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Behavioural change box? Applying the COM-B model to understand behavioural triggers that support consumption of fruits and vegetable among subscribers of a fruit and vegetable box scheme

Abstract

Objective

To understand the key mechanisms that support healthy dietary habits promoted by fruit and vegetable (F&V) box schemes, testing relevant behaviour change triggers identified under the COM-B model in an evaluation research study of a Portuguese F&V box scheme (PROVE).

Design

Correlation study with a post-test-only non-equivalent group design based on survey data. The mechanisms underpinning the differences between subscribers and non-subscribers are operationalized as mediation effects. Data availability, theoretical relevance and empirical validation supported the selection and testing of four potential mediators for the effects of subscribing to the box scheme on F&V consumption. These estimations derive from the coefficients of a structural equation model combined with the product coefficient approach and Sobel test.

Setting

The study is part of a wider evaluation study on the impact of the PROVE box scheme on sustainability, health, and equity.

Participants

A sample of PROVE box subscribers (n=294) was compared with a matched subsample of non-subscribers (n=571) in a nationally representative survey.

Results

Subscribing to the PROVE box correlates with an increased probability of eating at least five portions of F&V, irrespective of differences in age, education, and perceived economic difficulties. Diet quality perceptions, and more robustly, the strength of meal habits and household availability were identified as relevant mediators.

Conclusions

The subscription to an F&V box scheme is connected with proximal context that enables the consumption of F&V by ensuring more readily available F&V and better situational conditions associated with healthier meal habits.

Keywords:
Fruits and vegetable, box schemes, behaviour change, COM-B model

Introduction

Eating at least five portions of fruits and vegetables (F&V) a day is associated with a lower risk of coronary heart diseases and some types of cancers [1]. However, the majority of people in European countries do not comply with these dietary guidelines [2]. Understanding the behavioural triggers that support the regular intake of fruit and vegetables is, therefore, a public health issue of great relevance to national and international health priorities.

Recent research suggests that some purchase modalities (e.g. box schemes, farmers markets, cooperatives) may be more helpful in promoting healthier and more sustainable diets than others [3,4]. Farm to table delivery programs, known as "box schemes", are growing across Europe and North America, innovating the distribution and marketing of fresh produce while mostly relying on Community-Supported Agriculture (CSA) projects, cooperatives or other farmer networks [5,6]. These models typically ensure the regular provision of baskets of fruits and vegetables to consumers, based on a paid subscription fee to farmers that enables them to count on a stable stream of financial assets (sales or pre-sales) to their farming business [5,7,8,9]. Many such schemes rely on CSA initiatives that ensure not only a direct link between farmers and consumers but also the sharing of the risks related to the production process. Previous studies have mostly focused on the economic, social, and environmental benefits of F&V boxes [5]. Only recently have the implications of these new purchasing modalities on diets and health been explored in the literature [10].

Overall, subscription of these options has been linked with a higher consumption of fruit and vegetables [8]. The reported effects have relied on pre-post [10,11,12], cross-sectional [13,14] and qualitative research designs [7,15]. From the consulted literature, the most robust evidence comes from North American experiences. For example, Cohen and collaborators [10] designed a prospective cohort study targeting individuals affiliated with a seasonal CSA program in New York city, before and after the beginning of the CSA season. The study allowed to compare the changes in food consumption behaviour between the two points in time among active and non-active participants. In comparison with non-active CSA members, active CSA members described a significant increase in servings of F&V and homemade meals before and after the CSA season. More recently, Wilkins et al.[12] assessed the differences in weekly vegetable consumption during a seasonal CSA program cycle (before, after, mid season) among CSA members from a

