Impact of a Health-At-Every-Size intervention on changes in dietary intakes and eating patterns in premenopausal overweight women: results of a randomized trial

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Abbreviations: Health-At-Every-Size (HAES); Three-Factor Eating Questionnaire (TFEQ); Body mass index (BMI); Resting metabolic rate (RMR); Basal metabolic rate (BMR)

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Abstract

Background & Aims: Previous studies have shown improvements in eating behaviors following a Health-At-Every-Size approach (HAES). However, to our knowledge, no study has yet investigated how a HAES intervention could influence dietary intakes and eating patterns in overweight women. Therefore, objectives of this study were to determine changes in dietary intakes and eating patterns in premenopausal overweight women in response to a HAES intervention compared to a social support intervention and a control group, and then to determine whether changes in eating behaviors were associated with changes in dietary intakes and eating patterns in response to the HAES intervention. **Methods:** Women completed a 3-day food record and the Three-Factor Eating Questionnaire was used to assess eating behaviors. **Results:** Energy intake (main effect of time; p=0.045) and snack frequency (main effect of time; p=0.0004) decreased similarly over time in the three groups whereas proportion of energy intake from breakfast (main effect of time; p=0.03) increased over time. Within HAES group, decreases in hunger and external hunger were associated with a decrease in total daily energy intake (r=0.50, p=0.0009 and r=0.50, p=0.0007, respectively). **Conclusions:** HAES intervention has no specific impact on eating patterns. However, a decrease in hunger, which characterizes women who respond well to HAES, is associated with a decrease in overall energy intake.

Keywords : Eating behaviors, Eating patterns, Dietary intakes, Intervention, Health-At-Every-Size approach

Clinical trial registration number (www.clinicaltrials.gov): NCT01240499

1. Introduction

Over the last decades, prevalence of obesity increased[1] and weight preoccupation as well as body image dissatisfaction are particularly common, especially among women[2]. Some public advocacy groups have proposed a shift from the traditional "weight-centered" approach to a more "health-centered" approach, also referred to as "Health-At-Every-Size" (HAES)[3,4]. The aims of the HAES approach are to address the biological, psychological and sociocultural aspects of weight problem, to emphasize the importance of health and well-balanced life independently of body weight, and to improve lifestyle habits. Previous studies have demonstrated decreases in disinhibition and hunger with a HAES approach[5,6] and some studies have demonstrated that eating behaviors are associated with energy intake and adiposity[7-9]. In fact, dietary restraint, more specifically flexible restraint, has been associated with a decrease in energy intake and body mass index (BMI)[8,9]. Inversely, disinhibition has been associated with an increase in energy intake and BMI[8,10].

Although a HAES approach does not prescribe or suggest specific dietary intakes or eating patterns, part of the intervention is dedicated to information, discussions and reflections toward food intakes. Moreover, because changing eating behaviors represents an important target of the HAES approach, it is possible that changes in eating behaviors could be translated into dietary changes. For these reasons, we believe that it is relevant to determine whether dietary intakes and eating patterns are modified in response to a HAES intervention among premenopausal overweight women, and to determine whether changes in eating behaviors following a HAES intervention are associated with changes in dietary intakes and eating patterns.

2. Methods

2.1 Participants

The data were collected among a sample of 140 premenopausal overweight or obese women (mean age of 42±5.6 years) who voluntarily agreed to participate in the research project and who were recruited through different media advertisements in the Québec City Metropolitan area. Women included in the study were overweight or obese (BMI between 25 and 35 kg/m^2), had a stable weight (±2.5 kg) for a minimum of two months prior to the beginning of the study, were not currently dieting to lose weight, were not taking oral contraceptives, were not pregnant or lactating, were not presenting metabolic or important psychological disorders including anorexia and bulimia, had no drug addiction or alcoholism problem, and were not under treatment for coronary heart disease, diabetes, dyslipidemia, depression, or endocrine disorders (except stable thyroid disease). Before participation to the study, each woman signed an informed consent document, which was approved by the Laval University Research Ethics Committee.

2.2 Study Design

This study is a randomized parallel controlled trial. Randomization was performed by a research professional (LC) using sequentially numbered containers (from 1 to 3), within four equal phases (September 2003, January 2004, September 2004, and January 2005), during which the same tests and intervention were performed. Women were assigned to one of the 3 treatment conditions: Health-At-Every-Size group (HAES) (n=48), social support group (SS) (n=46), or control group (n=46), as previously described[5]. Women were tested during the follicular phase of their menstrual cycle to control for potential impact of hormonal variation on nutritional

variables, except for four women (3 were assigned to the HAES intervention; 1 woman was assigned to the control group) who were tested at another point in their cycle. However, when we excluded these women from analyses, similar results were observed, which explained why we kept them in the final analyses.

