


Effects of a nutritional intervention program based on the self-determination theory and promoting the Mediterranean diet

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Abstract

Our objective was to determine gender differences in the impact of a nutritional intervention based on the self-determination theory and promoting the Mediterranean diet on changes in eating-related self-determined motivation and adherence to the Mediterranean diet. Changes in eating-related self-determined motivation were larger in men than in women in response to the intervention and at follow-up, but the magnitude of change decreased with time in both genders. Changes in eating-related self-determined motivation were positively associated with changes in the Mediterranean diet adherence in response to the intervention and at follow-up in men only, suggesting that the nutritional program seems to fit better men than women.

Keywords

eating, eating behavior, education, gender, health promotion, theory

Introduction

A better understanding of the motivation to engage in health behaviors is essential. Up to now the focus has mainly been on the quantitative dimension of motivation (Silva et al., 2008). Deci and Ryan with the self-determination theory (SDT) emphasize the importance of motivation quality (Deci and Ryan, 1985; Ryan and Deci, 2000). In fact, this theory proposes that the regulation of a behavior may take many forms that correspond to different behavioral regulatory styles according to motivation differing by their self-determination level, and which can be differentiated along a continuum. Moreover, according to the SDT, different self-determined regulatory styles are associated with various consequences. In fact, self-determined forms of motivation are associated with positive consequences and least self-determined forms of motivation with more negative consequences. Another key postulate from the SDT addresses the processes that facilitate internalization of non-self-determined regulatory styles toward more self-determined regulatory styles (Deci and Ryan, 1985; Ryan

and Deci, 2000) if supportive conditions are in place, that is, a context that fosters satisfaction of three basic psychological needs which are autonomy, competence, and relatedness. In regard to the regulation of eating behaviors, previous studies showed that behaviors regulated by self-determined motivation promote adoption of healthy eating behaviors and long-term maintenance of healthy eating habits (Pelletier et al., 2004; Williams et al., 2002) and could also be a protective factor against social pressures unfavorable to healthy eating behaviors (Mask and Blanchard, 2011; Pelletier et al., 2004).

Evidence suggests that a person will be more likely to develop and maintain more self-determined motivation in a context that is autonomy-supportive (Deci et al., 1994;

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Williams et al., 2006). Autonomy support refers to eliciting and acknowledging a person's perspectives and values, supporting initiatives, offering options, and providing relevant information while minimizing persuasion and control (Resnicow and McMaster, 2012). Development of autonomy-supportive nutritional approaches aimed to promote self-determined motivation seems promising in the context of prevention of cardiovascular diseases (CVD) since sustained healthy dietary changes can improve many risk factors.

Benefits of the Mediterranean diet (MedDiet) on health is well established in the literature, and the MedDiet is now recognized as one of the best models of food patterns providing protection against chronic diseases, such as CVD (Estruch et al., 2013; Sofi et al., 2013). Although feasibility to adopt the MedDiet principles among non-Mediterranean population has been previously reported, maintenance of dietary changes remains a challenge on the long term (Bemelmans et al., 2000; Goulet et al., 2003) and might be improved by considering motivational factors related to eating regulation.

It has been reported that differences between men and women exist with respect to eating habits (Arganini et al., 2012; Wardle et al., 2004). Therefore, gender differences in motivational factors related to eating regulation need to be examined and considered within nutritional approaches to improve their efficacy. In this sense, gender differences in the level of eating-related self-determined motivation were previously reported, with women reporting higher level of self-determined motivation than men (Leblanc et al., 2015a). However, potential differences between men and women related to changes in self-determined motivation in response to a nutritional intervention based on the SDT remain unknown.

Only few studies examined self-determined motivation in a dietary context. More importantly, none has focused on gender differences in the impact of a nutritional intervention aimed at increasing self-determined motivation. The objective of this study was therefore to determine gender differences in short- and long-term effects of a 12-week nutritional intervention program based on the SDT and promoting the adoption of the MedDiet on changes in eating-related self-determined motivation and in adherence to the MedDiet.

Methodology

Participants

This study was conducted among a sample of 64 men and 59 premenopausal women aged between 25 and 50 years and recruited through different media advertisements in the Québec City Metropolitan area, Canada. In women, a follicle-stimulating hormone (FSH) measurement was performed if needed (e.g. when women presented periods irregularities) to confirm the premenopausal status