rural county in New York, finding that the entry in the programme is correlated with increases in vegetable consumption, vegetable exposure and increased vegetable preferences. Also in the United States, a study from the state of Kentucky, compared responses about food lifestyle behaviours and health outcomes pre and post enrolment in a CSA programme. Based on participant recall data, the results suggested positive impacts in dietary behaviour (including average daily fruit and vegetables servings), health, especially among participants with lower perceived health (and reference). Cross sectional studies with consumers enrolled with CSA programs reached similar conclusions [11, 12, 14]. Quantitative and qualitative designs identified perceived changes in dietary behaviours associated with the participation in CSA programs, along with other benefits such as freshness, affordability or diversity of the food accessed [8, 12, 15, 16, 18]. Beyond the benefits related to diets and food, CSA participants also value benefits of the program to farmers' revenue as well as social and environmental impacts of food consumption [e.g. 7, 12, 15, 16]. Additionally, although program subscribers tend to belong to a specific population group, i.e., more educated, affluent and concerned both about their health and about sustainability [6], the literature does report on some successful interventions targeting lower socioeconomic individuals and communities [16,17,18], enabling physical and monetary access to box schemes from CSA programs by families with lower socioeconomic position.

While some studies discuss plausible mechanisms for explaining how the subscription influences dietary behaviour, such as vegetable exposure and/or purchasing and cooking habits, they do not test the relevance of these explanations. In fact, to our knowledge, very little is known regarding how box scheme programs may influence behavioural triggers for more intake of fruits and vegetables. This study is part of a wider research project – INHERIT (INter-sectoral Health and Environment Research for InnovaTion) – that evaluates practices that aim to promote healthier and more sustainable behaviours by modifying contexts to enable behavioural change [19]. Within this scope, we selected the PROVE box subscription program for its potential to shape proximal food environments. Box delivery enables consumers to gain access - weekly or biweekly, accordingly to the user choice - to boxes of fruits and vegetables from local farmers, enabling a higher consumption of fruit and vegetables and less meat-centric diets than non-subscribers [13]. In this study, we explore the key pathways that account for the higher likelihood of fruit and vegetable intake levels among PROVE box subscribers.

The PROVE subscription program is a Portuguese 'box scheme' for local F&V. The program delivers to different locations across the country and is accessible on-line through its website. PROVE subscriptions constitute a variation of community-supported agriculture programs as it provides farmers with access to local networks for the direct selling of weekly subscription boxes of fresh produce. In turn, participating farmers ensure the provision of boxes of seasonal, locally produced fruits and vegetables all year round. The boxes come with a predetermined weight and contain three to five varieties of fruits and vegetables. The composition of the boxes depends on season and availability yet, the share of vegetables and fruits is the same, with a third each of soup vegetables, salad vegetables and fruits of 2 or 3 varieties, as set out in the PROVE handbook for farmers. Also, farmers are prepared to customize the basket depending on consumers preferences - consumers can replace up to 3 F&V varieties. Consumers commit to paying for the boxes, which they can either pick up from a pre-determined location or have home-delivered and are in direct contact with farmers. PROVE is a decentralized project and each local group is self-managed and can define different functioning rules. Overall, there is no minimum commitment for consumers and typically a phone call is sufficient to upgrade or downgrade the order with no penalization. Still, being a PROVE subscriber entails a regular purchase of in season F&Vs.

Following the principles of retrospective process evaluations, this study tests a set of theory-based, hypothesised mechanisms in order to better understand the components that make these programs a promising way to enhance dietary practices [20]. Although our design cannot establish causality between participation in the program and F&V intake, it can help to disentangle relevant explanations associated with higher consumption among PROVE users. The hypothesised mechanisms are derived from the COM-B model [21,22]. According to this model, any given behaviour occurs when individuals have the required physical and psychological abilities to perform that action (Capability), a supportive physical and social context / environment (Opportunity, e.g. regular exposure to fruit and vegetables), and reflective (such as intentions, e.g. intention to follow a recommended diet) or automatic processes (e.g., habits, e.g. routinely ending a meal with a fruit portion) that energise/activate it (Motivation) [21]. This framework served to identify the possible mechanisms underpinning a greater probability of consumption of at least five portions of F&V per day among subscribers of F&V boxes in comparison with non-subscribers.

