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The impact of self-efficacy and implementation intentions-based interventions on fruit and vegetable intake among adults

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This study tested the effect of interventions designed for people who do not eat yet the recommended daily fruit and vegetable intake (FVI) but have a positive intention to do so. Adults ($N = 163$) aged 20–65 were randomised into four groups: implementation intentions (II group), self-efficacy (SE group), combination of II + SE group) and a control group receiving written information on nutrition. Study variables were measured at baseline, post-intervention and at 3-month follow-up. At follow-up, compared to the control group, FVI increased significantly in the II and II + SE groups (1.5 and 1.9 servings per day, respectively). Most psychosocial variables significantly increased compared to the control group, with the exception of SE for vegetable intake (VI). Moreover, at 3-month follow-up, change in FVI was mediated by changes in fruit intake (FI) intention and VI action planning. In conclusion, II interventions were efficient to increase FVI, with or without consideration for the development of SE. Thus, future studies should favour the adoption of this approach to bridge the intention–behaviour gap for FVI.

Keywords: fruit; vegetables; health education; adult; moderation; mediation; implementation intentions

Introduction

Evidence suggests that fruit and vegetable intake (FVI) plays a protective role against major diseases. Indeed, FVI is associated with reduced risk of cardiovascular disease and especially cerebrovascular accidents (Dauchet, Amouyel, Hercberg, & Dallongeville, 2006; He, Nowson, & MacGregor, 2006). It is also associated with reduced risk of certain cancers, mainly of the digestive system (Boffetta et al., 2010; World Cancer Research Fund and American Institute for Cancer Research, 2007). Finally, a higher FVI is associated with lower body weight and fat mass (Buijsse et al., 2009; Davis, Hodges, & Gillham, 2006; Ledoux, Hingle, & Baranowski, 2010).

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However, in spite of the scientific evidence concerning the benefits of FVI, only 11.8% of the French population consumes at least five servings of fruits and vegetables (FV) per day (Escalon, Bossard, & Beck, 2009); respective figures for the USA (Serdula et al., 2004) and Canada (Garriguet, 2009) are 24.6% and 43.7%. Taking into account these previous statistics, it is justified to develop efficient FVI promotion programmes.

Few meta-analyses have reported that interventions among samples of the general adult population that were based on educational group programmes or individual counselling increase the mean FVI by 0.5 servings per day compared to the control group (Ammerman, Lindquist, Lohr, & Hersey, 2002; Pignone et al., 2003; Pomerleau, Lock, Knai, & McKee, 2005). The best results have been obtained among people at risk of illness, but these effects are not maintained over time. These meta-analyses have also indicated that interventions usually demonstrate positive effects on FVI although the clinical impact is considered marginal. Moreover, according to these reviews, most interventions were not theoretically based and consequently did not allow to precisely identify the behaviour change techniques and the psychosocial variables mediating behaviour change.

On this regard, a recent systematic review identified that besides habit and intention, SE was the most consistent factor explaining FVI (Guillaumie, Godin, & Vezina Im, 2010). SE is considered one of the main determinants of behaviour adoption (Bandura, 1997). The concept of SE comes from the social cognitive theory and is concerned with individuals' beliefs in their capability to exercise control over challenging demands and their own functioning. SE has a major role: it determines whether actions will be initiated, how much effort will be invested and how long it will be sustained in the face of obstacles and failures. According to this theory and in reference to Abraham and Michie's (2008) taxonomy, increase in SE can be achieved by means of different behaviour change techniques: to provide instruction, to model behaviour, to prompt barrier identification, to prompt practice and to provide general encouragement (see the taxonomy for the definitions).

Notwithstanding the role of SE, there is increasing evidence suggesting that implementation intentions (II) are an effective technique to translate intention into action (Gollwitzer & Sheeran, 2006). Indeed, intention may not translate into action either because the person does not have a clear idea of what to do or is not able to overcome the perceived or real barriers. Again, in reference to the taxonomy of behaviour change techniques (Abraham & Michie, 2008), II refer to techniques, such as prompting barrier identification and specific goal setting. The particularity of implementation intentions however resides in the explicit formulation if-then plans linking an event (or cue) to an action (e.g. 'If I have a lunch at the cafeteria, then I eat salad' and 'If I don't have time to cook, then I open a can of vegetables').

At this time, it remains unclear which behaviour change techniques are most efficient to provide change in FVI. Concerning IIs, the scientific evidence suggests that significant effects were observed after treatment (Armitage, 2007; Chapman, Armitage, & Norman, 2009; de Nooijer, de Vet, Brug, & de Vries, 2006; Kellar & Abraham, 2005) but not at 3-month follow-up (Jackson et al., 2005). Concerning action and coping plans (a technique similar to II), significant results were obtained at post-treatment (Wiedemann, Lippke, Reuter, Ziegelmann, & Schwarzer, 2009) and at 2-month follow-up (an increase of 0.45 portion; Luszczynska & Haynes, 2009). With respect to SE, a significant increase in FVI from 0.5 to 1.4 servings per day was observed at post-treatment or 4-month follow-up among interventions

aimed at simultaneously increasing SE, knowledge and attitude (Anderson, Winett, Wojcik, Winett, & Bowden, 2001; Campbell et al., 2008; Feldman et al., 2000; Fuemmeler et al., 2006; Langenberg et al., 2000; Marcus et al., 2001; Mosher et al., 2008). The effect of interventions based on SE could be larger (up to 3.4 servings per day at 6-month follow-up) when the number of contacts is high (e.g. 16 meetings; Epstein et al., 2001). FVI computer-based interventions with a focus on SE showed effect sizes but are smaller to those obtained in individual or group-based interventions (Kroeze, Werkman, & Brug, 2006; Oenema, Tan, & Brug, 2005). Finally, it is not known what would be the impact of interventions targeting simultaneously implementation intentions and SE. Only one previous study has tested the effect of combining action plans with the development of SE on FVI, and no further improvement was observed (Luszczynska, Tryburcy, & Schwarzer, 2007).

The goal of this study was to evaluate the efficacy of interventions aimed at increasing FVI at 3-month follow-up among motivated adults. Participants were randomised to one of the four following groups: (1) II; (2) development of SE; (3) II and development of SE (II + SE) and (4) control. The specific objectives of this study were: (1) to determine the impact of each approach (II, development of SE) and their combination on FVI, FI and VI; (2) to identify the moderators of change in FVI, FI and VI and (3) to identify the psychosocial mediators of change in FVI, FI and VI.