(FSH < 20 IU/L) (Landgren et al., 2004). Men and women had to present slightly elevated low-density lipoprotein cholesterol (LDL-C) concentrations, that is, between 3.0 and 4.9 mmol/L (Grundy et al., 2004) or a total-C to high-density lipoprotein cholesterol (HDL-C) ratio ≥ 5 , and at least one of the four following criteria of the metabolic syndrome (NCEP ATP III, 2002): (1) triglyceride concentrations ≥ 1.7 mmol/L, (2) fasting glycemia between 6.1 and 6.9 mmol/L, (3) blood pressure measurements $\geq 130/85$ mmHg, and (4) waist circumference ≥ 80 cm in women and ≥ 94 cm in men (International Diabetes Federation, 2006). Participants also had to have a stable body weight (± 2.5 kg) for a minimum of 3 months prior to the beginning of the study and to be involved in food purchases and/or preparation at home. Men and women who had cardiovascular events and used medication that could affect dependent variables under study, that is, hypertension, dyslipidemia, and diabetes, were excluded. Pregnant women, smokers, participants with an alcoholism history, or with a high Mediterranean score (Medscore > 29, that is, food pattern already highly concordant with the MedDiet) (Goulet et al., 2003) were also excluded. All participants voluntarily agreed to participate in the research project and written informed consent was obtained from all men and women prior to their participation in the study. This study was approved by the "Laval University" Research Ethics Committee. Previous publications using data from those participants examined gender differences in dietary, anthropometric, and metabolic changes (Leblanc et al., 2014; Leblanc et al., 2015b), but did not assess motivational mechanism through which those changes occurred following a nutritional intervention based on SDT within a gender perspective.

Study design

The 12-week nutritional program was based on the SDT. This theory relies on the quality of the motivation that regulates behaviors and lies on a continuum from lower to higher self-determined motivation forms (extending from amotivation to intrinsic motivation) (Ryan and Deci, 2000) (Figure 1). Dietitians who provided the intervention used a motivational interviewing (MI) approach. MI is a practical set of intervention strategies well-developed and field-tested in the context of clinical interventions (Resnicow and McMaster, 2012) and is largely consistent with SDT premises on motivation and lasting behavior change. MI has been used to test SDT constructs (Patrick and Williams, 2012; Vansteenkiste and Sheldon, 2006). The study was conducted into small groups (from January 2010 to November 2012), and the nutritional intervention included three group sessions, three individual sessions, and four follow-up phone calls with a registered dietitian (Figure 2). Three registered dietitians were trained to provide a standardized intervention, and participants always met with the

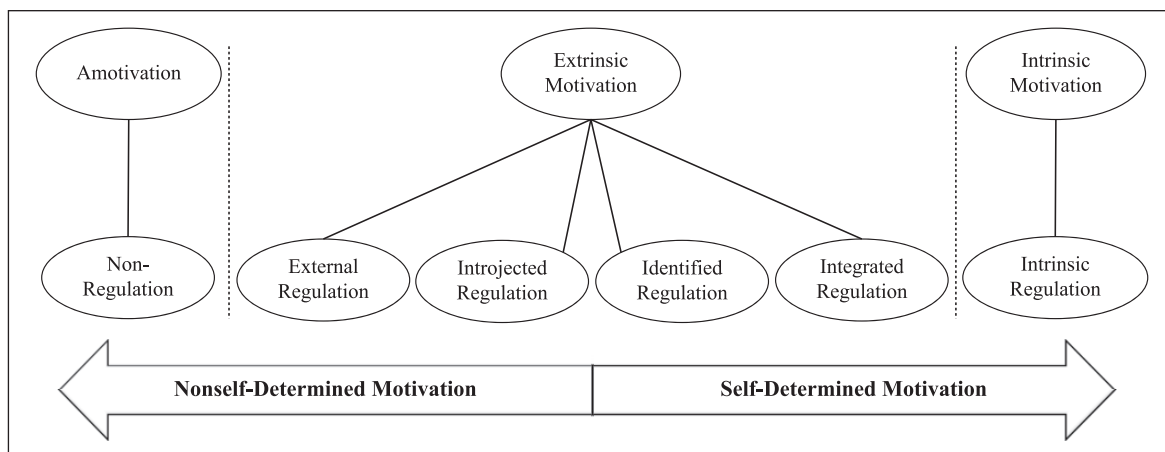


Figure 1. Continuum of the self-determined motivation. Source: adapted from Ryan and Deci (2000).