We intend to clarify the process around how a F&V box subscription may contribute to the probability of eating the recommended amount of F&Vs, by identifying the potentially relevant mediation effects between the subscription (PROVE) and the chances of eating at least five portions of F&V per day (five a day). The analysis was structured into three main sequential steps. First (1), we undertook preliminary studies to select the most relevant indicators of Capability, Motivation and Opportunity as related to F&V intake and available in the INHERIT Five-Country Survey [23] (Table A1, Supplementary materials). Then (2), a structural equation model was developed to estimated regression coefficients needed to (3) estimate and assess the relevance of each mediation effect.

Methods

Participants

The study relies on the data of two non-randomised surveys collected online (the PROVE and INHERIT surveys). The modules common to these two questionnaires apply sociodemographic indicators and key determinants of fruit and vegetable intake levels and healthy eating identified in the literature [28,29,30,27,31,24,32,33,34]. PROVE subscribers are compared with non-subscriber participants in the INHERIT survey of attitudes, preferences and behaviours related to consuming, moving and living. The formulation of the respective items took into account previous studies and was then validated in a pre-study phase [23] – details in Supplementary Materials, Table A1.

The PROVE survey was a self-selecting survey targeted to subscribers based on an online campaign via both the PROVE website, where consumers can check for program updates and baskets composition, and across the social network channels belonging to the PROVE initiative. A chance to win a one-month subscription payment was put forward as an incentive for participating in the study (selected randomly). Data were collected between November 2018 and January 2019 (n=295). PROVE is an ongoing project which entails a flow of users entering and leaving the program. At the beginning of 2018, there were an estimated 4875 active users who were eligible to receive the survey.

The INHERIT Five-Country Survey constitutes one component of an international study on the attitudes, preferences and behaviours related to consumption, mobility and housing [23]. Paid online panels compose the INHERIT Survey sample, targeting representative samples of the adult population of the five countries involved by quota sampling. Data were collected between July and November 2018.

We considered only the Portuguese INHERIT Five-Country Survey sample and selected a subsample from the data available to improve survey comparability. Firstly, this led to the exclusion of a few respondents because they reported buying fruits and vegetables by regular box schemes (based on the question 'where do you buy your fruits and vegetables'). We then selected a subsample according to a propensity score matching procedure (coarsened exact matching) that identified matched cases in both surveys based on key demographic features (gender, age group, education group, region) [35]. For this process, a subsample of PROVE sample is taken as the target sample, considering only full data cases in matched variables (n = 143). Bias treatment-effects were made to assess if samples selection process biased estimation of eating at least 5 portions of F&V a day with endogenous switching regressions. No evidence for sample selection bias was found - reported elsewhere [13].

This procedure led to the selection of a subsample of 571 cases. After combining the databases, the "PROVE" variable served to identify the members of each of the two samples ("subscriber" and non-subscriber). A flow chart on the sampling process is presented (Figure 1).

[Insert Figure 1]

Notes. [1]To ensure data quality, the study only considered individuals that completed the questionnaire and excluded responders both who took less than 40% of the median time for responding and those who took over three times the median response time. [2]Propensity score matching procedure is "*a statistical technique in which a treatment case is matched with one or more control cases based on each case's propensity score*" to reduce selection bias (35, p. 1). The procedure was generated by R software and the Matchit package, using testing alternative techniques. The final selection was based on the Coarsened Exact Matching technique, since it ensured better results in terms of reducing the propensity scores between samples [13]. [3]PROVE reference sample is a subsample composed by the cases with full data on the matching variables - gender, age group, education group, and region (N = 143).