Method

Recruitment of participants

Participants were recruited between April and November 2008 by means of advertisements in local newspapers and health services in cities near Paris, France. During a phone interview conducted by a research assistant (15-minute length), the study was described, inclusion criteria were specified and participants were randomly assigned to one of the study groups. Participants were included if they were aged between 20 and 65 and reported eating less than five portions of FV per day. They were screened using a validated questionnaire measuring FVI (Godin, Bélanger-Gravel, Paradis, Vohl, & Pérusse, 2008). Exclusion criteria were living outside the reach of the intervention centres, unavailability during the intervention period and being pregnant or currently planning to get pregnant. There was no exclusion for medical reasons. Participants were blinded to the content of other interventions and randomised using a computer-generated randomisation list to one of the four groups. Ethical consent was obtained from the local university and the database was registered to the French National Commission on Information Technology and Liberties. All participants gave a written informed consent.

It was calculated that the generalised estimating equations (GEE) analysis, with an exchangeable correlation of 0.47 and 0.37 participants per group, would allow to detect a significant group × time effect between four groups with a statistical power of 80% and a $p = 0.05$ (Dahmen, Rochon, König, & Ziegler, 2004). This was based on the mean FVI (2.4 ± 1.68) in the French population and a one-portion increase at post-treatment and follow-up (Guilbert & Perrin-Escalon, 2002).

Interventions

Training of dieticians. All group meetings and face-to-face interviews were led by a trained dietician. A total of 14 dieticians experienced in health education were randomly assigned to an intervention type, blinded to the content of other

interventions, and received a 1-day training. Fidelity of programme delivery was promoted through tape-recording of all sessions, supervision once a week and use of intervention manuals.

Interventions manuals. They were developed following series of focus groups to identify barriers associated with FVI, using the Intervention Mapping framework and were pre-tested (Bartholomew, Parcel, Kok, & Gottlieb, 2006). The general objective of the interventions was to promote eating at least two servings of fruits and three servings of vegetables per day. The content of the experimental interventions was divided into five performance objectives (POs) addressed in four successive weekly meetings: (1) to take the decision to eat at least two servings of fruits and three servings of vegetables per day; (2) to buy enough FV to eat at least two servings of fruits and three servings of vegetables per day; (3) to prepare or cook at least three servings of vegetable per day and (4) to eat at least two servings of fruits per day, and to eat at least five servings of FV during the next 12 months despite obstacles (Table A1). The content of the first meeting was common to the three experimental groups. It was concerned with knowledge, outcome expectations and intention regarding FVI. For that purpose, the behaviour change techniques used were 'providing information about behaviour–health link', 'providing information on consequences', 'prompting self-monitoring of behaviour' and 'prompting intention formation'. In the subsequent meetings, each experimental group was exposed to specific techniques.

For participants in the II group. A total of four face-to-face interviews of 20–30 minutes each were offered. At each meeting (with the exception of the first meeting), the 'prompting barrier identification' and 'prompting specific goal setting' techniques were used. Participants were required to identify the barriers to achieve the POs and then to plan, in detail, how the behaviour or preparatory behaviours would be performed and how the barriers to behaviour performance would be overcome. They formulated and wrote down between two and five II plans in response to each PO. The plans were of two types: 'To do x, I will do y (where, when and how)'; and 'If the situation x arises, then I do y' (Gollwitzer & Sheeran, 2006). No control was implemented to verify if participants took these plans away with them.

For the participants in the SE group. A total of four group meetings of 2 h each were offered with a maximum of 12 participants per group. At each meeting (with the exception of the first meeting), the following techniques were used to increase SE: to prompt barrier identification, to prompt practice, to provide instruction and to provide general encouragement. As this was done in a group setting, it inevitably involved another technique 'to provide opportunities for social comparison'. Participants were required to identify the barriers to achieve the POs, to develop strategies to overcome the barriers and to practice the implementation of these strategies by means of role-playing. Dieticians provided instruction on how to perform the behaviour and used encouragements.

For the participants of the II + SE group. Four two-hour group meetings were offered. The techniques used in the II and the SE groups were combined. First, the behavioural change techniques pertaining to the development of SE were used. Then, participants were required to individually formulate II plans.

For the control group. They received brochures on healthy eating including factual information on FVI: four weekly mailings were sent with a personalised letter. The content of the mailed documents was written without reference to psychosocial theories.

Measures

Variables were measured by means of questionnaires administered to participants at the beginning of the study, at the end of the 1-month intervention, as well as 3 months after the end of the intervention. FVI, FI and VI were measured using a self-reported, reliable and validated questionnaire for obese and non-obese populations; the Pearson correlation coefficient with the FFQ for the mean daily intake was $r = 0.65$, $p < 0.0001$ (Godin et al., 2008). This questionnaire contained 6 items, measuring FVI during a period of 7 days and was expressed as a daily average. Demographic variables included gender, age, height and weight (body mass index), marital status, maternal country of birth, education level and income.

Psychosocial variables were measured separately for two behaviours: 'to eat at least two portions of fruit during the next 30 days' and 'to eat at least three portions of vegetables during the next 30 days'. Variables measured were intention (3 items), SE (between 5 and 6 items), action planning (6 items) and coping planning (4 items; Schwarzer, 2008; Sniehotta, Schwarzer, Scholz, & Schütz, 2005). Habit of eating FV was measured at baseline only (8 items; de Bruijn et al., 2007). For most items, a 5-point Likert-type scale was used (from *Certainly No* to *Certainly Yes*). Psychometric qualities were adequate. All alpha coefficients were above 0.75 and scores for temporal stability (intraclass coefficients) ranged from 0.58 to 0.83, with the exception for FI coping planning (0.47).

Data analysis

Descriptive analyses were first performed to verify the equivalence of the groups on sociodemographic, psychosocial and behavioural variables. Then, the GEE approach with three measurement times (pre-intervention, post-intervention and 3-month follow-up) was adopted to test the impact of the intervention on each of the three dependent variables: FVI, FI and VI. The GEE are considered as an extension of the GLM for longitudinal repeated data providing more efficient and unbiased regression estimates (Liang & Zeger, 1986). In the GEE, the behavioural measure was entered as the dependent variable and group, time and group $\times$ time as the independent variables. Contrast analyses compared the mean increases in FVI, FI and VI between groups. The same approach was used to study the impact of the interventions on psychosocial variables. These analyses were 'complete case analyses', i.e. included only the participants providing complete data at the three measurement times. Finally, an intention-to-treat analysis (baseline observation carried forward) was also performed on the FVI as the main outcome variable.