2.3 Description of Treatment Conditions

The HAES intervention (n=48) was conducted among small groups of about 12 women, and 14 weekly sessions were scheduled (13 three-hour evening sessions and 1 intensive-day session of 6 hours). For each phase of the intervention, the same registered dietitian and clinical psychologist were in charge of the group and had previously received intensive training to provide the HAES approach. This HAES intervention, named Choisir de Maigrir? ("What about losing weight?"), focus on general well-being and positive ways of having a healthy and satisfying lifestyle. This intervention is aiming at enhancing awareness and knowledge about biological, psychological, and sociocultural aspects of body weight. A complete workbook was given to each woman, so that she can be guided by the health professional through self-reflection and observations, group discussions, practical exercises, and lectures. Different topics were discussed during sessions (e.g., enjoyment of physical activity and healthy nutrition, identification of realistic objectives as regard to body weight management, recognition of internal cues of hunger and satiety, identification of external influences on eating behaviors and food intake, and acceptation of their own and others' body image). In the HAES group, interveners were active leaders, providing specific information and structured activities to women.

Similarly to the HAES group, the SS intervention (n=46) was conducted in small groups of 12 women and for 14 weekly sessions (14 two-hour evening sessions). To control for potential bias

related to providers, the same registered dietitian and clinical psychologist involved in the HAES intervention were also in charge of the SS group for the 4 phases of the project. Every HAES and SS session was videotaped and reviewed by two investigators (SL; CB) of the study to ensure that both interventions were appropriate. The main objective of the SS intervention was to reproduce a structural social support provided by the group itself. More specifically, each theme discussed in the HAES group was also discussed in the SS group, following the same chronology and women offer their support to each other. However, the registered dietitian and the clinical psychologist were not active leaders (as in the HAES group) but were rather acting as facilitators in the group discussion and were not influencing the content and the direction of the discussion. Therefore, no specific information, exercise, or counselling was provided to women. Moreover, they did not receive any verbal nor printed information from the interveners.

The control group (n=46) was a waiting list control condition in which women were instructed to follow their usual lifestyle habits. Women in this group did not receive any form of contact from the research team during the 4-month intervention period and were invited for post-intervention testing, as performed for HAES and SS groups.

2.4 Measurements of Dependent Variables

All measurements were taken at baseline (T=0) and at the end of the intervention period (T=4 months) in the 3 treatment conditions and for all women under study.

2.4.1 Eating Behaviors

The Three-Factor Eating Questionnaire (TFEQ) is a 51-item validated questionnaire[11-13] which assesses three factors that refer to cognitions and behaviors associated with eating: dietary

restraint (conscious control of food intake with concerns about shape and weight), disinhibition (overconsumption of food in response to a variety of stimuli associated with a loss of control on food intake), and hunger (food intake in response to feelings and perceptions of hunger). More specific subscales can also be derived from these three general eating behaviors[14,15], as previously described[5]. In the present study, subscales of hunger were analysed. More specifically, external hunger refers to hunger triggered by external cues, contrary to internal hunger which is interpreted and regulated internally[15].

2.4.2 Dietary Variables

Self-reported dietary intakes were assessed by a 3-day food record, which included two weekdays and one weekend day[16]. The food record was explained and reviewed by experimented registered dietitians. Participants were asked to complete the 3-day food record on days where usual amounts and types of foods and drinks were consumed. Each subject had to report quantities of foods and drinks as accurately as possible using a scale (Terraillon (based on a spring mechanism), model number T280, with a graduation of 10 g and a maximal capacity of 500 g, made in China) that was provided for the project, and also had to identify the time of the day and the location for each eating occasion. Dietary intakes were evaluated using the Nutrition Data System for research software (version 4.03, developed by the Nutrition Coordination Center, University of Minnesota, Minneapolis, MN, Food and Nutrient Database 31, released in November 2000)[17].

2.4.3 Eating Patterns

The combined information provided by the 3-day food record about the time of the day and the type of foods and drinks consumed at each eating occasion allowed the setting of eating patterns.