Measures

F&V intake

A standardised 15 items for the Self-Reported Food Frequency Questionnaire (Food Frequency Questionnaire, FFQ) served for the collection of dietary information [36,23]. The frequency of consumption for each food group was asked about on separate screens complemented by visual depictions of a typical portion. Respondents were asked to indicate how often they consume fruits and vegetables separately (9-point Likert scale). The daily portions of fruits and vegetables were estimated on the basis of the conversion table adopted by the authors [36]. The final variable resulted from the sum of daily portions

of fruits and vegetables recoded as a dichotomous variable (Five a day: less than 5 portions a day; 5 or more portions a day).

COM-B mediation variables

The selection of potential explanatory variables was based on data availability, their theoretical relevance and empirical validation criteria. The relevant variables established in the literature on the determinants of diet and diet change [24,25,26,27] were identified in the survey – details in the Supplementary materials (Table A1, Supplementary materials). The variables individually correlated with F&V irrespective of selected control variables (Tables A2 – A6, Supplementary materials) were considered as potential mediations.

In line with the literature, indicators for knowledge and self-regulatory skills were considered for assessing capability [24]. For motivation, indicators designed to assess behaviour intention (to follow a recommended diet – including the intake of 5 F&V portions per day), values (health, sustainability, social justice) and habits, were considered [37,38]. For opportunity, indicators describing social and physical features of proximal context [34,31,28], were considered, including indicators concerning social norm for healthy eating, F&V household availability, or perceived impact of higher higher affordability and accessibility (distance from store) to fruits and vegetables in stores, restaurants and public places on diet change.

From the initial set, the following four variables were selected as potential mediators: diet quality perception, strength of habit of consuming fruit after meals, strength of habit of consuming dessert after meals, and F&V home availability index.

The diet quality perception variable addresses the capability domain of the COM-B model and assesses individual perceptions of how healthy their diet is on a scale of 1-7 (from 1, very unhealthy, to 7, totally healthy, in response to the question: how healthy do you think your diet is?), here taken as a proxy for knowledge on healthy eating.

Habits, in turn, concern the motivation domain and are defined as “a process by which a stimulus automatically generates an impulse towards action” [27]. In order to understand motivation for behaviour change, it is important to consider healthy and unhealthy habits interactions [38]. Habits refer to contextualized-learned associations in which given situational cues would suffice to (automatically) start the behaviour without any deliberate decision to do so [27], for example, serving a salad portion with the meal when the bowl is on the table. Our study measured the strength of two habits based on an adapted short version of the Self-Reported Habit Index [39], considering the habitual intake

(i) of fruits and/or vegetables (F&V habit assessed conjointly) and (ii) of desserts with main meals. Each habit strength score was computed by calculating the average score of six items, assessed on an agreement scale for three sentences concerning the lunch and dinner situation ("Eating fruits or vegetables/dessert at lunch/dinner time on weekdays is something that .... I do without thinking; ... is natural for me to do; ... I do automatically"). Both measures demonstrated good internal consistency scores (fruit after meals Cronbach's Alpha = .913; dessert after meals, Cronbach's Alpha= .919).

Finally, the physical availability of fresh fruits and vegetables was measured by the household availability scale originally adapted from the Home Food Assessment tool [40]. The score was computed by averaging three items that assessed the frequency of fresh fruit or vegetables available in the household, ready for consumption and visible at home on a scale from 1 to 7 (Cronbach's Alpha=.971).

Control variables

A set of sociodemographic variables were considered as control variables, specifically gender (female), age group (18-34 years old, 35-50 years old, 50+ years old), perceived economic difficulties (no difficulties, some economic difficulties) and education group (primary/lower secondary, upper secondary, tertiary). Education group is defined following the International Standard Classification of Education designations. The first category encompasses people with primary and lower secondary education (in Portugal, lower secondary education corresponds to full "basic" education, ending after 9 years of schooling); the second category encompasses people with upper secondary, ending after 12 years of schooling in Portugal; tertiary education refers to college degree education.