As recommended by Aiken and West (1991), a three-step analysis was conducted to test moderating effects of the intervention. Gender, age and income associated in previous studies with FVI (Kennedy et al., 2005; Tohill, Seymour, Serdula, Kettel-Khan, & Rolls, 2004) and the psychosocial variables at baseline were examined as moderators. The moderating effect was detected if the interaction term was statistically significant and if the explained variance (R^2) significantly increased ($p < 0.05$). If a moderating effect was detected, simple slopes by levels of moderators were generated (at mean − 1 SD, mean and mean + 1 SD).

Finally, mediators of the effect of the intervention were verified. The investigated mediators included intention, SE, action planning and coping planning, respectively, for FI and VI. We used the SAS bootstrap procedure (1000 re-samples) for multiple mediation proposed by Preacher and Hayes (2009) to estimate mediation effect with the 95% bias-corrected bootstrap confidence intervals (CI). In the mediating and moderating analyses, as group was a four-level categorical variable, it was dummy coded taking the control group as reference for comparisons. Moreover, the term 'change' on the behavioural or psychosocial variables was used to refer to the variables adjusted for the baseline level and not to a change score *per se*. Statistical software used for all analyses was SAS version 9.1 (SAS Institute Inc., Cary, NC).

Results

Descriptive statistics

A total of 319 participants were randomised and 28 were excluded (flowchart in Table A2). Among the 291 participants remaining, 218 completed their programme; that is, they attended at least three of four meetings for the experimental groups or received weekly mails in the control group, 192 completed the post-treatment questionnaire and 163 completed both the post-treatment and 3-month follow-up questionnaires. In the final sample analysed ($N = 163$), there were 36, 47, 52 and 28 participants in the II, SE, II + SE and control groups, respectively. Study dropouts were de-briefed, with most reporting lack of time to take part in the study, and lack of interest as a reason for not completing the intervention.

The randomisation check on the study variables indicated a significant difference only for gender ($\chi^2 = 17.4$; $p < 0.001$) although gender was not correlated to baseline FVI ($r's = 0.08$, $p = 0.28$). Individuals who participated only at baseline were compared to those who completed both the post-treatment and follow-up questionnaires. No between group differences were found with the exception for gender and maternal country of birth. Those who did not complete all questionnaires were more often male ($\chi^2 = 4.5$; $p < 0.05$) and, more often, had a mother born abroad ($\chi^2 = 11.78$; $p < 0.001$). Notwithstanding these differences, it is important to note that there was no group difference on these variables at follow-up that is among the final sample analysed ($N = 163$).

Participants at baseline ($N = 291$) were aged between 20 and 65 ($M = 40.8$, SD = 10.6), 85% were women and 22% were obese (i.e. body mass index ≥ 30). Most of the respondents were living as a couple (64%), had completed college education (53%), and one third had a mother born abroad (36%) and earned less than the national median monthly income (33%). Participants reported consuming an average of 3.4 ± 1.54 servings of FV per day, that is 1.85 servings of vegetables (SD = 1.01) and 1.55 servings of fruits (SD = 0.94). Also, the participants reported a

high intention to eat at least three servings of vegetables per day (3.9 on a 5-point scale) and a very high intention to eat at least two servings per day of fruits (4.3 on a 5-point scale).

Effects of the intervention on FVI, FI and VI

The GEE analysis of FVI revealed a significant group × time effect ($N = 163$, $\chi^2 = 15$, $p = 0.02$). Contrast analyses showed that at 3-month follow-up, compared to the control group, FVI increased significantly in the II and II + SE groups (1.5 and 1.9 servings per day, respectively). Regarding the effect of the intervention on FI, the GEE indicated a significant time effect ($p < 0.001$), but a non-significant group - time effect ($\chi^2 = 7.6$, $p = 0.26$). On VI, a significant group × time effect ($\chi^2 = 21.0$, $p < 0.01$) was observed. Contrast analyses showed that compared to the control group, the VI increased significantly in the II + SE group compared to the control and SE groups; it was near significance ($p < 0.06$) in the II group (Table 1). It is remarkable that the GEE analysis of FVI, when carried out by intention to treat, also shown a significant group × time effect ($N = 291$, $\chi^2 = 17$, $p < 0.01$). The contrast analyses also showed that at 3-month follow-up, compared to the control group, FVI increased significantly in the II and II + SE groups ($p = 0.02$ and $p < 0.01$, respectively).

Effects of the intervention on psychosocial variables

Concerning FI, there were significant group × time effects on intention ($N = 163$, $\chi^2 = 14.9$, $p = 0.03$), SE ($\chi^2 = 12.9$, $p = 0.05$) and coping planning ($\chi^2 = 16.8$, $p = 0.001$); action planning was near significance ($\chi^2 = 11.5$, $p = 0.07$). Concerning VI, significant group × time effects were observed for intention ($\chi^2 = 21.0$, $p = 0.001$) and SE ($\chi^2 = 14.3$, $p = 0.03$). Despite significant time effects ($p < 0.001$), no significant group × time effects were observed for action planning ($\chi^2 = 8.3$, $p = 0.22$) and coping planning ($\chi^2 = 9.15$, $p = 0.17$). Means and contrast analyses of the psychosocial variables are reported in Table 2. At 3-month follow-up, compared to the control group, the II and II + SE groups increased in intention, respectively for FI and VI (nearly significant in the II + SE group for VI; $p < 0.06$). For the same period, SE for FI was significantly increased in the three experimental groups, whereas no changes were observed in SE for VI. Finally, compared to the control group, the three experimental groups significantly increased action planning and coping planning (with the exception for VI action planning in the II + SE group).

Moderators of the effects of the intervention

With FVI at post-intervention as the dependent variable, two significant interactions were found between group and the baseline level of FI coping planning and between group and the baseline level of VI action planning. They explained, respectively, an additional 3% and 5% of the variance. The significant interaction terms were II × FI coping planning ($p = 0.01$) and II + SE × VI action planning ($p = 0.01$; group variable was dummy coded; details in Table A3). Participants in the II group with a low level of FI coping planning at baseline showed greater improvement in FVI

Table 1. Means and contrast analyses on mean increase for daily fruit and vegetable intake (FVI), fruit intake (FI) and vegetable intake (VI) at post-treatment and 3-month follow-up per group ($N = 163$).