A meal was represented by breakfast, lunch or dinner and constituted of an eating occasion taken at regular hours, and according to the order of the subject's description in the food record, whereas a snack was represented by any other eating occasion that occurred during the day, evening or night, and usually constituted of an eating occasion taken at irregular hours. The identification of the eating occasions (as meals or snacks) was done by the same experimented registered dietitians who computerized dietary intakes from the food record. To determine the influence of the time of the day on total daily food intake, some interval periods were established to capture peak intake, as observed in previous studies including North American subjects[18]. Accordingly, meals and/or snacks consumed before and after 5:00 pm were assessed, and energy and nutrient intakes associated with these periods were calculated.

2.4.4 Anthropometric Profile

According to standardized procedures[19] height was measured to the nearest millimeter with a stadiometer (Stadiometer HR-100, Tanita, Arlington Heights, IL), body weight was measured to the nearest 0.1 kg on a calibrated balance (BWB-800S Digital scale, Tanita), and BMI was then calculated. Waist circumference measure was also taken to the nearest millimeter according to standardized procedures[19]. Women were asked to dress lightly and to remove their shoes for these measurements.

2.4.5 Resting metabolic rate and Activity diary

Resting metabolic rate (RMR) was assessed in the fasting state by indirect calorimetry measurements (mouthpiece and nose-clip protocol), using a MOXUS Modular VO_2 System (AEI Technologies, Naperville, IL)[20]. Women were required to lie supine in a comfortable position and were asked to breathe normally through a Hans-Rudolph mouthpiece with nose-clip. Moreover,

women were also asked not to fidget during the measurements. VO_2 and VCO_2 (and thus RMR) measures were collected as breath-by-breath samples and averaged at 1-minute intervals for 15 minutes. A 3-day activity diary including 2 weekdays and 1 weekend day was used to measure moderate and intense physical activity level, as previously reported[5].

2.5 Statistical Analyses

To estimate the sample size required in our study, power analyses were performed using G*Power statistical software (version 3.0.10, 1992-2008, Kiel University, Kiel, Germany). Based on the possibility to detect significant differences with a small effect-size estimate (Cohen's *d* estimate of 0.15[21]), power analyses for repeated measures, and within-between interactions indicated that a total sample size of n=120 would be sufficient to detect significant differences in the outcomes under study with an α=0.05 and a power (1-ß error probability) of 0.95. Analyses were performed using the MIXED procedure, which allow the inclusion of participants with missing data at some time points[22]. The MIXED procedure for repeated measurements was performed to determine differences within and between groups regarding dietary intakes and eating patterns changes. In order to consider possible underreporting as a potential limit in our study, cut-off limits were used, as proposed by Goldberg et al.[23]. These cut-off limits have been developed to identify subjects with a self-reported energy intake below 1.35 x basal metabolic rate (BMR), since such an intake cannot be representative of long-term intakes in weight stable subjects. Although the RMR value for a given subject is usually slightly higher than their BMR value, it was reported that Schofield equations tend to overestimate BMR value and thus, this predicted BMR value is unsuitable, especially among obese populations[24]. Accordingly, predicted BMR of women in our sample was slightly higher than measured RMR (data not shown), which explains why we have decided to use RMR in our calculations and to identify women who had

reported total energy intake below the cut-off point of 1.35 x RMR. The second part of our analyses focused on associations between significant changes in eating behaviors that occurred more specifically in response to HAES intervention[5] and changes in eating patterns. More specifically, we have previously shown that hunger and external hunger decreased significantly more in response to the HAES intervention than what was observed in the SS intervention and in the control group. Pearson's correlation analyses were then conducted in the HAES group to test for univariate associations between variables. The probability level for significance used for the interpretation of all statistical analyses was set at a α level of $p<0.05$. All analyses were performed using SAS statistical software (version 9.1, SAS Institute Inc., Cary, NC).

3. Results

Table 1 shows women's characteristics at baseline. Women reported a mean total daily energy intake of 2016±447 kcal, with about 34% of total energy intake from lipids, 47% from carbohydrates, 18% from proteins, and 3% from alcohol. Moreover, 20% of total energy intake was consumed at breakfast, 27% at lunch, 37% at dinner and 16% as snacks. In addition, **Table 2** shows mean values for eating behaviors at baseline within each group.