Analysis

The analytical process was structured into three main steps. First, we undertook preliminary studies to select the most relevant indicators of Capability, Motivation and Opportunity as related to F&V intake and available in the INHERIT Five-Country Survey. These included descriptive, correlational and regression studies (Table A1, Supplementary materials). The variables individually correlated with F&V irrespective of our selected control variables were selected as potential mediators (Tables A2 – A6, Supplementary materials).

The second step concerned the estimation of the direct and mediated effects of a PROVE subscription in eating at least 5 portions of F&V a day. This included calculating

the structural equation model that incorporated the variables selected as mediators – the model accordingly includes paths concerning the effects of a PROVE subscription on the potential mediators and their respective effects on F&V intake levels. The initial model was adjusted by deleting non-significant paths and assessing the modification indices. This estimated the regression coefficients and fitness statistics according to the Lavaan package in R [41], based on robust estimations.

All the paths included the same set of control variables. The initial path included five equations (four predicting each potential mediator and one for F&V intake) and six correlation associations (pairwise correlations among all the potential mediators). In order to better adjust the model to the data, we then deleted the non-statistically relevant paths ($p>.05$). The final version of the structural equation model incorporates 842 cases due to missing dealing procedures (listwise) and estimates five regression equations and five correlation relations.

The model goodness of fit was evaluated by the normed $\chi 2$ statistic (χ^2/df), the comparative fit index (CFI), the Tucker–Lewis index (TLI), the standardized root mean-square residual (SRMR), and the root-mean-square error of approximation (RMSEA). As criteria, we considered a good data fit as duly reflected in the following scores: $\chi 2 /df < 3$, CFI>0·90, TLI>0·90, SRMR<0.08, RMSEA $IC_{90\%}$ <0.08, $p<.05$.

The third step involved estimating and statistically testing each potential mediation effect. The mediation effect was estimated by the product of the coefficients approach (the effect the coefficient produces on the independent mediator variable and the coefficient effect of the mediator on the dependent variable), after rendering the coefficients comparable [42]. Finally, a Sobel test was computed in order to assess the statistical relevance of each mediation effect.

Results

The study included a total of 865 participants (571 non-subscribers and 294 subscribers), mostly female (68.5%), aged between 35 and 49 (49.2%), with tertiary education qualifications (66.7%), living in urban settings (93.9%) without any perceived economic difficulties (64.7%) (Table 1). Overall, 39% of the sample consumed at least five F&V a day: 60% among subscribers and 29% among non-subscribers. PROVE baskets serve households of singles and couples (27%), three people (30%) and four or more people (33%). A wide variety of subscription times in the program was observed

among responders (from only a few months up to 12 years), while the average subscription time was 1.5 years. Subscription time in the program (less than 1 year, 1 year, 2 years, more than 2 years) and frequency of basket (weekly, biweekly, monthly, less than monthly) did not influence chances of having at least 5 portions a day of F&V after controlling for socioeconomic variables (Supplementary materials, table A8).

[Insert Table 1]

To confirm whether the differences between subscribers and nonsubscribers remain relevant after controlling for sociodemographic variables (i.e., gender, age, education, perceived economic difficulties), we estimated a regression model for the F&V intake variable (probit models). All the variables showed a relevant statistical effect on the probability of eating at least five portions of F&V a day ($p < 0.05$) (Table 2).

[Insert Table 2]

The coefficients showed that the likelihood of eating at least five portions of F&V a day is lower among younger age groups (in comparison with people aged 50 or over), among lesser educated persons (in comparison with people with tertiary education), and higher among people without any perceived economic difficulties and among PROVE subscribers (Table 3).

[Insert Table 3]

All the variables selected as potential mediators differed significantly between the respective samples ($p <.05$) (Table 3). Subscribers had higher scores for perceived diet healthiness, habit strength regarding the eating of F&Vs at main meals, higher scores of household F&V availability and weaker habits of eating desserts after main meals.