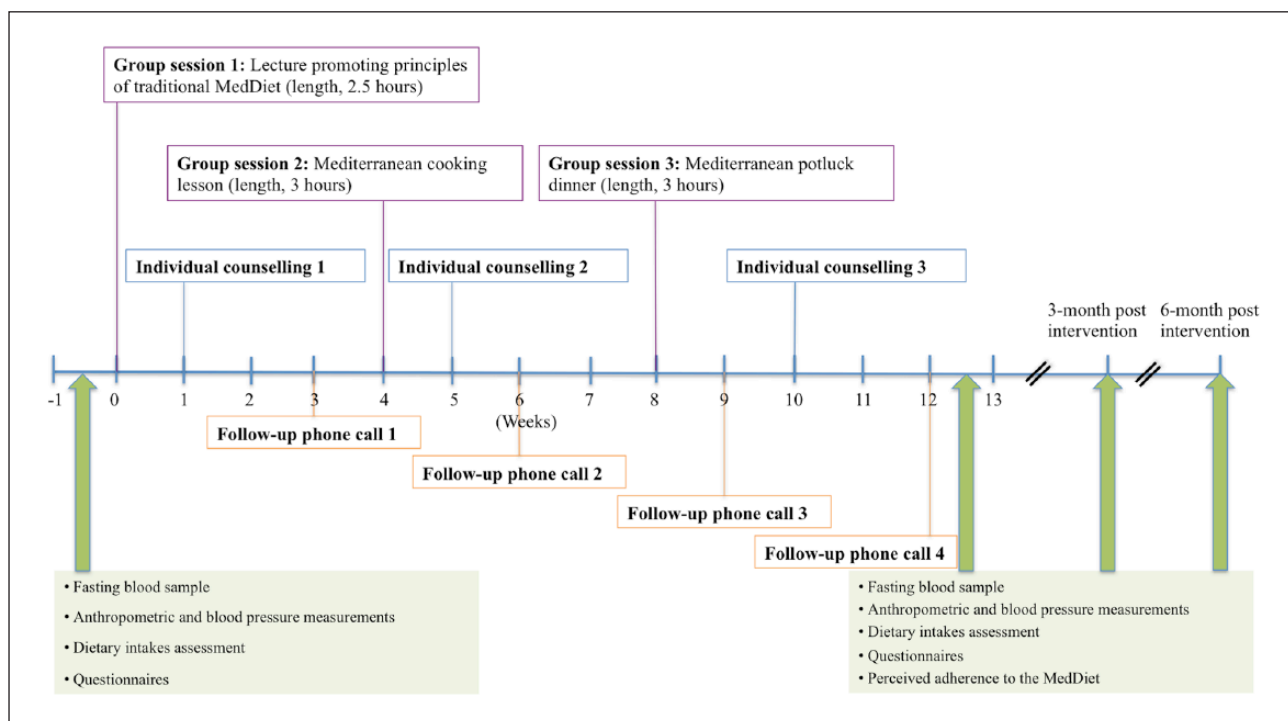


Figure 2. Description of the 12-week nutritional intervention program and measurements performed at baseline ($t=0$), after the end of the intervention ($t=3$ months), and then at 3-month and 6-month after the end of the intervention ($t=6$ months and $t=9$ months, respectively).

same dietitian during individual sessions. The first group session was a lecture, always provided by the same dietitian and aiming at explaining principles of the traditional MedDiet (length: 2.5 hours, $n=13-25$ participants/group). At week 4, men and women actively participated in a 3-hour Mediterranean cooking lesson during which they had to cook a Mediterranean meal ($n=8-14$ participants/group). At week 8, they shared a 3-hour Mediterranean potluck dinner aimed at discussing barriers met in adopting

dietary recommendations since the beginning of the intervention ($n=5-12$ participants/group). Face-to-face individual counseling took place at weeks 1, 5, and 10 and lasted between 45 minutes and 1 hour for each appointment. Individual follow-up phone calls took place at weeks 3, 6, 9, and 12, and each lasted for about 20–30 minutes. The main objective of face-to-face individual counseling and follow-up phone calls was to assess dietary changes and to determine progressive personal goals with potential and

realistic strategies aimed at improving the adherence to MedDiet principles. In accordance with the SDT (Ryan and Deci, 2000), basic psychological needs (i.e. autonomy, competence, and relatedness) were supported during the nutritional intervention in order to increase self-determined motivation. More specifically, competence was promoted during the lecture aimed at increasing nutritional and health knowledge of individuals by presenting key principles of the traditional MedDiet (group session 1), and during the Mediterranean cooking lesson by actively involving individuals in the preparation of different Mediterranean foods and exploring with them different tastes and ways to increase variety in cooking methods, foods seasoning, and so on (group sessions 2 and 3). Autonomy of men and women was promoted as they had to choose their own dietary objectives during individual counseling sessions, the best strategies to reach their objectives, as well as to identify actions to overcome potential barriers related to dietary changes. Men and women were also responsible to choose their own progress speed toward dietary changes during the intervention. Relatedness was fostered by the dietitian during all individual counseling sessions and follow-up phone calls by considering individual's social and family contexts in facilitating factors and barriers toward dietary changes, and also in group sessions by promoting sharing about difficulties and strategies among participants. Different tools congruent with the SDT tenets were used during these sessions to formulate dietary objectives while increasing self-determined motivation. More precisely, the decisional balance allowed assessment of pros and cons of keeping dietary habits stable as well as pros and cons of changing dietary habits. The action plan was used to determine concrete dietary objectives, that is, the starting point for the change, frequency of adoption of the behavior, perceived benefits from the behavior change, main strategies considered to achieve the change, actions planned to overcome barriers, and potential people who would support them into their process of dietary changes. The dietitian had a client-centered approach and put no pressure on participants about the type of dietary objectives to be chosen. In addition, no emphasis was put on body weight control. Men and women were encouraged to maintain dietary changes in an autonomous way at the end of the nutritional program, and there was no additional contact with the dietitian after the end of the 12-week intervention.