	M ± (SD) T0	M ± (SD) T1	M ± (SD) T2	Difference T0–T1[a] (*d*)	Difference T0–T2[a] (*d*)	Contrasts on mean increase	T0–T1 *p*	T0–T2 *p*
FVI								
Control ($n = 28$)	3.4 ± 1.3	4.5 ± 1.6	4.2 ± 1.4	1.1 (0.8)	0.8 (0.6)	II vs C	*<0.01*	*0.04*
II ($n = 47$)	3.0 ± 1.4	5.3 ± 2.1	4.4 ± 1.7	2.3 (1.3)	1.5 (0.9)	SE vs C	0.09	0.20
SE ($n = 36$)	3.7 ± 1.7	5.5 ± 2.2	5.0 ± 1.5	1.8 (0.9)	1.3 (0.8)	II + SE vs C	*0.01*	*<0.01*
II + SE ($n = 52$)	3.6 ± 1.6	5.6 ± 1.9	5.4 ± 2.3	2.0 (1.2)	1.9 (0.9)	II + SE vs II	0.44	0.30
						II + SE vs SE	0.57	0.16
FI								
Control ($n = 28$)	1.4 ± 0.8	2.1 ± 0.9	1.9 ± 0.8	0.8 (0.9)	0.6 (0.7)	II vs C	*0.04*	0.17
II ($n = 47$)	1.4 ± 1.0	2.6 ± 1.3	2.2 ± 1.0	1.2 (1.3)	0.9 (0.9)	SE vs C	0.46	0.10
SE ($n = 36$)	1.8 ± 1.0	2.7 ± 1.1	2.8 ± 1.1	0.9 (0.9)	1.0 (0.9)	II + SE vs C	0.45	0.14
II + SE ($n = 52$)	1.7 ± 0.8	2.6 ± 0.9	2.6 ± 1.3	0.9 (1.1)	0.9 (0.8)	II + SE vs II	0.18	0.78
						II + SE vs SE	0.95	0.86
VI								
Control ($n = 28$)	2.0 ± 0.9	2.4 ± 1.0	2.2 ± 1.0	0.4 (0.4)	0.2 (0.2)	II vs C	*<0.01*	0.06
II ($n = 47$)	1.6 ± 0.9	2.7 ± 1.1	2.2 ± 0.9	1.1 (1.1)	0.6 (0.7)	SE vs C	*0.05*	0.80
SE ($n = 36$)	1.9 ± 1.1	2.8 ± 1.4	2.2 ± 1.1	0.8 (0.7)	0.3 (0.3)	II+SE vs C	*<0.01*	*<0.01*
II + SE ($n = 52$)	1.9 ± 1.1	3.0 ± 1.3	2.9 ± 1.3	1.1 (0.9)	1.0 (0.8)	II + SE vs II	0.98	0.12
						II + SE vs SE	0.37	*0.02*

Notes: M = Mean; SD = standard deviation; T0 = baseline; T1 = post-treatment; T2 = 3-month follow-up; C = control group; II = implementation intentions group; SE = development of self-efficacy group; II + SE = implementation intentions and development of self-efficacy group; vs = versus.
[a]Within-group mean difference between T0 and T1 or T0 and T2 and Cohen's *d*.

Table 2. Means and contrast analyses on mean increase for cognitive variables at post-treatment and 3-month follow-up per group ($N = 163$).

	FI intention						VI intention					
	M ± SD T0	M ± SD T1	M ± SD T2	Contrasts	T0–T1[a] *p*	T–T2[a] *p*	M ± SD T0	M ± SD T1	M ± SD T2	Contrasts	T0–T1[a] *p*	T0–T2[a] *p*
Control	44.2 ±0.7	4.0 ± 1.0	4.1 ± 0.7	II vs C	*<0.01*	*0.03*	4.0 ± 0.7	3.6 ± 0.8	3.8 ± 0.9	II vs C	*<0.01*	*0.05*
II	4.1 ± 0.8	4.6 ± 0.5	4.4 ± 0.5	SE vs C	0.08	0.31	3.7 ± 0.9	4.2 ± 0.9	4.0 ± 1.0	SE vs C	*0.03*	0.23
SE	4.4 ± 0.5	4.6 ± 0.6	4.5 ± 0.6	II + SE vs C	*0.03*	0.06	4.0 ± 0.6	4.0 ± 0.8	4.0 ± 0.9	II + SE vs C	*<0.01*	*0.01*
II + SE	4.4 ± 0.7	4.6 ± 0.6	4.6 ± 0.5	II + SE vs II	0.08	0.53	3.8 ± 0.8	4.2 ± 0.7	4.1 ± 0.8	II + SE vs II	0.74	0.87
				II + SE vs SE	0.52	0.45				II + SE vs SE	*0.04*	0.26
	FI SE						VI SE					
Control	3.5 ± 0.8	3.4 ± 0.8	3.3 ± 0.8	II vs C	*<0.01*	*0.01*	3.1 ± 0.9	2.9 ± 0.9	3.2 ± 0.9	II vs C	*<0.01*	0.36
II	3.2 ± 0.9	3.7 ± 0.9	3.6 ± 0.8	SE vs C	*0.01*	*<0.01*	3.1 ± 0.9	3.6 ± 0.8	3.4 ± 1.0	SE vs C	*0.01*	0.40
SE	3.3 ± 0.7	3.7 ± 0.8	3.9 ± 1.0	II + SE vs C	*<0.01*	*0.02*	3.0 ± 1.0	3.4 ± 0.8	3.4 ± 1.0	II + SE vs C	*0.01*	0.70
II + SE	3.6 ± 0.8	3.9 ± 0.8	3.9 ± 0.9	II + SE vs II	0.50	0.80	3.4 ± 0.8	3.6 ± 0.8	3.6 ± 0.8	II + SE vs II	0.13	0.50
				II + SE vs SE	0.90	0.19				II + SE vs SE	0.57	0.55
	FI action planning						VI action planning					
Control	3.7 ± 1.0	3.8 ± 0.9	3.7 ± 1.0	II vs C	*<0.01*	*<0.01*	3.5 ± 1.1	3.7 ± 0.8	3.8 ± 1.0	II vs C	*0.01*	*0.01*
II	3.4 ± 1.0	4.3 ± 0.8	4.3 ± 0.7	SE vs C	0.08	*0.02*	3.4 ± 1.0	4.2 ± 0.8	4.2 ± 0.7	SE vs C	0.14	*0.04*
SE	3.6 ± 0.9	4.1 ± 0.7	4.3 ± 0.6	II + SE vs C	*0.02*	*0.01*	3.3 ± 1.0	3.9 ± 0.9	4.0 ± 0.8	II + SE vs C	0.17	0.17
II + SE	3.7 ± 1.0	4.3 ± 0.6	4.4 ± 0.6	II + SE vs II	0.32	0.46	3.7 ± 0.7	4.2 ± 0.7	4.3 ± 0.6	II + SE vs II	0.11	0.15
				II + SE vs SE	0.51	0.68				II + SE vs SE	0.70	0.34
	FI coping planning						VI coping planning					
Control	3.2 ± 1.0	3.1 ± 0.9	3.3 ± 0.9	II vs C	*<0.01*	*<0.01*	3.1 ± 0.9	3.2 ± 0.9	3.4 ± 0.8	II vs C	*0.01*	*0.04*
II	3.0 ± 0.9	3.8 ± 0.7	3.9 ± 0.9	SE vs C	*<0.01*	*<0.01*	2.9 ± 1.0	3.6 ± 1.0	4.2 ± 0.9	SE vs C	*0.01*	*0.02*
SE	2.8 ± 1.0	3.8 ± 0.8	4.0 ± 0.9	II + SE vs C	*<0.01*	*0.02*	2.7 ± 1.0	3.5 ± 0.9	3.7 ± 1.0	II + SE vs C	*<0.01*	*0.04*
II + SE	3.3 ± 0.9	4.0 ± 0.7	4.1 ± 0.8	II + SE vs II	0.39	0.48	3.1 ± 1.0	3.8 ± 0.8	3.8 ± 0.8	II + SE vs II	0.90	0.79
				II + SE vs SE	0.30	0.10				II + SE vs SE	0.85	0.45

