



## Long term effect of spa therapy combined with patient education program on subjects with overweight and obesity – A controlled study



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### ABSTRACT

The aim of this single center prospective controlled study in volunteers with obesity and overweight was to evaluate the effect of a patient therapeutic education program (PTE group) combined with spa therapy on weight, physical activity, eating habits and quality of life versus spa therapy alone (control group). The main endpoint was weight change at 5 months after the end of the program.

The PTE group of 151 subjects with obesity or overweight followed a 3-week program combining patient education with spa therapy and 189 attended a course of spa therapy alone. At 5 months significant loss was observed in the PTE group compared to controls (−2.69 kg vs −1.24 kg,  $p=0.008$ ), a relative weight loss of −2.8% vs −1.3%. At 11 months after spa therapy, only the PTE group maintained a weight loss in addition to the weight loss obtained during spa therapy. The control group returned to the weight they had at the end of spa therapy. In both groups, a significant increase in physical activity was observed at 5 ( $p<0.001$ ) and 11 months ( $p<0.001$ ) with a significant better improvement in the PTE group. In addition, while in both groups some quality of life parameters and dietary choices were improved, the improvement (more fruit, vegetables, fish and water) was significantly higher in the PTE group, at both 5 and 11 months after spa therapy.

In conclusion, while spa therapy alone initiated positive changes in weight loss, physical activity and some quality of life parameters, the PTE program enhanced this effect.

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### Introduction

Obesity is a major and increasing public health issue worldwide [1,2]. For most people it remains difficult to manage and obesity lacks a simple solution. Drug therapy once considered an answer is no longer available or has adverse effects [3] and weight reduction diets and lifestyle changes are usually followed by regain in weight in the medium and long terms [4–6].

Spa therapy is a recognised non-pharmacological therapy for people with overweight and obesity. In France, it consists of a 3-week course of mineral water treatments (drinking mineral water,

showering, individual and collective bathing, underwater massages, . . .), counselling in dietary change and adapted physical activity and the promotion of a healthy lifestyle. To be reimbursed by the French Social Security a medical prescription is required and the spa therapy must be delivered by certified practitioners under medical supervision. Spa therapy combined with practical workshops have been shown to be effective in the management of obesity in young adults [7] and metabolic syndrome in adults [8]. In 2012, Hanh et al. observed that a 3-week balneotherapy program with individual dietary consultations and encouragement to practice a physical activity led to a significant benefit at one year for patients with overweight or obesity compared with usual weight management programs (oral and or written dietary advice) [9]. It was thus relevant to investigate the respective roles of spa therapy and patient education program.

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Patient therapeutic education can play an important role in the treatment of chronic diseases, in particular by helping patients to improve their lifestyle. For children with overweight or obesity, therapeutic education of the whole family has been shown to contribute to weight reduction [10]. In the medium-term, therapeutic education appears to reinforce both the effects of dietetics and the physical activity level [11,12].

Many reports have concluded that weight management (usually loss) has important physical and mental health benefits with several studies highlighting the relations between obesity and quality of life, particularly the mental health and the risk of depression [13,14]. A study of 482 American families found body mass index (BMI) to be a significant risk factor of depression with a risk significantly increased in patients with a BMI over 35 kg/m<sup>2</sup> [15]. Analysis of mental health surveys by Scott et al. confirmed this relationship [16]. Previous studies also showed the interest to combine education based on self-managed exercise programs with spa therapy in order to improve fears and beliefs, anxiety and depression [17] in patients with musculoskeletal symptoms.

In the present study, we hypothesised that a patient therapeutic education program (PTE program) associated with spa therapy is more effective both on weight management and on some criteria of quality of life than spa therapy alone, and that these effects might be more sustainable than a Spa Therapy alone. Weight loss measured at home, at different time-points after the end of spa therapy, irrespective of any weight loss achieved during the spa therapy course, would be a relevant outcome measure of this benefit.

## Subjects

### Ethics statements

All participants gave consent after being informed of the purposes, methodology and potential risks of the study. This study was conducted in accordance with the guidelines of the Declaration of Helsinki of 1975 as revised in 2013 and was approved by the Caen ethics committee (Comité de Protection des personnes Nord-Ouest III) (ref. 2013–15). This study was registered on the [ClinicalTrials.gov](https://www.clinicaltrials.gov) website: NTC02284776.

