young people. The role of descriptive norm and habit in the Theory of Planned Behavior. *TPM: Testing, Psychometr., Methodol., 23*(1), 83–97. https://doi.org/10.4473/TPM23.1.6
Claassen, M. A., Klein, O., Bratanova, B., Claes, N., & Corneille, O. (2019). A systematic review of psychosocial explanations for the relationship between socioeconomic status and body mass index. *Appetite, 132*(June), 208–221. https://doi.org/10.1016/j.appet.2018.07.017, 2018.
Cleghorn, C. L., Harrison, R. A., Ransley, J. K., Wilkinson, S., Thomas, J., & Cade, J. E. (2016). Can a dietary quality score derived from a short-form FFQ assess dietary quality in UK adult population surveys? *Public Health Nutrition, 19*(16), 2915–2923, 0.1017/S1368980016001099.
Darmon, N., & Drewnowski, A. (2008). Perspective Does social class predict diet quality ? *American Journal of Clinical Nutrition, 87*, 1101–1117. https://doi.org/10.1093/ajcn/87.5.1107
Eurostat. (2017). Population on 1 January by age group and sex. Available at: https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/database.
Eurostat. (2018). Fruit and vegetable consumption statistics. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Fruit_and_vegetable_consumption_statistics.
Eurostat. (2019). Level of internet access - households [TIN00134]. Available at: https://ec.europa.eu/eurostat/databrowser/view/tin00134/default/table?lang=en.
Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science, 8*(3), 223–241. https://doi.org/10.1177/1745691612460685
Fisher, G. G., Matthews, R. A., & Gibbons, A. M. (2016). Developing and investigating the use of single-item measures in organizational research. *Journal of Occupational Health Psychology, 21*(1), 3–23. https://doi.org/10.1037/a0039139
Gardner, B. (2015). A review and analysis of the use of "habit" in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238
Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity, 9*(102), 1–12. https://doi.org/10.1186/1479-5868-9-102
Giskes, K., Avendaño, M., Brug, J., & Kunst, A. E. (2010). A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults. *Obesity Reviews, 11*(6), 413–429. https://doi.org/10.1111/j.1467-789X.2009.00658.x
Godinho, C. A., Carvalho, J., & Lima, M. L. (2014). Promoting healthy eating: A brief review of research on predictors and interventions. *Transcultural, 4*(1), 39–53.
Hall, J. N., Moore, S., Harper, S. B., & Lynch, J. W. (2009). Global variability in fruit and vegetable consumption. *American Journal of Preventive Medicine, 36*(5), 402–409. https://doi.org/10.1016/j.amepre.2009.01.029. e5.
Ham, M., Jeger, M., & Ivković, A. F. (2015). The role of subjective norms in forming the intention to purchase green food. *Economic Research-Ekonomska Istrazivanja, 28*(1), 738–748. https://doi.org/10.1080/1331677X.2015.1083875
Kamphuis, C. B. M., Giskes, K., de Bruijn, G. J., Wendel-Vos, W., Brug, J., & van Lenthe, F. J. (2006). Environmental determinants of fruit and vegetable consumption among adults: A systematic review. *British Journal of Nutrition, 96*, 620–635. https://doi.org/10.1079/bjn20061896, 2006.
Kothe, E. J., Mullan, B., & Butow, P. (2012). Promoting fruit and vegetable consumption. Testing an intervention based on the theory of planned behaviour. *Appetite, 58*(3), 997–1004. https://doi.org/10.1016/j.appet.2012.02.012
Krieger, N., Williams, D. R., & Moss, N. E. (1997). Measuring social class in US public health research: Concepts, methodologies, and guidelines. *Annual Review of Public Health, 18*(1), 341–378. https://doi.org/10.1177/1359105315576606
Lahema, E. (2010). In W. C. Cockerham (Ed.), *The new blackwell Companion to medical sociology (71-96)Health and social stratification*. West Sussex, UK: Blackwell Publishing Ltd.
Lê, J., Dallongeville, J., Wagner, A., Arveiler, D., Haas, B., Cottel, D., et al. (2013). Attitudes toward healthy eating: A mediator of the educational level-diet relationship. *European Journal of Clinical Nutrition, 67*(8), 808–814. https://doi.org/10.1038/ejcn.2013.110
Leganger, A., & Kraft, P. (2003). Control constructs: Do they mediate the relation between educational attainment and health behaviour? *Journal of Health Psychology, 8*(3), 361–372. https://doi.org/10.1177/13591053030083006