Notes: T0 = Baseline; T1 = post-treatment; T2 = 3-month follow-up; C = control group; II = implementation intentions group; SE = development of SE group; II + SE = implementation intentions and development of SE group; FI = fruit intake; VI = vegetable intake.
[a]Contrasts compare the within-group mean differences between T0 and T1or T0 and T2.
Values in italics have a statistical significance of $p < .05$.

compared to those with a high level of FI coping planning. Also, participants in the II + SE group with a low level of VI action planning at baseline showed greater improvement in FVI compared to those with a high level of action planning. The contrary was observed in the control group: the lower the level of planning at baseline, the lower the increase in FVI (Figure 1). The R^2 changes associated with the interactions were not statistically significant at 3-month follow-up.

Mediators of behaviour change

Multiple mediation analysis examined whether changes in behaviour were explained by changes in psychosocial variables (intention, SE, action planning and coping planning, respectively, for FI and VI; Table A4). At post-treatment, change in FVI was fully mediated by changes in FI intention, coping planning and VI intention (Figure 2 for indirect effects and 95% CI). Group predicted changes in FVI (c path), FI intention, coping planning and VI intention (a path), and changes in these latter variables predicted changes in FVI (b path). At follow-up, change in FVI was mediated by changes in FI intention and VI action planning (Figure 2 for indirect effects and 95% CI; full mediation in the II + SE and SE groups). Group predicted changes in FVI (c path; significant for the II + SE and SE groups), FI intention and VI action planning (a path), and changes on these latter variables predicted changes in FVI (b path).

Discussion

The aim of this study was to evaluate the efficacy of theory-based interventions designed for people who have a positive intention to increase their FVI, but have not yet reached that goal. First, all groups improved their FVI, including the control group. Nonetheless, at 3-month follow-up, compared to the control group, FVI increased significantly in the II and II + SE groups (1.5 and 1.9 servings per day, respectively). This impact was obtained with or without consideration for the development of SE, although a slightly larger increase in FVI was observed in the II + SE group. On the contrary, the SE group did not significantly differ from the control group, even if it responded to the intervention at a level similar to the most efficient published studies based on the same approach and a similar number of meetings (1.3 servings per day; (e.g. Feldman et al., 2000; Fuemmeler et al., 2006). This means that interventions based on implementation intentions demonstrated superiority compared to interventions based on the development of SE.

This study assessed the effect of II plans in face-to-face and group interventions on eating habits. Previous interventions that implemented either II plans or action/coping plans about FVI used planning sheets. As a result, these interventions reported an increase in FVI either at the end of treatment or at 2-month follow-up only (Luszczynska & Haynes, 2009); this latter study reported an increase of 0.45 portions in FVI. In this study, II plans were implemented differently: several plans were formulated for all preparatory behaviours, plans were preceded by an identification of salient barriers and this process was facilitated by a dietician. In this context, II plans were efficient to increase FVI in a clinically meaningful manner at 3-month follow-up. The positive effect of the intervention among the II and II + SE groups is comparable to previously published interventions delivered by