### Selection of participants

Patients booked to follow a spa therapy course at Brides-les-Bains (France) thermal care facility were selected by investigators who proposed that they participated in the study. The inclusion criteria were: male or female aged over 18 with a BMI  $\geq 27$ –40 kg/m<sup>2</sup>. Non-inclusion criteria were: current serious progressive illness (cancer, neurodegenerative disease, infectious disease, chronic inflammatory condition), pregnancy, patient following a rheumatology (RH) spa therapy program, psychiatric disorders hindering compliance, diagnosed severe eating disorders (bulimia, bulimia-anorexia alternation), inability to perform physical activity due to severe musculoskeletal handicap, person on weight loss course prior to bariatric surgery, person taking weight loss drugs (Orlistat: Xenical<sup>®</sup>, Alli<sup>®</sup>) and person taking desmopressin-based drugs (Minirin<sup>®</sup>).

## Methods

### Main and secondary endpoints

The main endpoint was weight loss over 5 month compared from the end of spa treatment. Secondary endpoints were weight loss at 11th and 17th months after the end of spa treatment; reduction in weight of at least 5% at 5th and 11th months; changes in

diet, physical activity, quality of life and well being at 5th and 11th months after the end of spa treatment.

### Study design

#### Spa therapy only (control group)

Patients attended a spa therapy program six days a week over 3 consecutive weeks in a spa center for 3 weeks. The hydrothermal care program consisted of drinking about 600 ml of mineral water per day, and daily individual mineral water baths (10 min at 34 °C), mineral water showers (3 min at 4 bars) and underwater massages (10 min) performed by a registered physiotherapist. The composition of the resort's mineral water of the resort is given in Supplementary Table 1. During their stay at the spa resort optional activities included (i) one dietary counselling consultation with a dietician, (ii) practical workshops about nutrition, (iii) physical activity with or without coaching.

#### Patients therapeutic education combined with spa therapy (PTE group)

Patients benefited from the same 3-week spa therapy (hydrothermal care program) as controls and were required to follow the PTE program. The PTE program delivered during the stay consisted of (i) two 45 min dietary consultations with a dietician; (ii) six 90 min workshops about nutrition and physical activity and (iii) six 60 mn adapted physical activity sessions with a coach. During 5 months after the end of spa treatment, all patients in this group were contacted monthly by phone or email by a dietician.

### Group allocation

Before the start of spa therapy, and after being informed about the two study groups, patients chose which study group they wanted to participate in, bearing in mind that they had to pay for the therapeutic education.

### Patients self-assessment

Patients measured their own **weight** at home always using the same personal scales – first immediately after the end of spa treatment, and then at 5, 11 and 17 months. Therefore, the weight measurements collected during the study did not take into account any weight loss achieved during the course of spa therapy.

**Physical activity** was scored using the Ricci & Gagnon (RG) self-questionnaire with the score calculated according to the declared daily activity: “active” 12–16; “very active” 17–25; “unactive” 0–11) before spa therapy and at 5 and 11 months after the end of spa therapy.

**Dietary change** was measured using a 12 item food frequency self-questionnaire based on the French National Nutrition and Health Program Guidelines: (1) bread, rusks, breakfast cereals; (2) rice, pasta, potatoes, semolina; (3) legumes; (4) dairy products; (5) fruits; (6) vegetables; (7) meat, poultry, eggs; (8) fish; (9) fats; (10) sweet products; (11) drink; (12) salt. A personal score was calculated from the frequency of consumption of each item before spa therapy and at 5 and 11 months after spa therapy.

**Quality of life was assessed using the 36-Item Short Form Health Survey (SF-36 questionnaire)** [18]. The eight SF-36 subscales assess: physical functioning (PF), physical role functioning (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), emotional role functioning (RE) and mental health (MH). Component analyses have shown that two distinct concepts are measured by the SF-36: (i) the physical dimension, expressed as the Physical Component Summary (PCS), and (ii) the mental dimension, expressed by the Mental Component Summary (MCS). The SF-36

questionnaire was completed before spa therapy and at 5 and 11 months after spa therapy.