Measurements of dependent variables

All measurements were performed before ($t=0$) and after the 12-week nutritional intervention program ($t=3$ months), and then 3 and 6 months after the end of the nutritional intervention ($t=6$ months and $t=9$ months, respectively).

Motivational variables. The regulation of eating behaviors scale (Pelletier et al., 2004) is a 24-item validated

questionnaire that assesses self-determined motivation for the regulation of eating behaviors. Items included in this questionnaire (four items per self-determined regulatory styles) assess intrinsic motivation (e.g. "I like to find new ways to create meals that are good for my health"), different self-determined regulatory styles which are integrated (e.g. "Eating healthy is an integral part of my life"), identified (e.g. "I believe it will eventually allow me to feel better"), introjected (e.g. "I feel I must absolutely be thin"), external (e.g. "Other people close to me insist that I do"), and amotivation (e.g. "I don't know why I bother"). Evaluation of the internal consistency of the subscales revealed to be adequate (Cronbach's alphas ranged from 0.79 to 0.91) (Pelletier et al., 2004). Each item is measured on a 7-point Likert scale, which allows calculation of the self-determination index (SDI) (Vallerand, 1997), specific to eating regulation.

Health care climate. The Health Care Climate Questionnaire is a 15-item validated questionnaire (Williams and Deci, 2001) which assesses clients' perception of the degree to which their practitioner is autonomy-supportive. In our study, the word "practitioner" was replaced by the word "dietitian." Cronbach's alpha reliability for the 15 items of this questionnaire has consistently been above 0.90 (Williams and Deci, 2001). This scale includes three dimensions considered essential for an optimally supportive health care context, which reflect autonomy support (e.g. "I feel that the dietitian has provided me choices and options"), involvement (e.g. "The dietitian handles peoples' emotions very well"), and structure (e.g. "The dietitian has made sure I understand the links between foods and health and which dietary changes I can do to improve my diet"). Each item is measured on a 7-point scale (from disagree to strongly agree) and allows calculation of a global score (range=15–105), with a higher average score representing a higher level of perceived autonomy support.

Dietary variables. A validated food frequency questionnaire (FFQ) (Goulet et al., 2004) was administered by a registered dietitian. The FFQ is based on typical foods available in Québec and contains 91 items and 33 subquestions. Participants were questioned about the frequency of intake of different foods and drinks during the last month and could report the frequency of these intakes in terms of day, week, or month. As previously described (Goulet et al., 2003), the Medscore was calculated based on the FFQ and allowed to assess the level of adherence to the Mediterranean food pattern, which could vary between 0 and 44 points. Components of the Medscore are as follows: grains (whole and refined); fruits (whole and juices); vegetables (whole and juices); legumes, nuts, and seeds; olive oil (including olives); dairy products; fish (including seafoods); poultry; eggs; sweets; and red meat/processed meat. Briefly, a high consumption of food groups promoted by the MedDiet

Table 1. Characteristics of men and women at baseline.

	Men (n = 64)		Women (n = 59)	
	Mean	SD	Mean	SD
Age (years)	41.0	7.9	41.8	6.7
Body mass index (kg/m ²)	30.8	4.4	29.6 ^a	6.0
Waist circumference (cm)	106.1	10.2	95.8 ^a	11.5
Total cholesterol (C) (mmol/L)	5.7	0.8	5.8	0.8
LDL-C (mmol/L)	3.6	0.7	3.6	0.7
HDL-C (mmol/L)	1.1	0.2	1.4 ^a	0.3
Total-C/HDL-C ratio	5.1	1.0	4.2 ^a	0.9
Triglycerides (mmol/L)	1.9	0.9	1.5 ^a	0.6
Fasting glucose (mmol/L)	5.3	0.5	5.2	0.7

SD: standard deviation; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol.

Measurements of blood lipids and glucose levels were performed in 63 men and 58 women.

^aMean values were significantly different between men and women ($p \leq 0.05$, Student's *t*-test).

(bottom of the pyramid) (e.g. legumes) contributed to increase the Medscore, whereas a high consumption of food groups at the top of the Mediterranean pyramid (e.g. red meat) contributed to decrease the Medscore, as previously described (Goulet et al., 2003).

Anthropometric and metabolic profile. According to standardized procedures (Lohman et al., 1988), height was measured to the nearest millimeter with a stadiometer (Seca 222 Mechanical Telescopic Stadiometer), body weight was measured to the nearest 0.1 kg on a calibrated balance (BWB-800S Digital scale, Tanita), and body mass index (BMI) was then calculated. Waist circumference measure was also taken to the nearest millimeter according to standardized procedures (Lohman et al., 1988). Blood lipids and glucose level were measured after a 12-hour overnight fast.