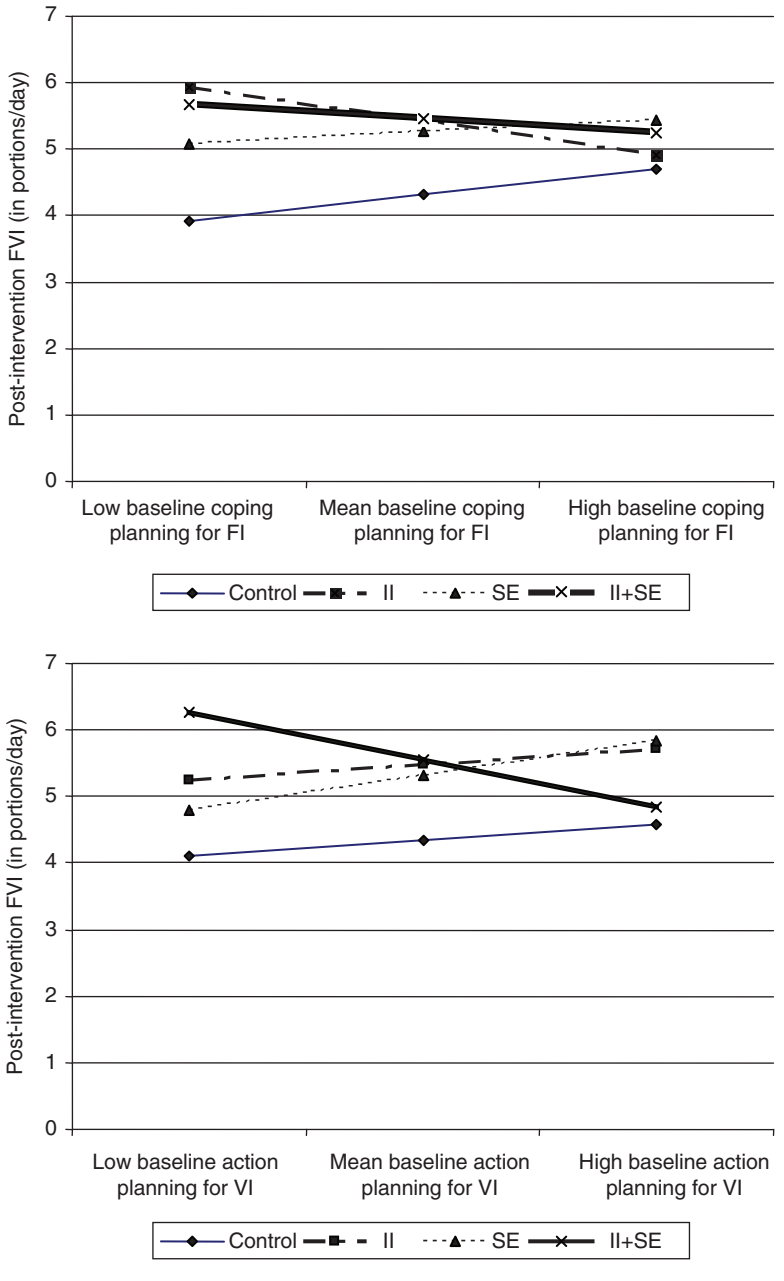

Figure 1. Fruit and vegetable intake at post-intervention by groups and level of coping planning for fruit intake (upper part) and action planning for vegetable intake ($N = 192$). Notes: II = Implementation intentions group; SE = Development of SE group; II + SE = implementation intentions and development of SE group; FVI = fruit and vegetable intake; FI = fruit intake; VI = vegetable intake.

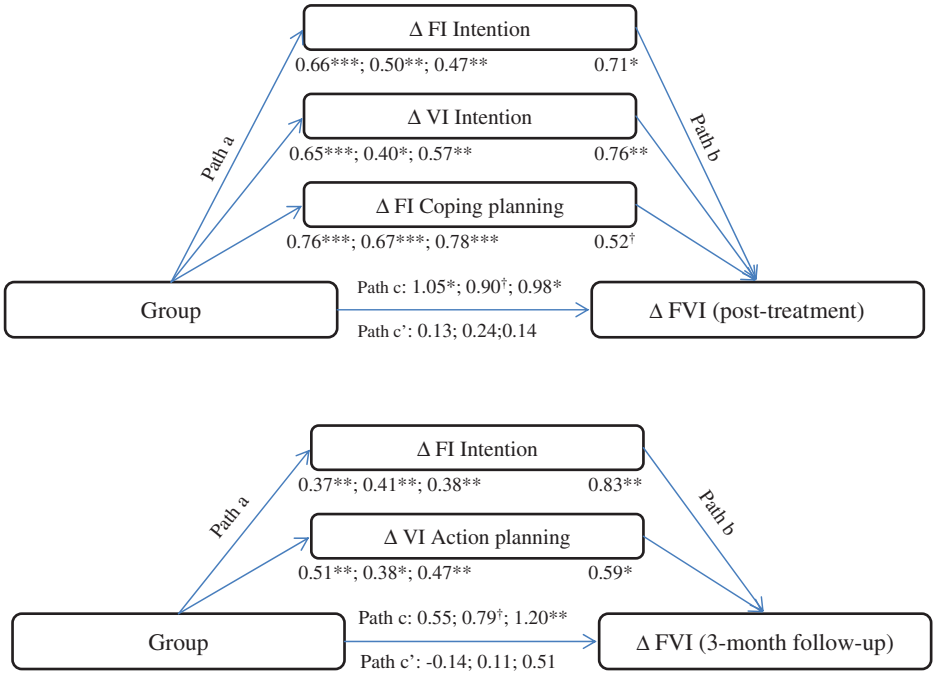

Figure 2. Mediators of the effect of the intervention on FVI at post-treatment (upper part) and 3-month follow-up (lower part) ($N = 163$).
Notes: Only significant mediators are reported. Indirect effects ranged from 0.23 to 0.50 and the 95% CIs did not include zero. Three mediation analysis coefficients pertaining to the dummy coded group variable are provided and referred, respectively, to II, SE and II + SE versus control comparisons. All coefficients are unstandardised.
$^{\dagger}p < 0.06$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

means of individual or group meetings using various behavioural change techniques at a similar intensity (an average of four meetings; e.g. Fuemmeler et al., 2006; Resnicow et al., 2001; Steptoe et al., 2003). In fact, only interventions providing more than eight meetings have reported better effects than the values in our II and II + SE groups (Epstein et al., 2001; Newman, Flatt, & Pierce, 2008). Consequently, this study provides strong support for the efficacy of implementation intentions to promote FVI among an adult population.

Concerning the impact of interventions on the targeted determinants, it was shown that participants in the SE group did not significantly increase their VI SE at 3-month follow-up, while VI action planning and coping planning were enhanced. In fact, the development of SE for VI was not successfully achieved in this study. The higher increase in VI SE was observed in the SE group (0.4 on a 5-point scale) and this increase appeared higher than the values reported in previous studies (Campbell et al., 2008; Fuemmeler et al., 2006; Mosher et al., 2008). Considering that SE is reported as one of the main determinants of FVI, there is an urgent need to investigate which behaviour change techniques and parameters should be used to allow a sustainable increase in FVI SE. In addition, the levels of action planning and coping planning were increased not only by the interventions based on implementation intentions, but also by the interventions based on the development of SE.

In fact, although each of these approaches was based on specific theoretical assumptions, both shared the development and implementation of strategies to adopt the behaviour and to overcome barriers to action.