**Patients self-perception of well-being** was assessed using a personal unpublished patient overall assessment tool based on 6 visual analogue scales (VAS from 0 to 10): (1) how do you feel physically? (from very bad “0” to very good “10”); (2) how do you feel mentally? (from very bad “0” to very good “10”); (3) how do you feel? (general feeling)(from very bad “0” to very good “10”); (4) are you feeling full of energy? (from not at all “0” to very much “10”); (5) do you feel anxious? (from very much “0” to not at all “10”); (6) do you feel demeaned by your weight? (from very much “0” to not at all “10”). Each VAS was completed before spa therapy and at 5 and 11 months after spa therapy.

### Statistics

We used propensity score matching to address imbalance between the groups. The propensity-score model included age, BMI, fish consumption, and 4 VAS scores corresponding to the questions: (1) Are you feeling full of energy?; (2) Do you feel anxious?; (3) Do you feel demeaned by your weight?; (4) How do you feel physically? A one-to-one nearest neighbour caliper of width 0.1 was used for treatment group matching (R software). Kolmogorov–Smirnov ( $n > 50$ ) or Shapiro–Wilks ( $n \leq 50$ ) tests were used to compare continuous variables between the two groups. For some data, intragroup comparisons were made with the initial values (before spa therapy, identified on tables as T0). Categorical variables were analyzed using Generalized Estimating Equation logistic models. A  $p$  value  $< 0.05$  was considered to indicate a significant difference. Variables are expressed as the mean with standard deviation (SD) or 95% Confidence Interval (CI). Analyses were performed using SAS 9.4 software (Cary, NC).

## Results

### Patients baseline characteristics

A total of 340 patients were included in this single-center study between July 2013 and June 2015. More patients chose spa therapy only (189 patients) than spa therapy + the patient therapeutic education program (151 patients) (Fig. 1).

No adverse event related to spa therapy or the PTE program was observed or reported by the patients at any time during the study.

Patients characteristics at baseline are shown in Table 1. With the exception of a significant difference in age, weight and BMI between the two groups, no major clinically significant difference in biological parameters or socio-professional category was found between the two groups. The characteristics of the population after propensity score matching are shown in Supplementary Table 2).

### Weight loss

Weight loss was analyzed both on the propensity score matched population (Table 2) and on the total population (before propensity score matching: Supplementary Table 3). Weight loss observed during the spa therapy was similar in both groups ( $-3.8$  kg (SD 1.8) in control group and  $-3.7$  kg (SD 1.5) in PTE group). Mean weight before spa therapy was  $90.9 \pm 15.6$  kg for PTE group and  $92.5 \pm 15.3$  kg for control group (Supplementary Table 2).

Five months after spa therapy, the PTE group showed a greater weight loss compared to controls ( $-2.69$  vs  $-1.23$  kg, respectively;  $p = 0.008$ ) (Table 2), a weight loss of 2.8% in the PTE group and of 1.3% in controls. 30.17% in the PTE group lost at least 5% of their end-spa therapy weight compared to 16.97% in the control group ( $p < 0.005$ ). Eleven months after spa therapy, a significant difference between the two groups persisted ( $-1.95$  in the PTE group vs  $-0.19$  kg in the

**Table 1**  
Patients baseline characteristics.

	PTE	Control	p
n=	151	189	
Female	80%	83%	0.713
Male	20%	17%	
Age (SD)	54.7 (11.7)	58.2 (9.5)	0.003
BMI (SD)	36.0 (5.9)	34.1 (4.7)	0.002
Weight (SD)	97.7 (17.2)	92.6 (15.7)	<0.001
Socio-professional category			
• Employee	20%	25%	
• Retired	29%	34%	
• Artisan, trader, business manager	7%	3%	0.271
• Senior manager, higher intellectual profession	30%	16%	
• Intermediate occupation	9%	15%	
• Unemployed or students	5%	7%	
Systolic blood pressure (SD)	128.4 (10.6)	131.1 (10.8)	0.018
Diastolic blood pressure (SD)	73.9 (9.4)	78.9 (5.6)	<0.001
Waist, cm (SD)	119.0 (13.2)	111.9 (12.6)	<0.001
Biological parameters			
• Blood glucose, g/L (SD)	1.01 (0.16)	1.03 (0.22)	0.293
• TG, g/L (SD)	1.15 (0.47)	1.22 (0.59)	0.219
• Total cholesterol, g/L (SD)	2.05 (0.41)	2.11 (0.42)	0.224
• HDL cholesterol, g/L (SD)	0.54 (0.12)	0.54 (0.13)	0.745
• LDL cholesterol, g/L (SD)	1.29 (0.38)	1.35 (0.38)	0.173