Statistical analyses

All analyses were performed using SAS statistical software (version 9.2; SAS Institute, Inc., Cary, NC). The Student's *t*-test allowed comparisons of baseline characteristics, and also the health care climate, between men and women. Motivational variables measured are presented as means \pm standard deviations for the baseline value but otherwise as changes \pm standard deviations. Mixed models for repeated measurements, which allow the inclusion of participants with missing data at some time points (Beunckens et al., 2005), were performed to determine gender, time, and gender by time interaction effects on changes in dependent variables measured (delta values). Delta values were calculated as post-nutritional intervention values (post-nutritional intervention minus pre-nutritional intervention values) and as follow-up values at $t=6$ months (6 months minus pre-nutritional intervention values) and at $t=9$ months (9 months minus pre-nutritional intervention values), respectively. Using this approach, a significant

time effect means that the magnitude of the change is varying with time, while a non-significant time effect means that changes are maintained with time. Moreover, a significant gender by time interaction means that the trajectory of changes with time is not the same in men and women. The Lsmean procedure, which can be defined as a linear combination (sum) of the estimated effects, for example, means, from a linear model and based on the model used, allowed determining significant changes in outcomes over time within each gender. Pairwise differences between and within gender were further tested with the Tukey–Kramer adjustment. Pearson's correlation analyses were performed to examine associations between eating-related SDI, adherence to the Medscore and BMI, in men and women separately. Afterwards, covariance analyses (Lsmean procedure) were performed to determine whether an interaction between gender and changes in eating-related SDI explains changes in the Medscore, and whether or not this relation remains the same after controlling for baseline eating-related SDI. For variables not normally distributed, a transformation was performed, but these variables are presented as raw data in the tables. For determination of sample size, we considered a difference of 35 percent in the change in Medscore as being clinically significant, based on previous results (Goulet et al., 2003). Therefore, a final sample size of 45 men and 45 women was needed to detect a difference of 35 percent in the change in Medscore between men and women with a power of 0.80 and alpha of 0.05, considering that standard deviation corresponds to 55 percent of the mean of the change in Medscore. The probability level for significance used for the interpretation of all statistical analyses was set at an alpha level of $p \leq 0.05$.

Results

Table 1 shows characteristics of men and women at baseline. Men and women were about the same age, but men

had higher BMI, waist circumference, total-C to HDL-C ratio, and triglyceride levels than women, whereas women had higher HDL-C levels than men. Of the 64 men and 59 premenopausal women included in our study at baseline, 89, 78, and 69 percent of men and 86, 78, and 75 percent of women completed assessments at the end of the 12-week nutritional intervention program ($t=3$ months), and at $t=6$ months and $t=9$ months post intervention follow-up visits, respectively, without significant gender differences in the attrition rate at any of the three visits. Moreover, men and women who withdrew from the study presented similar characteristics at baseline to those who completed the intervention until the end of the follow-up (not shown).

Level of perceived autonomy support from the dietitian

No gender difference was observed for the health care climate measured at the end of the nutritional intervention, that is, men and women similarly perceived that their dietitian was autonomy-supportive during the 12-week nutritional intervention program (98.0 ± 8.5 in men and 97.6 ± 8.9 in women; t -test, $p=0.81$).

Changes in eating-related self-determined motivation and in adherence to the MedDiet

Changes in eating-related SDI and its different subscales of regulatory styles in men and women are presented in Table 2. Changes observed in eating-related SDI were larger in men than in women in response to the 12-week nutritional intervention and at follow-up (gender effect, $p=0.04$). Similarly, a trend for larger changes was observed in integrated regulatory style in men than in women in response to the intervention and at follow-up (gender effect, $p=0.08$). However, for these variables, the magnitude of change decreased with time (time effects, $p=0.0002$ for eating-related SDI and $p=0.008$ for integrated regulation). Significant changes in intrinsic motivation were observed in both men and women in response to the intervention, but no gender difference was observed. Moreover, this variable tended to return toward baseline values during follow-up (time effect, $p=0.08$). Although significant decreases in amotivation were observed in response to the nutritional intervention in men only, no gender difference was observed, and this variable progressively returned toward baseline values during follow-up in both men and women (time effect, $p=0.002$). No gender by time interaction was observed for changes in eating-related SDI nor its different subscales, meaning that trajectories of changes during the follow-up were not significantly different between men and women. When changes in eating-related SDI and its subscales of regulatory styles were adjusted for the baseline value of the response variable, significant gender differences and trend for gender differences initially observed all became non-significant.

As for changes in adherence to the MedDiet, a significant increase was observed in the Medscore in men and women in response to the nutritional intervention and at follow-up (22.7 ± 4.3 , 27.6 ± 4.7 , 25.4 ± 4.8 , 24.6 ± 4.6 units in men and 24.1 ± 3.6 , 27.2 ± 4.9 , 25.8 ± 4.2 , 24.9 ± 5.1 units in women, at baseline, after the 12-week nutritional intervention, at $t=6$ months and $t=9$ months, respectively), but without gender differences (gender effect, $p=0.25$). However, the Medscore progressively returned toward baseline values during the follow-up in men and women with a significant time effect (time effect, $p<0.0001$). Moreover, no gender by time interaction was observed for the Medscore, meaning that trajectories of changes during the follow-up were the same in men and women (gender by time interaction, $p=0.42$). Regarding changes in BMI, significant decreases were observed in both men and women after the end of the nutritional intervention and at follow-up (30.8 ± 4.4 , 30.2 ± 4.0 , 30.1 ± 3.5 , 30.0 ± 3.8 kg/m² in men and 29.6 ± 6.0 , 29.4 ± 6.0 , 29.7 ± 6.2 , 29.6 ± 6.3 kg/m² in women, at baseline, $t=3$ months, $t=6$ months, and $t=9$ months, respectively), but no gender differences were found (gender effect, $p=0.18$).