After these preliminary analyses, the structured equation model was estimated. Table 4 presents the final regression coefficients estimated in the path analysis to assess the mediation effects. The model reported a good fit to the data (χ^2/df= 2.60, CFI=.997, TLI=.974, SMRM=.011, $RMSEA_{IC90\%}$= 0.01 - .196, p=.508).

As Table 4 sets out, in terms of the first set of equations (path a), the PROVE subscription correlates with the scores for diet quality perception, diet habit strength and

household availability and is relevant independent of the socioeconomic variables (control variables): subscribing to PROVE interlinks with healthier perceived personal diets, healthier eating habits (stronger habits of eating F&Vs and weaker habits of eating desserts at main meals) and higher household F&V availability scores (the R output is available for consultation in appendix Table A7).

In the F&V intake (path b) calculation results, it is interesting to observe, how in the equation considering the potential mediators, the subscription effect (PROVE) on the five a day variable loses significance (B=.581, p = .166), suggesting a total mediation effect, hence, suggesting the variables introduced explain the differentials between the samples (the PROVE variable) as regards the likelihood of consuming the recommended amount of F&Vs (Table 4).

[Insert Table 4]

The result of estimating each mediation effect derives from the product between the respective coefficients in path a and path b, after these were rendered comparable. Figure 1 depicts these converted coefficients with the significance of the mediation effect coefficients calculated by the Sobel test.

[Insert Figure 2]

Notes.
Direct effects in black (full line arrows). Mediated effects in gray (dotted line arrows).
Direct effect – Paths (a), left side of the figure Paths (b), right side of the figure – regression coefficients made comparable according to MacKinnon and Dwyer (42).
Control variables omitted in the Figure.
*p<.05, **p<.01, ***p<.001.

All the mediation effects emerged as both statistically relevant (Sobel test, $p < .05$). Since mediation effect coefficients are above zero (positive mediation effects), results suggest that the association between the F&V box subscription and a higher intake of F&V is partially explained by the shaping of diet quality perceptions, habits at main meals and on household availability that in turn raises the probability of eating at least five F&V portion per day. The operation standardises the regression coefficients to allow for comparisons between the effects on F&V intake. Among the mediators identified, household availability reports the highest estimate followed by the strength of the habit of eating F&Vs at main meals. These results indicate that the association between the

PROVE subscription and dietary intake mainly arises from the higher availability of F&V in the household and the strength of habit in terms of F&V consumption at main meals.

Conclusion

Eating at least five portions of fruit and vegetables (F&V) per day is an important benchmark for promoting public health nutrition. F&V box subscription programs have already been shown to be associated with higher levels of fruit and vegetable intakes [8] but evidence is still lacking in regards potential explanatory mechanisms. In this study, we tested the potential explanatory factors behind the relatively higher fruit and vegetable intakes among F&V box scheme subscribers. Based on the COM-B model proposed by Michie and collaborators (2011) [21], we were able to identify the main variables that significantly influence this process.

In our study, after controlling the effect of socioeconomic factors, the subscriber advantages in F&V consumption stem from differences in diet knowledge, the strength of healthy habits (fruits and not dessert after main meals) and F&V household availability. Our results demonstrate higher daily F&V consumption among fruit and vegetable box subscribers is mediated by higher perception of diet quality (capability factor), higher habit strength in relation to eating F&Vs and not eating desserts (motivation factor) and the higher household availability of F&Vs (opportunity factor).

F&V availability in the household has been consistently signalled as a key contextual predictor of intake [43,44]. In this sense, F&V basket schemes overcome initial difficulties arising from the lack of availability of fresh food in local grocery stores [45] and place F&V right onto the plates of consumers. In keeping with how habit formation implies consistent exposure to situational cues, it is also plausible that the increased household F&V availability ends up supporting these processes and helps to overcome frequently cited barriers for F&V intake, such as forgetting to eat it [46]. This increase in available fresh food, coupled with an increase in F&V consumption habits and more positive perceptions may constitute an important trigger for change. Diet knowledge also helps support higher F&V consumption among subscribers. The PROVE box scheme and other F&V outlets bring consumers close to farmers, such as farmers' markets, have been linked to consumer awareness of issues such as seasonality and F&V diversity [13]. Building knowledge and understanding about the importance of purchasing and preparing F&V may be an effective intervention for behaviour change [47,48,49].