The effects of the intervention on FVI at follow-up were mediated by changes in FI intention and VI action planning. In the II and II + SE groups, a small-to-medium change in FI intention ($d = 0.45$ [95% CI 0.02–0.9] and $d = 0.33$ [95% CI 0.06–0.7], respectively) and a large change in VI action planning ($d = 1.1$ [95% CI 0.69–1.56] and $d = 0.9$ [95% CI 0.5–1.32], respectively) were responsible for the change in FVI ($d = 0.9$ [95% CI 0.5–1.3] in both groups). The mediating role of intention is in line with most psychosocial theories and a large corpus of studies. It was previously shown that a medium-to-large change in intention ($d = 0.66$ [95% CI 0.51–0.82]) would lead to a small-to-medium change in behaviour ($d = 0.36$ [95% CI 0.22–0.55]; Webb & Sheeran, 2006). The mediating role of action planning observed in this study adds to an emergent but rapidly growing scientific literature. In previous studies, either interventions engendered no change in action planning (Araujo-Soares, McIntyre, & Sniehotta, 2009; Scholz, Ziegelmann, Lippke, & Schwarzer, 2008), or changes in action planning mediated behaviour change (Luszczynska et al., 2007; Wiedemann et al., 2009). Moreover, it was shown that implementation intentions had a medium-to-large effect on goal attainment ($d = 0.65$ [95% CI 0.60–0.70]; Gollwitzer & Sheeran, 2006). Therefore, these findings on the mediating role of action planning confirm the importance of implementation intentions in bridging the gap between intention and behaviour (Gollwitzer & Sheeran, 2006).

It was also shown by the mediation analyses that different variables mediated the effects of intervention on FVI. FI and VI intentions were both involved as mediating variables. However, it was coping planning pertaining to FI and action planning for VI that mediated the effect of the intervention. Two explanations can be offered to explain this difference. First, at the onset of the intervention, participants were almost eating two portions of fruit per day, as recommended ($M = 1.55$, $SD = 0.94$), but were still at some distance from eating the recommended three portions of vegetables per day ($M = 1.85$, $SD = 1.01$). Thus, the target for FI was more attainable than for VI. Second, FI is considered an easier behaviour to adopt, contrary to VI. Indeed, VI is more time consuming, requires more cooking skills and preparatory behaviours, and vegetables are usually consumed in complex contexts (e.g. a family dinner; Aarts, Paulussen, & Schaalma, 1997; Armitage, 2007). Considering the paucity of studies on this issue, it can only be suggested that coping planning may especially mediate behaviour change for easy-to-adopt behaviours while action planning for more complex behaviours.

The responses of the participants in the control group also require attention. Indeed, whereas participants demonstrated no change on psychosocial variables, they increased their daily FVI of 0.8 portions at follow-up. This result is similar to what was obtained in previous interventions that used printed material (Resnicow et al., 2009). Given that the studied population was motivated at the onset of the study, this effect may be due to the fact that they were provided with information on healthy diet and were requested to complete psychosocial and behavioural questionnaires three times. To provide general information as well as to prompt self-monitoring in completing a questionnaire are identified as behaviour change techniques (Abraham & Michie, 2008). To fill a questionnaire on cognitions towards a behaviour is known to have mere measurement effects (Godin, Sheeran, Conner, & Germain, 2008).

Finally, the effect of the intervention on behaviour was moderated by FI coping planning and VI action planning. Indeed, the lower was the baseline level on these variables the higher was the impact of the intervention. This indicates that implementation intentions may be more beneficial for people in need for intervention. To our knowledge, this is the first intervention study to demonstrate the moderating role of these variables.

Limitations

One of the limitations of this study is the small sample size. The concern is that analyses can be heavily influenced by one or two extreme cases. In our study, similar results were obtained when GEE, moderation and mediation analyses were carried out with and without extreme cases. Another limitation is the attrition rate even though there were no between-group differences among participants who returned all questionnaires or not. This could be the result of the lack of felt involvement with the study resulting from the type of contacts (e.g. no face-to-face contacts) with dieticians offering the intervention. However, this potential bias did not negatively influence the effects of the intervention on FVI as showed by the intention-to-treat analysis.

Conclusions

Implementation interventions as implemented in this study demonstrated efficacy to increase FVI in a clinically significant manner at 3-month follow-up in a context where low-income as well as ethnically diverse participants were recruited. Practitioners should therefore consider developing FVI interventions based on this approach among a motivated population. In addition, this study underlined the knowledge gap on the behaviour change techniques allowing reaching a significant and sustainable increase in VI SE. As SE is recognised as a main determinant of FVI, there is an urgent need for additional investigations on this topic. Finally, changes in coping planning and action planning mediated behaviour change. Therefore, this study provides an additional support for adding action planning and coping planning to psychosocial theories such as social cognitive theory or theory of planned behaviour (Schwarzer, 2008). However, relationships between these variables and the variables from these theories should be clarified.

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Appendix

Table A1. Matrix of change objectives.

	Determinants of behaviour				
PO	Outcome expectations	Knowledge	SE	Implementation intentions	Intention
PO 1: to take the decision to eat at least two servings of fruits and three servings of vegetables per day (Meeting 1)	Expect that a low FVI involves health problems Expect that FVI recommendations prevent illness and help to control weight	Cite the definition of one serving Calculate its current daily FVI Cite the daily FVI recommendation Cite the advantages and risks associated with FVI			Formulate intention to eat at least two servings of fruits and three servings of vegetables per day
PO 2: to buy enough FV to eat at least two servings of fruits and three servings of vegetables per day (Meeting 2)			Express confidence in capacity to buy enough FV to eat at least two servings of fruits and three servings of vegetables per day and overcome barriers associated with purchase	Formulate plans on how he/she will buy enough FV and overcome barriers associated with it	
PO 3: to prepare or cook at least three servings of			Express confidence in capacity to prepare at least three servings of vegetables	Formulate plans on how he/she will prepare vegetables and overcome	

(*continued*)

Table 3. Continued.

	Determinants of behaviour				
	Outcome expectations	Knowledge	SE	Implementation intentions	Intention
PO vegetable per day (Meeting 3)			per day and overcome barriers associated with vegetable preparation	barriers associated with vegetable preparation	
PO 4: to eat at least two servings of fruits per day (Meeting 4)			Express confidence in capacity to eat at least two servings of fruits per day and to overcome barriers associated with fruit intake	Formulate plans on how he/she will eat fruits and overcome barriers associated with fruit intake	
PO 5: to eat at least five servings of FV the next 12 months despite obstacles (Meeting 4)			Express its confidence in capacity to eat at least five servings of FV over the next 12 months and to overcome obstacles associated with it	Formulate plans on how he/she will eat at least five servings of FV over the next 12 month and overcome barriers associated with it	

Table A2. Flowchart of participants.