Pattern of associations between eating-related SDI and adherence to the MedDiet according to gender, in response to the 12-week intervention and at follow-up

In men, a significant and positive association was found between changes in eating-related SDI and changes in the Medscore in response to the intervention ($r=0.41$, $p=0.002$), as well as between changes observed in these variables at $t=9$ months ($r=0.39$, $p=0.009$) (Table 3). Also, a trend for a negative association between changes in eating-related SDI and changes in BMI ($r=-0.26$, $p=0.06$) was observed in response to the intervention in men, and this negative association was significant for changes measured at $t=9$ months ($r=-0.33$, $p=0.03$). In women, no association was observed between changes in eating-related SDI and changes in the Medscore measured either at the end of the intervention ($r=-0.08$, $p=0.57$) or at follow-up ($r=-0.03$, $p=0.84$) (Table 3). Moreover, although no association was found between changes in eating-related SDI and changes in BMI in response to the intervention in women, a significant and negative association was observed between changes in these variables measured at $t=9$ months ($r=-0.40$, $p=0.007$).

Additional analyses were performed to further document the differences observed between men and women in the association between changes in SDI and changes in the Medscore. Accordingly, a significant interaction was observed between gender and changes in eating-related SDI in the determination of changes in the Medscore in response to the intervention (interaction, $p=0.02$). In order to verify if higher baseline level of eating-related SDI found in women would contribute to explain this interaction (i.e.

Table 2. Changes in the eating-related self-determination index and its specific forms of regulation in men and women in response to the 12-week nutritional intervention program and at follow-up.

Variables	Men		Women		Gender differences <i>p</i>	Time effect <i>p</i>	Gender × time interaction <i>p</i>	Gender differences adjusted for baseline value <i>p</i>
	Mean	SD	Mean	SD				
Intrinsic motivation					0.49	0.08	0.93	0.40
Baseline ^a	5.27	1.05	5.78	0.87				
0–3 months ^b	0.37 ^c	0.86	0.28 ^c	0.86				
0–6 months ^b	0.36 ^c	0.82	0.27 ^d	0.75				
0–9 months ^b	0.22 ^d	0.90	0.18	0.70				
Integrated regulation					0.08	0.008	0.95	0.48
Baseline ^a	4.88	1.18	5.32	1.04				
0–3 months ^b	0.57 ^c	0.96	0.28 ^c	0.81				
0–6 months ^b	0.61 ^c	1.03	0.37 ^c	0.71				
0–9 months ^b	0.44 ^c	1.28	0.11	0.71				
Identified regulation					0.33	0.14	0.14	0.57
Baseline	6.23	0.70	6.33	0.64				
0–3 months ^b	0.08	0.96	−0.08	0.52				
0–6 months ^b	0.15	1.03	−0.13	0.73				
0–9 months ^b	−0.13	1.28	−0.11	0.53				
Introjected regulation					0.55	0.17	0.39	0.68
Baseline	2.35	1.01	2.30	0.93				
0–3 months ^b	−0.04	0.65	−0.06	0.75				
0–6 months ^b	0.005	0.90	0.07	0.78				
0–9 months ^b	−0.06	0.73	0.18	0.76				
External regulation					0.23	0.0454	0.86	0.45
Baseline ^a	1.95	1.05	1.63	0.72				
0–3 months ^b	−0.16	0.72	−0.04	0.60				
0–6 months ^b	−0.10	0.83	0.04	0.73				
0–9 months ^b	−0.03	0.83	0.17	0.70				
Amotivation					0.10	0.002	0.70	0.43
Baseline	1.38	0.49	1.22	0.42				
0–3 months ^b	−0.15 ^c	0.52	0.01	0.42				
0–6 months ^b	−0.19 ^c	0.52	−0.09	0.44				
0–9 months ^b	−0.09	0.58	0.09	0.41				
Eating-related self-determination index					0.04	0.0002	0.97	0.49
Baseline ^a	21.33	6.43	25.08	6.58				
0–3 months ^b	3.17 ^c	5.83	1.43 ^d	4.20				
0–6 months ^b	3.31 ^c	5.66	1.56 ^d	4.48				
0–9 months ^b	1.85 ^c	6.89	−0.13	3.96				

SD: standard deviation.