Overall, the study encountered relevance in three factors in the COM-B model dimensions that convey how higher F&V consumption receives support from both conscious (e.g., diet perceptions) and automatic (e.g., habit strength) individual factors, but also more structural environmental factors (e.g., F&V availability). This result concurs with dual models of information processing [50].

PROVE subscribers tend to be urban female, higher educated, with no economic difficulties - the upper socioeconomic profile has been identified in other consumer studies of these subscribing schemes [6]. Our study seeks to control its effects on the mediation studies, yet the identification of the socio-economic profile may signal a strategy not available or underused among less low resource people and households.

These results contain important practical policy implications and help to strengthen the arguments in favour of F&V basket schemes. By providing the opportunity to increase the availability of fruit and vegetables in households, this type of alternative commercialization scheme may indeed constitute a powerful policy tool for promoting healthier dietary patterns. Considering the importance of diet profiles rooted in socioeconomic disadvantages, one way to upgrade is effect may be broad the social profile of consumers. Promotion campaigns should target those with less privileged socioeconomic backgrounds by ensuring free or affordable options [16,17,18]. To enable less privileged socioeconomic groups to use such schemes requires steps to make F&V box subscription affordable and desirable. Capabilities of diverse groups in the form of familiarity with produce varieties and cooking methods also need to be addressed [55-57].

To foster chances for behaviour change and increase of F&V intake, the programs may be complemented with initiatives that help people integrate different F&V in meals and snacks (capabilities)– addressing reported unfamiliarity and low exposure to F&V variety seasonality in some low socio-economic groups [55-57] – and suggesting tips to include F&V in relevant contexts to make household availability evident (opportunity) and allow healthy habits development (motivation).

This study adds to our understanding of the explanatory factors behind the increased consumption of fruit and vegetables among F&V box scheme subscribers. Nevertheless, the identification of relevant facts was constrained by data availability. The surveys were developed built upon a broad literature review and on indicators tested and validated by previous research. This led to exclusion of some theoretical relevant factors due to operationalization difficulties in a questionnaire format - such as the emotional factors (part of the motivation component, [21]).

Also, taking the correlational nature of the data into consideration, it is not possible to disentangle the causal relationships studied; it may be the case that individuals with previous higher F&V intake levels are those who opt to sign up to these box schemes in the first place. Hence, this requires intervention studies with randomly selected samples in the future to draw firmer conclusions regarding the actual nature of these relationships. Another limitation stems from the subscriber sample registering higher levels of education, fewer economic difficulties and with a greater proportion of women, which all constitute social-demographic variables previously associated with higher levels of F&V intake [51,52,53]. Nonetheless, these were duly controlled for in the estimated regression models in which the tested mediators were able to explain differences in F&V intake over and above these social-demographic predictors. Also, we attempt to compare matched samples from the two surveys, selected with a propensity score matching procedure (Figure 1). Even though missing data hindered a more complete match between the groups, sample heterogeneity effect was studied with endogenous switching regressions that found no evidence for sample selection bias – reported in Craveiro et al. [13].

Based on the behavioural change model "COM-B" it was possible to identify relevant pathways by which a F&V box scheme contributes to F&V intake. Differences in F&V intake levels between subscribers and non-subscribers of PROVE can be attributed to differences in home F&V availability, the strength of meal habits, and perceptions of diet quality, in terms of healthiness. The benefits of such programs should be extended by devising strategies to target low-income households and poor socioeconomic backgrounds [16,17,18], fostering knowledge regarding healthy diets [47], and enabling people to shape proximal environments, in order to associate F&V consumption to relevant meal contexts through making F&V easily accessible, and thereby fostering the development of F&V consumption habits [54].