MacKinnon, D. P., & Dwyer, J. H. (1993). Estimating mediated effects in prevention studies. *Evaluation Review, 17*(2), 144–158. https://doi.org/10.1177/0193841X9301700202
McGill, R., Anwar, E., Orton, L., Lloyd-Williams, F., O'Flaherty, M., Taylor-Robinson, D., et al. (2015). Are interventions to promote healthy eating equally effective for all? Systematic review of socioeconomic inequalities in impact. *BMC Public Health, 15*(457), 1–15. https://doi.org/10.1186/s12889-015-1781-7
McLeod, E. R., Campbell, K. J., & Hesketh, K. D. (2011). Nutrition knowledge: A mediator between socioeconomic position and diet quality in Australian first-time mothers. *Journal of the Academy of Nutrition and Dietetics, 111*(5), 696–704. https://doi.org/10.1016/j.jada.2011.02.011
Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6*(1), 42. https://doi.org/10.1186/1748-5908-6-42
Mulder, B. C., De Bruin, M., Schreurs, H., Van Ameijden, E. J., & Van Woerkum, C. M. (2011). Stressors and resources mediate the association of socioeconomic position with health behaviours. *BMC Public Health, 11*(798), 1–10. https://doi.org/10.1186/1471-2458-11-798
Naska, A., Vasdeki, V.G. S., Trichopoulou, A., Friel, S., LeonhaÈuser, I.U., Moreiras, O., et al Fruit and vegetable availability among ten European countries: How does it compare with the 'five-a-day' recommendation? British Journal of Nutrition, 84(4), 549-556.
Park, C. L., Cho, D., & Moore, P. J. (2018). How does education lead to healthier behaviours? Testing the mediational roles of perceived control, health literacy and social support. *Psychology and Health, 33*(11), 1416–1429. https://doi.org/10.1080/08870446.2018.1510932
Pechey, R., Jebb, S. A., Kelly, M. P., Almiron-Roig, E., Conde, S., Nakamura, R., et al. (2013). Socioeconomic differences in purchases of more vs. less healthy foods and beverages: Analysis of over 25,000 British households in 2010. *Social Science & Medicine, 92*(100), 22–26. https://doi.org/10.1016/j.socscimed.2013.05.012
Pechey, R., & Monsivais, P. (2016). Socioeconomic inequalities in the healthiness of food choices: Exploring the contributions of food expenditures. *Preventive Medicine, 88*, 203–209. https://doi.org/10.1016/j.ypmed.2016.04.012
Phelan, J. C., Link, B. G., & Tehranifar, P. (2010). Social conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior, 51*(1_suppl), S28–S40. https://doi.org/10.1177/0022146510383498
Raaijmakers, I., Sijtsema, S., Labrie, C., & Snoek, H. (2018). Consumer segmentation based on health-related motive orientations and fruit and vegetable consumption. *British Food Journal, 120*(8), 1749–1763. https://doi.org/10.1108/BFJ-02-2018-0098
Rao, M., Afshin, A., Singh, G., & Mozaffarian, D. (2013). Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open, 3*(12), 1–16. https://doi.org/10.1136/bmjopen-2013-004277
Rekhy, R., & McConchie, R. (2014). Promoting consumption of fruit and vegetables for better health. Have campaigns delivered on the goals. *Appetite, 79*, 113–123. https://doi.org/10.1016/j.appet.2014.04.012
Ridder, D., Kroese, F., Evers, C., Adriaanse, M., & Gillebaart, M. (2017). Healthy diet: Health impact, prevalence, correlates, and interventions. *Psychology and Health, 32*(8), 907–941.
van't Riet, J., Sijtsema, S. J., Dagevos, H., & de Bruijn, G. J. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*(3), 585–596. https://doi.org/10.1016/j.appet.2011.07.010
Rimal, A., Moon, W., Balasubramanian, S. K., & Miljkovic, D. (2011). Self-efficacy as a mediator of the relationship between dietary knowledge and behavior. *Journal of Food Distribution Research, 42*(3), 1–14.
Roos, G., Johansson, L., Kasmel, A., Klumbiené, J., & Prättälä, R. (2001). Disparities in vegetable and fruit consumption: European cases from the north to the south. *Public Health Nutrition, 4*(1), 35–43. https://doi.org/10.1079/PHN200048
Rosseel, Y., Jorgensen, T. D., Oberski, D., Byrnes, J., Vanbrabant, L., Savalei, V., et al. (2019). Lavaan: Latent variable analysis. Available at: https://cran.r-project.org/web/packages/lavaan/index.html.
Story, M., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health, 29*, 253–272. https://doi.org/10.1146/annurev.publhealth.29.020907.090926
Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.