control group,  $p = 0.027$ ), a weight loss of 2.0% and 0% respectively. A loss of at least 5% of end-spa therapy weight was 30.30% in PTE group and 10.00% in the control group ( $p < 0.001$ ). Eleven months after spa therapy, 50% of the PTE group continued to lose weight while this was no longer the case for controls. Seventeen months after spa therapy, results were similar to those at 11 months ( $-1.79$  in PTE group vs  $+0.55$  kg in control group), but the difference was no longer significant. Likewise at 17 months the loss of at least 5% of end-spa therapy weight, was no longer significantly different between the two groups (24.14% in PTE group vs 15.63% in control group). Thus, the PTE group lost more weight than controls, and this loss lasted over time. The PTE program helped patients to increase their weight loss.

### Changes in diet

At baseline the proportion of the study population drinking at least 1.5 l water per day (in accordance with the French Nutritional Guidelines) was high and similar in both groups (Supplementary Table 4). A significant increase in daily water intake was observed 5 months after end of spa therapy, compared too baseline, only in the PTE group ( $p = 0.049$ ).

Fish consumption was significantly increased in the PTE group compared to controls at both 5 ( $p = 0.029$ ) and 11 months ( $p = 0.036$ ). While fruits and vegetables consumption increased in both group, the increase was greater in the PTE group ( $p = 0.035$  at 5 months and  $p = 0.09$  at 11 months).