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Tables and figures

Table 1. Sample description

Variables		PROVE				Total	
		Non-subscriber		Subscriber			
		N	%	N	%	N	%
Gender	Male	256	44.8%	47	16.0%	303	35.0%
	Female	315	55.2%	191	65.0%	506	58.5%
	NR	0		56	19.0%	56	6.5%
	Total	571	100.0%	294	100.0%	865	100.0%
Age group	18-34 years	116	20.3%	51	17.8%	167	19.5%
	35-49 years	276	48.3%	146	51.0%	422	49.2%
	50+ years	179	31.3%	89	31.1%	268	31.3%
	Total	571	100.0%	212	100.0%	857	100.0%
Education level	Primary/lower secondary	91	15.9%	8	2.7%	99	11.5%
	Upper secondary	160	28.0%	29	9.9%	189	21.9%
	Tertiary	320	56.0%	256	87.4%	576	66.7%
	Total	571	100.0%	293	100.0%	864	100.0%
Town	Rural	30	5.3%	18	8.5%	48	6.1%
	Urban	541	94.7%	194	91.5%	735	93.9%
	Total	571	100.0%	212	100.0%	783	100.0%
Economic difficulties	No	302	52.9%	249	88.6%	551	64.7%
	Yes	269	47.1%	32	11.4%	301	35.3%
	Total	571	100.0%	293	100.0%	852	100.0%
Total		571	100.0%	294	100.0%	865	100.0%

Notes. N, Frequency. %, Percentage.

Table 2. Regression coefficients: simple equation

		Five a day	
Independent variables		Beta	SE
Age group	18-34 years old	-.483**	.144
	35-49 years old	-.437***	.115
Education group	Primary/lower secondary	-.723***	.180
	Upper secondary	-.452***	.128
Economic difficulties	No	.207*	.105
PROVE	Subscriber	.754**	.110

Notes. Beta, Unstandardized coefficients. SE, Standard Error.

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

Table 3. Descriptives of potential mediators

	PROVE				T test	
	Non-subscriber		Subscriber			
Variables	M	SD	M	SD	t	p
Diet perception	4.7	1.1	5.0	1.0	3.193***	0.001
Habit strength F&V	4.8	1.7	5.6	1.5	6.816***	0.001
Habit strength dessert	2.7	1.7	2.0	1.5	-6.185***	0.001
Household availability	6.2	1.1	9.4	1.0	42.515***	0.001

Notes. M, Mean. SD, Standard deviation. t, T-test statistics. p, Significance.

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

Table 4. Regression coefficients from path model (N=842)

		Paths a								Paths b	
		Diet Perception		Habit strength F&V		Habit strength dessert		Household availability		Five a day	
Independent variables		Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Age group	18-34 yrs	-.381*	.112	-.451*	.172	-.306	.176	-.465***	.111	-.183	.131
	35-49 yrs	-.235*	.089	-.21	.138	-.307*	.129	-.216*	.090	-.294*	.109
Education group	Primary/lower secondary	-.395*	.114	-.203	.209	.361	.205	-.12	.139	-.522*	.167
	Upper secondary	-.273*	.096	-.135	.140	.455**	.138	-.131	.093	-.282*	.118
Economic difficulties	No	.263*	.080	.33*	.127	.163	.123	.375**	.084	-.031	.098
PROVE	Subscriber	.231*	.087	.912**	.138	-.537**	.139	3.337*	.087	-.581	.166
Mediators	Diet perception									.283***	.044
	Habit strength F&V									.124***	.031
	Habit strength dessert									-.064*	.026
	Household availability									.339***	.044

Notes. Beta, Unstandardized coefficients. SE, Standard Error.

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