In men, for T=0, 0–3 months, 0–6 months, and 0–9 months, *n* = 63, 56, 49, and 44, except for integrated regulation (*n* = 62, 55, 48, and 43, respectively). In women, for intrinsic motivation (*n* = 59, 49, 44, and 44); integrated regulation (*n* = 59, 49, 43, and 43); identified regulation (*n* = 58, 49, 43, and 43); introjected regulation (*n* = 59, 50, 44, and 44); external regulation (*n* = 59, 49, 43, and 44); amotivation (*n* = 59, 50, 44, and 44); eating-related self-determination index (*n* = 59, 50, 44, and 44).

^aMean value significantly different between men and women (*p* ≤ 0.05, Student's *t*-test).

^b0–3 months: changes from baseline to the end of the 12-week nutritional intervention; 0–6 months: changes from baseline to 3-month post intervention; 0–9 months: changes from baseline to 6-month post intervention.

^c*p* ≤ 0.05; significant change within the same gender.

^d*p* ≤ 0.10; trend for a significant change within the same gender.

differences between men and women in the association between changes in SDI and changes in the Medscore), baseline level of eating-related SDI was added to the model

of covariance. It was found that the interaction between gender and changes in eating-related SDI in the determination of changes in the Medscore remains significant despite

Table 3. Associations between changes in eating-related self-determined motivation and changes in the Medscore and in BMI in men and women.

	Eating-related SDI (0–3 months) ^a				Eating-related SDI (0–9 months) ^a			
	Men (<i>n</i> = 6)		Women (<i>n</i> = 50)		Men (<i>n</i> = 44)		Women (<i>n</i> = 44)	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Medscore (0–3 months) ^a	0.41	0.002	–0.08	0.57	–	–	–	–
Medscore (0–9 months) ^a	–	–	–	–	0.39	0.009	–0.03	0.84
BMI (0–3 months) ^a	–0.26	0.0562	–0.22	0.13	–	–	–	–
BMI (0–9 months) ^a	–	–	–	–	–0.33	0.03	–0.40	0.007

SDI: self-determination index; BMI: body mass index.

Eating-related SDI, eating-related self-determination index.

^a0–3 months: changes from baseline to the end of the 12-week nutritional intervention; 0–9 months: changes from baseline to 6-month post intervention; for Medscore (0–9 months) in women, *n* = 43.

adjustment for baseline level of eating-related SDI in response to the intervention (interaction, $p=0.03$). At $t=9$ months, no significant interaction (interaction, $p=0.12$) was found between gender and changes in eating-related SDI in the determination of changes in the Medscore.

Discussion

The aim of our study was to determine gender differences in the impact of a nutritional intervention program based on the SDT and promoting the MedDiet on eating-related motivation and adherence to the MedDiet. Results indicate that men and women perceived the motivational approach as autonomy-supportive in a similar manner although it led to larger increases in self-determined motivation in men than in women. Moreover, increases in eating-related self-determined motivation were associated with increases in adherence to the MedDiet in men only.

Changes observed in eating-related self-determined motivation evolved in a similar direction in men and women as no gender by time interaction was observed. However, larger increases in eating-related self-determined motivation were observed in men than in women in response to the 12-week intervention and at follow-up. The SDT posits that a context fostering satisfaction of autonomy, competence, and relatedness is essential in promoting self-determined motivation (Deci and Ryan, 1985; Ryan and Deci, 2000). Accordingly, different aspects of our nutritional intervention aimed at promoting satisfaction of these psychological needs. More precisely, competence of men and women was promoted by the Mediterranean cooking lesson, the Mediterranean potluck dinner, and by nutritional information and practical tools discussed during individual and group sessions. The need for relatedness was fostered by the development of a relationship based on trust, consideration, and collaboration between the dietitian and the participant, by the group cohesion promoted between participants during group sessions and also by the consideration of

important others in the action plan for dietary changes. Then, autonomy was supported when individuals had to determine their personal dietary objectives, the best strategies regarding the objectives, and the key factors to overcome barriers. Moreover, recipes and nutritional tools were not automatically provided to individuals but rather given according to individuals' needs.

In regard to the impact of our intervention in men and women, factors that can explain why women did not increase their level of eating-related self-determined motivation as much as men, such as level of eating-related self-determined motivation at baseline, need to be considered. Indeed, as women reported higher level of eating-related self-determined motivation than men at baseline, room for improvement in motivation could have been more limited for women than men. In this regard, the adjustment for the baseline value of the response variable indicated that if a similar level of eating-related self-determined motivation at baseline had been observed in men and women, no significant gender difference would have been found in changes in eating-related self-determined motivation. In addition, despite the fact that men and women perceived the intervention as similarly autonomy-supportive, it can be hypothesized that gender differences exist in the level of need satisfaction for autonomy, competence, and relatedness specific to the dietary context. However, to our knowledge, no validated questionnaire allows assessment of the satisfaction of the psychological needs specific to the dietary context. Moreover, a better understanding of the impact of the health care climate in men and women on changes in eating-related self-determined motivation could be achieved in future studies by assessing perceived level of satisfaction of the psychological needs at different time points of an intervention. Indeed, data from a recent qualitative study in the field of physical activity reported that satisfaction of the needs for competence and relatedness were essential during the phase of adoption of the exercise behavior, while satisfaction of autonomy had more impact

in the maintenance phase (Kinnafick et al., 2014). Those results suggest that stages of development of these needs might differ and should be considered in order to facilitate internalization of non-self-determined regulatory styles toward more self-determined regulatory styles. In addition, the idea of monitoring people on a daily basis using an ecological momentary assessment technique could be interesting as previous studies reported within-person fluctuations in psychological need satisfaction (Verstuyf et al., 2012).