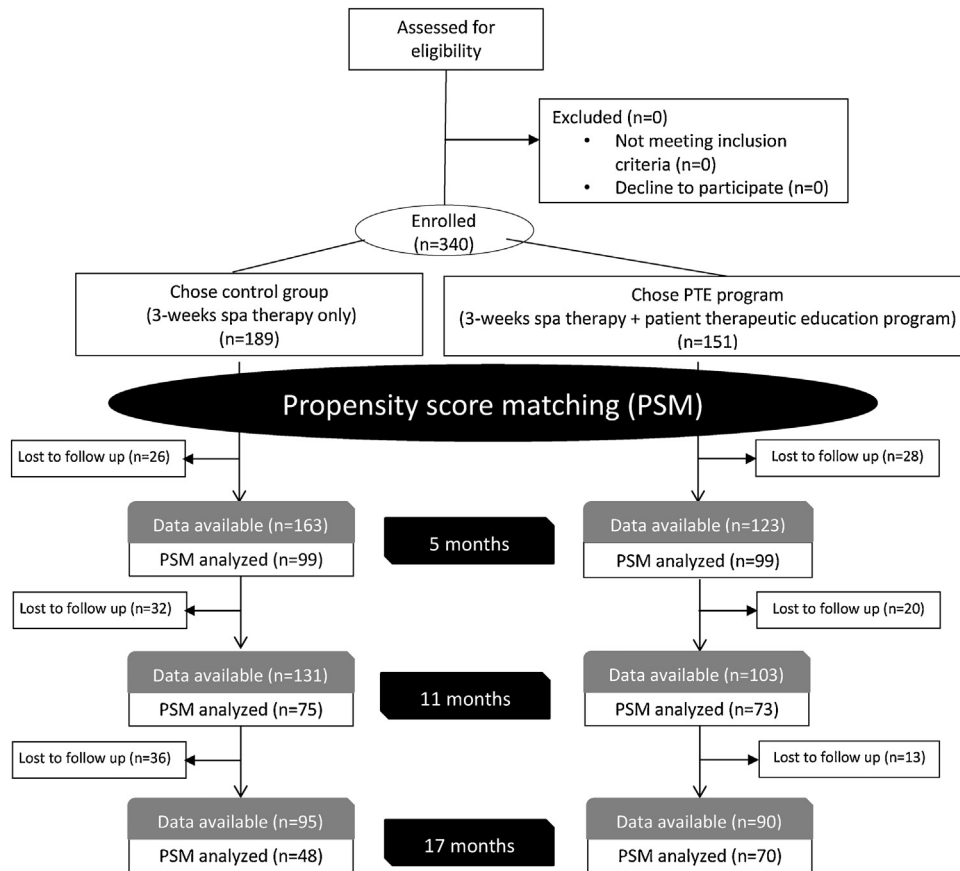


Fig. 1. Patient flowchart.

**Table 2**  
Weight loss at 5, 11 and 17 months after spa therapy in control and PTE groups after PSM.

		PTE [95%CI]	Control [95%CI]	p
At 5 months	n=	99	99	
	Weight loss (kg)	-2.69 [-3.51; -1.87]	-1.23 [-2.08; -0.38]	0.008
	Relative weight loss (%)	-2.8 [-3.7; -1.9]	-1.3 [-2.2; -0.4]	0.011
At 11 months	n=	73	75	
	Weight loss (kg)	-1.95 [-3.16; -0.74]	-0.19 [-1.64; 1.26]	0.027
	Relative weight loss (%)	-2.0 [-3.3; -0.7]	+0 ± [-1.4; 1.4]	0.035
At 17 months	n=	70	48	
	Weight loss (kg)	-1.79 [-3.12; -0.46]	+0.55 [-5.02; 6.12]	NS
	Relative weight loss (%)	-1.8 [-3.4; -0.2]	+2.8 [-3.5; 9.1]	NS

The weight loss was the difference between participants weight immediately after spa therapy and their weight at 5, 11 or 17 months after the end of spa therapy.

**Physical activity**

As measured by the Ricci & Gagnon score, five months after spa therapy, physical activity had increased in both groups compared to before treatment: PTE group: 18.01 vs 14.23 (p < 0.001), control group: 15.41 vs 14.16 (p = 0.025), the increase being significantly greater in the PTE group (Table 3). Eleven months after spa therapy physical activity was still increased in both groups: PTE group: 16.97 vs 14.23 (p < 0.001), controls: 15.61 vs 14.16 (p = 0.013) but the difference between the PTE group and controls was no longer significant.

**Quality of life and well-being**

**Quality of life** assessed using the SF36 showed significant improvement in both the physical and mental dimensions in both

**Table 3**  
Physical activity (Ricci&Gagnon score) at 5 and 11 months after spa therapy in control and PTE PSM groups.

	PTE	Control	p
0 months (before spa therapy)	14.23	14.16	NS
5 months + 3 weeks	18.01 <sup>a,*</sup>	15.41 <sup>a,**</sup>	<0.001
11 months + 3 weeks	16.97 <sup>a,*</sup>	15.91 <sup>a,***</sup>	NS

PSM: propensity score matching.  
<sup>a</sup> significant difference with T0 value (before spa therapy).  
<sup>\*</sup> p < 0.001.  
<sup>\*\*</sup> p = 0.025.  
<sup>\*\*\*</sup> p = 0.013.

study groups at 5 and 11 months compared to baseline (Table 4). There was no significant difference between the study groups.

**Well-being** assessed through the question “How do you feel?” was also significantly and similarly improved in both groups

**Table 4**  
Quality of life scores of study population at 5 and 11 months after spa therapy in control and PTE program PSM groups.