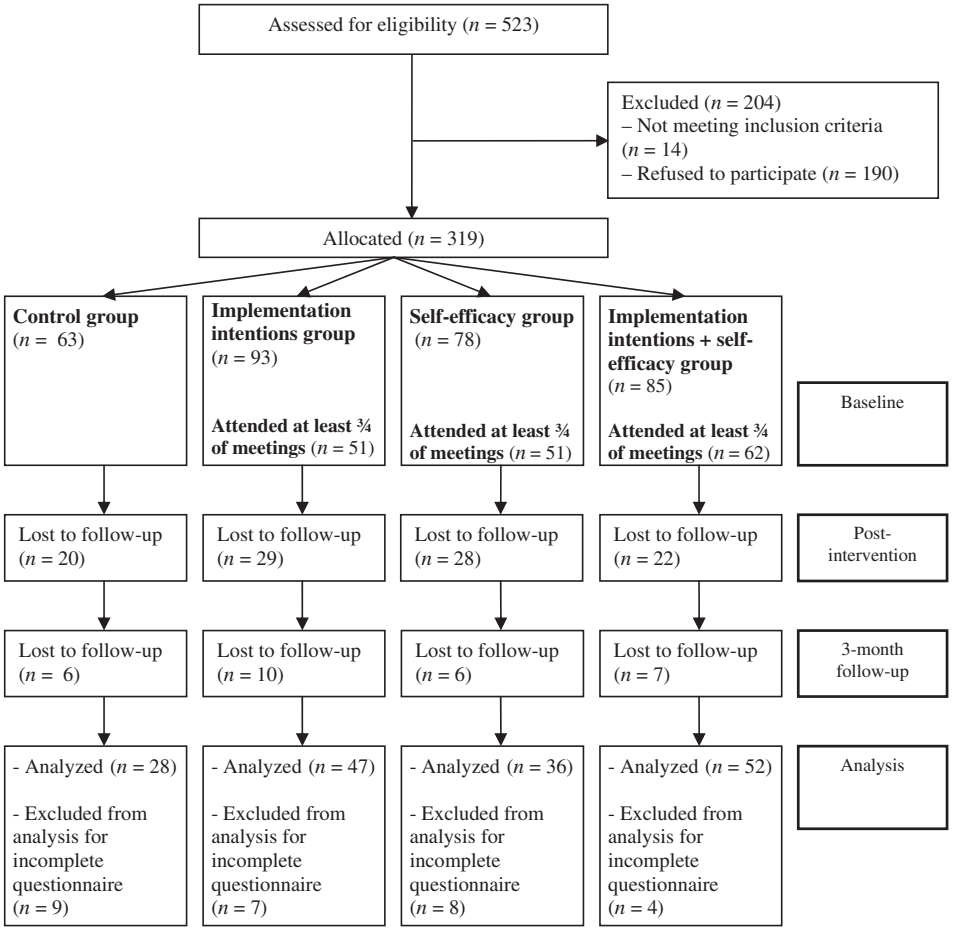

Table A3. Moderating effects of the impact of the intervention ($N = 192$).

Steps and variables	*B*	SE *B*	*p*	95% CI	R^2
Step 1					
Baseline FVI (covariate)	0.51	0.09	<0.001	0.35, 0.69	
II	1.13	0.39	0.004	0.36, 1.89	
SE	0.86	0.42	0.04	0.04, 1.68	
II + SE	1.09	0.39	0.005	0.33, 1.85	
FI coping planning (moderator)	−0.07	0.15	0.62	−0.36, 0.21	0.20
Step 2					
II × FI coping planning	−0.96	0.39	0.01	−1.74, −0.19	
SE × FI coping planning	−0.23	0.41	0.57	−1.04, 0.57	
II + SE × FI coping planning	−0.67	0.40	0.11	−1.44, 0.16	0.03*

(*Continued*)

Table A3. Continued.

Steps and variables	*B*	SE *B*	*p*	95% CI	R^2
Step 1					
Baseline FVI (covariate)	0.49	0.09	<0.001	0.31, 0.66	
II	1.13	0.39	0.004	0.37, 1.90	
SE	0.91	0.41	0.03	0.09, 1.73	
II + SE	1.06	0.39	0.007	0.30, 1.83	
VI action planning (moderator)	0.11	0.15	0.44	−0.17, 0.40	0.21
Step 2					
II × VI action planning	0.00	0.37	0.99	−0.73, 0.73	
SE × VI action planning	0.31	0.40	0.44	−0.48, 1.10	
II + SE × VI action planning	−1.00	0.41	0.01	−1.81, −0.20	0.05**

Notes: CI = Confidence interval; FI = fruit intake; VI = vegetable intake.
Group variable was dummy coded taking the control group as reference for comparisons.
*$p = 0.06$; **$p = 0.01$.

Table A4. Correlation matrix among psychosocial and behavioural variables at baseline for fruit intake (upper part) and vegetable intake (lower part) ($N = 163$).

Pertaining to fruit intake	Intention	SE	Action planning	Coping planning	Habit	Fruit intake	Fruit and vegetable intake
Intention	1.00						
SE	0.40***	1.00					
Action planning	0.37***	0.33***	1.00				
Coping planning	0.19*	0.31***	0.59***	1.00			
Habit	0.28***	0.22**	0.26***	0.32***	1.00		
Fruit intake	0.41***	0.27***	0.25**	0.21**	0.41***	1.00	
Fruit and vegetable intake	0.39***	0.29***	0.24**	0.27***	0.59***	0.77***	1.00
Pertaining to vegetable intake	**Intention**	**SE**	**Action planning**	**Coping planning**	**Habit**	**Vegetable intake**	**Fruit and vegetable intake**
Intention	1.00						
SE	0.57***	1.00					
Action planning	0.39***	0.37***	1.00				
Coping planning	0.31***	0.39***	0.60***	1.00			
Habit	0.18*	0.26***	0.39***	0.33***	1.00		
Vegetable intake	0.31***	0.30***	0.33***	0.35***	0.51***	1.00	
Fruit and vegetable intake	0.28***	0.24**	0.35***	0.35***	0.59***	0.81****	1.00

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.