The fact that eating-related self-determined motivation returned toward baseline values in both men and women underlines the difficulty to maintain motivation changes. Despite 12 weeks of intervention aimed to internalize motivational factors related to the adoption of a diet of better quality, the transition between the end of the intervention program and the follow-up period and the complete absence of support during the follow-up seem to represent critical points to consider. Moreover, intrinsic motivation, that is, highest level of eating-related self-determined motivation and which refers to undertaking an activity for its inherent interest and enjoyment, might be more difficult to maintain than other types of motivation (Resnicow and McMaster, 2012; Verstuyf et al., 2012). This can partly be explained by the fact that the delay to internalize intrinsic motivation might have been insufficient. It is also possible that attempts to maintain dietary intakes were directed more to other outcomes such as to improve health condition or decrease body weight, which could have thwarted the intrinsic motivation toward changing dietary habits per se (e.g. for the interest and pleasure of eating or preparing food according to the MedDiet) (Verstuyf et al., 2012). Although the magnitude of the changes in eating-related self-determined motivation also decreased with time among men, level of motivation remained significantly higher than at baseline, suggesting a non-negligible impact from the nutritional intervention program on motivational factors. In addition, previous results demonstrate that our intervention based on a motivational approach had a beneficial impact on the adoption of healthy dietary intakes and risk factors for CVD such as waist circumference and lipid profile, more particularly in men (Leblanc et al., 2014).

To our knowledge, assessment of the influence of changes in motivation on changes in the adherence to the MedDiet according to gender is a novelty in the literature. We found that an increase in eating-related self-determined motivation was associated with an increase in the adherence to the MedDiet in response to the 12-week intervention as well as at follow-up, in men but not in women. Moreover, additional analyses revealed that differences found between men and women in the association between changes in motivation and changes in adherence to the MedDiet may not be explained by gender differences in the level of eating-related self-determined motivation at

baseline. This suggests that other gender-related factors are involved to explain these differences in the pattern of associations between eating-related self-determined motivation and adherence to the MedDiet. Those factors may be related to eating-related attitudes, behaviors and norms, societal role, and responsibilities attributed to men and women (Institute of Gender and Health, 2012; Wang and Worsley, 2014). Although these factors were not specifically assessed in our study, some components of the nutritional intervention program may have better suited men than women. Previous studies indicate that men are more ambivalent than women toward healthy eating choices (Povey et al., 2001; Sparks et al., 2001); therefore supporting our hypothesis that tools used in our intervention and aimed at increasing eating-related self-determined motivation such as the decisional balance might have been more beneficial for men than women.

As no previous study assessed gender differences in changes in eating-related self-determined motivation, several hypotheses remain to be verified in the future regarding basic psychological needs for autonomy, competence, and relatedness in the dietary context and potential moderators in the association between changes in motivation and changes in dietary intakes to allow a better understanding of the influence of the quality of the motivation in the context of healthy eating in both men and women. The fact that men and women recruited in our study were middle-aged adults and presented specific characteristics regarding CVD risk limits the generalization of our results to the whole population. Moreover, although missing data could contribute to overestimate changes found at follow-up in self-determined motivation in men and women, gender differences observed are unlikely to be influenced by this possible bias since the attrition rate was the same in men and women. Nevertheless, this study has important strengths and clinical implications that need to be mentioned. Our nutritional education program was developed based on the SDT, which facilitated and guided our methods of intervention. Moreover, this study design allowed the assessment of long-term impact of a nutritional intervention, during which individuals were actively involved in the process of dietary changes followed by a 6-month period with no additional support provided which can be more representative of a real-life setting. Our results showed that a nutritional intervention program promoting active involvement of individuals in the determination of dietary changes and strategies had a positive impact on eating-related self-determined motivation, which in turn contributed to improve the level of adherence to the MedDiet in men only. As a matter of fact, motivational factors seem to be an important target of intervention in the context of dietary changes in men. As for women, our results suggest that other factors may have possibly interfered in the association between motivational changes and changes in adherence to the MedDiet, and thus indicate that health professionals should explore factors

besides motivation to properly support women in the context of dietary changes.

Overall, although both men and women increased their adherence to the MedDiet in response to the nutritional intervention, results indicate that the nutritional intervention program aimed at promoting eating-related self-determined motivation in order to improve the quality of the diet seems to fit better men than women as changes in eating-related self-determined motivation were associated with increases in adherence to the MedDiet in men only.

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