		PTE	Control	p
Physical health score (SF-36)	0 months (before spa therapy)	57.04	55.84	–
	5 months + 3 weeks	65.80 <sup>§*</sup>	64.34 <sup>§*</sup>	NS
	11 months + 3 weeks	66.47 <sup>§*</sup>	65.90 <sup>§*</sup>	NS
Mental health score (SF-36)	0 months (before spa therapy)	54.15	50.02	–
	5 months + 3 weeks	60.83 <sup>§*</sup>	58.85 <sup>§*</sup>	NS
	11 months + 3 weeks	59.40 <sup>§**</sup>	57.06 <sup>§**</sup>	NS
Physical feeling score <sup>a</sup> (visual analogue scale)	0 months (before spa therapy)	4.13	3.91	–
	5 months + 3 weeks	6.02 <sup>§*</sup>	5.28 <sup>§*</sup>	0.014
	11 months + 3 weeks	5.87 <sup>§*</sup>	5.08 <sup>§*</sup>	NS
Psychological feeling score <sup>b</sup> (visual analogue scale)	0 months (before spa therapy)	5.36	4.84	–
	5 months + 3 weeks	6.29 <sup>§*</sup>	5.55 <sup>§**</sup>	NS
	11 months + 3 weeks	6.14 <sup>§**</sup>	5.44	NS
General well-being <sup>c</sup> (visual analogue scale)	0 months (before spa therapy)	4.97	4.72	–
	5 months + 3 weeks	6.22 <sup>§*</sup>	5.58 <sup>§*</sup>	0.028
	11 months + 3 weeks	6.06 <sup>§*</sup>	5.63 <sup>§*</sup>	NS
Energy feeling <sup>d</sup> (visual analogue scale)	0 months (before spa therapy)	4.87	4.56	–
	5 months + 3 weeks	5.68 <sup>§*</sup>	5.11 <sup>§***</sup>	NS
	11 months + 3 weeks	5.60 <sup>§***</sup>	5.08	NS
Anxiety feeling <sup>e</sup> (visual analogue scale)	0 months (before spa therapy)	4.53	4.32	–
	5 months + 3 weeks	5.55 <sup>§*</sup>	5.00 <sup>§**</sup>	NS
	11 months + 3 weeks	5.49 <sup>§**</sup>	5.05 <sup>§**</sup>	NS
Embarrassed by weight <sup>f</sup>	0 months (before spa therapy)	2.64	2.46	–
	5 months + 3 weeks	4.70 <sup>§*</sup>	3.96 <sup>§*</sup>	NS
	11 months + 3 weeks	4.28 <sup>§*</sup>	3.95 <sup>§*</sup>	NS

\* p < 0.001.

\*\* p ≤ 0.01.

\*\*\* p < 0.05.

<sup>a</sup> How do you feel physically? (from very bad “0” to very good “10”).

<sup>b</sup> How do you feel psychologically? (from very bad “0” to very good “10”).

<sup>c</sup> How do you feel in general? (from very bad “0” to very good “10”).

<sup>d</sup> Do you feel full of energy? (from not at all “0” to very much “10”).

<sup>e</sup> Do you feel anxious? (from very much “0” to not at all “10”).

<sup>f</sup> Do you feel demeaned by your weight? (from very much “0” to not at all “10”).

§ Significant difference with value before spa therapy).

(p < 0.001) at both 5 and 11 months after spa therapy compared to baseline. VAS scores to the questions “physically, how do you feel?” and “psychologically, how do you feel” were also improved in both groups at 5 and 11 months after spa therapy with no difference between the two groups. In the controls the score of psychological well-being at 11 months was not significantly different from this score before treatment. Patients of both groups declared that they were full of energy, less anxious and less affected by their bodily limitations at 5 and 11 months after spa therapy. The improvement of this score for vitality didn’t reach significance at 11 months in controls.

## Discussion

The main endpoint of the study was weight change at 5 months after the end of spa therapy. No account was taken of any weight change during the the 3 week spa therapy course, which was in fact similar with and without the added PTE program. We observed a significantly greater weight loss at 5 months and 11 months in the PTE group compared to controls. Nevertheless, controls maintained the weight loss they had reached during the spa therapy course, suggesting the interest of a yearly program of spa therapy. After 17 months, there was no statistical difference between the two groups but, in the PTE group the weight remained below the initial measure. It has been previously shown that spa therapy is an efficient weight loss intervention for people with overweight or obesity [7,8] and is useful in the management of metabolic syndrome [9,19]. In the present study, we observed that PTE program enhances a significantly greater weight loss for 11 months compared to controls.

Spa therapy alone induces a significant but less important weight loss over the following 5 months after the end of spa therapy. The controls patients return at 11 months to their weight of the end of spa therapy.