Tharrey, M., Perignon, M., Dubois, C., Gaigi, H., & Darmon, N. (2019). Opticourses: Promoting healthier food purchases at no additional cost in low-income households. *The European Journal of Public Health, 29*(Supplement_4). https://doi.org/10.1093/eurpub/ckz186.464, 2019.

Thow, A. M., Downs, S., & Jan, S. (2014). A systematic review of the effectiveness of food taxes and subsidies to improve diets: Understanding the recent evidence. *Nutrition Reviews, 72*(9), 551–565. https://doi.org/10.1111/nure.12123

Ungar, N., Sieverding, M., & Stadnitski, T. (2013). Increasing fruit and vegetable intake. "Five a day" versus "just one more. *Appetite, 65*, 200–204. https://doi.org/10.1016/j.appet.2013.02.007

Vecchio, R., & Cavallo, C. (2019). Increasing healthy food choices through nudges: A systematic review. *Food Quality and Preference, 78*(103714), 1–12. https://doi.org/10.1016/j.foodqual.2019.05.014

Verplanken, B., & Holland, R. W. (2002). Motivated decision making: Effects of activation and self-centrality of values on choices and behavior. *Journal of Personality and Social Psychology, 82*(3), 434–447.

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology, 45*, 127–134. https://doi.org/10.1016/j.jenvp.2015.11.008

Watanabe, D., Nanri, H., Sagayama, H., Yoshida, T., Itoi, A., Yamaguchi, M., et al. (2019). Estimation of energy intake by a food frequency questionnaire: Calibration and validation with the doubly labeled water method in Japanese older people. *Nutrients, 11*(7), 1–15. https://doi.org/10.3390/nu11071546, 1546.

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 289–314. https://doi.org/10.1146/annurev-psych-122414-033417

World Health Organization (WHO). (2019). *Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases*. e-Library of Evidence for Nutrition Actions (eLENA). Available at: https://www.who.int/elena/titles/fruit_vegetables_ncds/en/.

World Health Organization (WHO) and Food and Agriculture Organization of the United Nations (FAO). (2005). Fruit and vegetables for health. Report of a Joint FAO/WHO Workshop, 1-3 September, 2004, Kobe, Japan. Available at: http://www.fao.org/3/a-y5861e.pdf.

Zvěřinová, I., Ščasný, M., & Máca, V. (2018). *Barriers and potential for adopting healthier, more equitable and environmentally friendly solutions identified in a five-country survey*. Available online: . (Accessed 1 January 2019).