The greater and longer lasting weight loss in the PTE group appears to be related to changes in dietary habits and physical activity. Although there was no significant difference between the two groups in changes for the diet (apart from higher fish consumption after 5 months in the PTE group), at 5 months there was an improvement of the amount of water drunk each day and, at 5 and 11 months, in fish, fruits and vegetables consumption in the PTE group compared to before spa therapy indicating a change in eating habits in the PTE group.

Physical activity is known to help patients in their weight management preventing several non-communicable diseases such cardio-vascular diseases, chronic obstructive pulmonary diseases, type 2 diabetes and cancers (mainly breast, colon, . . .), and contributes to reduce the mortality [20]. In our study, physical activity, assessed by the Ricci & Gagnon score, was increased at 5 months in the PTE group. The observed increase in water intake could be linked to an increase in physical activity; thus questioning the relationship with the significant increase of water intake and physical activity observed 5 months after spa therapy in the PTE group. These positive changes might be a result of the PTE program.

For adult patients with a chronic disease, attending therapeutic education sessions is a relevant way of improving knowledge of the disease and increasing motivation, to make positive lifestyle changes [21,22], particularly the changes in diet and exercise needed to manage obesity in both the short and long term

[3,23–25]. Tanas et al. showed that a therapeutic education program (delivered by a pediatrician) for children with overweight or obesity and their families helped them to lose more weight than conventional diets [10]. Encouraging results of PTE have also been observed in people with psychiatric disorders [26]. In the present study, we showed the interest of adding a patient therapeutic education program to spa therapy so as to improve weight management.

Improving the sensation of well-being for people with chronic diseases such as obesity is a relevant therapeutic aim as mood disorders and depression are common in the people with obesity [13,16]. At 5 months following spa therapy the sensations of physical and general well-being were greater in the PTE group than in controls. We note that the physical health and mental health scores from the SF-36 questionnaire significantly improved in both group without any difference between them and this from the beginning of spa therapy. This suggests that spa therapy alone is efficacious in improving the sensation of well-being and this persists during the ensuing year, although it is difficult to separate the effect on well being from weight loss [27,28]. Furthermore, compared to drug treatment, no serious adverse events were reported suggesting that spa therapy is a safe approach to weight management.

A strength of this study is the relatively long duration of follow-up, particularly as long-term weight-loss maintenance is the final objective [29,30], but is often difficult to achieve [3]. The multidisciplinary approach used for the weight management in this study could also be considered as a strength. Indeed, as supported by recent European guidelines, the ideal medical management of people with obesity includes nutrition, physical activity, eating/life style behaviours and psychological aspects, as a treatment algorithm in order to optimise the weight management [31].

Our study has several limitations. The first being that the patients were not randomised. In France, patients have to contribute financially if they wish to attend PTE. Thus, eligible patients had to be given the choice of whether they wished to pay for PTE or not, ruling out randomisation. The choice of study arm (PTE or not) may have been influenced by willingness/ability to pay which can be related to a better educational level as observed in the PTE group. This bias is common in real life. Thus, we overcame potential differences in baseline characteristics between the groups by propensity score matching allowing a statistical comparison.

Another limitation was patients lost to follow-up after 11 and 17 months. Loss to follow-up is commonly observed in studies on people with obesity [3] and reduces the statistical power (reducing the possibility of obtaining significant differences) particularly at long follow-up time-points.

In conclusion, in the months following a 3-week course of spa therapy, PTE induced a significantly greater weight loss at 5 and 11 months compared to controls. However, all patients had lost weight irrespective of whether they had PTE or not. While the PTE group maintained the weight loss at 11 months, controls stabilised at about their weight achieved at the end of spa therapy, supporting the interest of a yearly program of spa therapy for the people with overweight and obesity. At 5 months, PTE program induced significantly positive changes in dietary habits, physical activity and well-being. Increased physical activity and well-being were observed in both groups at 11 months. A PTE program contributes to the lasting benefits in weight control.

### Conflict of interest statement

CFR is a member of the scientific committee of AFRETH, an independent non-profit organisation. NN works at the Brides-les-Bains thermal cares facility. The other authors declare no conflict of interest.

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### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.orcp.2019.06.005>.

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