3.1 Dietary intakes, eating patterns and body weight changes in response to the intervention

As shown in **Table 3**, trends for significant group by time interaction were observed for proportion of energy intake from alcohol (p=0.06) and for body weight (p=0.10). For the proportion of energy intake from alcohol, none of the simple effect of time measured within each group was significant. Although no group by time interaction was observed for energy intake nor physical activity level (physical activity data not shown), the decrease in body weight was found to be significant only within the HAES group (p=0.0008 for HAES, p=0.42 for SS, p=0.91 for control) but no between-group difference was observed for body weight measured at 4 months. For all other variables, including waist circumference, no group by time interaction was observed. A significant time effect was observed for overall energy intake (main effect of time; p=0.045). However, simple effect of time within each group was not significant. Regarding eating patterns, no group by time interaction was found for any of the variables studied (**Table 4**). However, snack frequency (main effect of time; p=0.0004) decreased with time, and simple effect of time tended to be significant only in HAES (p=0.06). Also, the proportion of energy intake from snacks tended to increase in response to the intervention (main effect of time; p=0.06), but none of the simple effect of time measured within each group was significant.

Moreover, a significant main effect of time was observed for the proportion of energy intake from breakfast (p=0.03), but once again, none of the simple effect of time measured within each group was significant.

3.2 Associations between changes in eating behaviors and changes in eating patterns in response to the HAES intervention

Pearson's correlation analyses were conducted to determine if significant changes in eating behaviors that occurred more specifically during the HAES intervention could be related to dietary intakes and eating patterns changes. As shown in **Table 5**, changes in hunger and external hunger measured by the TFEQ were positively associated with changes in total daily energy intake (r=0.50, p=0.0009 and r=0.50, p=0.0007, respectively) observed in response to the HAES intervention. Moreover, changes in hunger tended to be inversely associated with changes in the proportion of energy intake consumed at breakfast (r= -0.27, p=0.09).

4. Discussion

The present study examined changes in dietary intakes and eating patterns in a sample of premenopausal overweight women in response to a HAES intervention, compared to a SS intervention or a control group. It was found that total daily energy intake and snack frequency decreased whereas the proportion of energy intake from breakfast increased significantly with time, but irrespective of the intervention received. We also found that within the HAES group, decreases in hunger and external hunger were associated with a decrease in overall energy intake.

To our knowledge, this is the first intervention study that assessed dietary intakes and eating patterns changes in response to a HAES intervention. Overall, our results showed that the HAES had no specific effect on either dietary intakes or eating patterns. In fact, we hypothesized that some of the intervention content about nutrition could lead to changes in dietary profile. Moreover, we thought that changes in eating behaviors which were found to be significant in response to our intervention[25] could be translated into concrete and significant changes in food consumption and nutrient intakes.

The decrease in body weight (-1.4 kg) in the HAES group was more important than what could be predicted by the change in energy intake (-15 kcal/day), and on the other hand, the decrease in body weight (-0.5 kg) in the control group was smaller than what could be predicted by energy intake changes (-176 kcal/day). Although the food record is considered as the gold standard for dietary assessment, this tool has some limitations and the precision in estimating the real energy intake is far from being perfect[26]. The presence of underreporters can influence the precision of this assessment method. While cut-off limits proposed by Goldberg et al. [23] can be used to

evaluate the importance of underreporting at baseline, proportion of women underreporting at the end of the intervention remains difficult to evaluate because some women were in the process of weight change. A total of 41 women (29% of our sample of women) were considered underreporters at baseline. When excluding these underreporters from analyses, changes in body weight and in energy intake were similar as values obtained with the total sample (results not shown). The discrepancy between energy intake changes and body weight changes could also be explained by an increase in physical activity level. However, no group by time interaction nor time effect occurred for physical activity level in response to the intervention.

Some explanations might be proposed to explain the absence of specific effect of the HAES on dietary profile. Although some issues related to food and nutrition were addressed during the intervention, it was clearly not a main target of the HAES approach, which emphasizes the importance of healthy lifestyle habits, intuitive eating by recognition of internal cues of hunger and satiety, and healthy attitudes and behaviors towards food intake. Moreover, during the intervention, women established their own objectives in regards of their food habits and/or eating behaviors and did changes that they were willing to initiate. This could have led to large heterogeneity in changes, and could then partially explain the absence of significant change in dietary profile following the HAES intervention. As suggested by Blundell et al.[27], the inter-individual variability could possibly be explained by a variety of psychobiological factors such as physiological signalling, psychological responsiveness, traits and states (hunger and satiety control) of women. In addition, our group of women had, prior to the intervention, a dietary profile with macronutrient proportions that agreed with Health Canada Recommendations according to Acceptable Macronutrient Distribution Ranges[28]. In that context, there is less room for improvement in response to any kind of intervention.

The use of self-reported measures to assess eating behaviors and dietary intakes may not be sufficient to grasp all dimensions of behavioral aspects of eating. Therefore, it could have been of interest to perform an *ad libitum* test meal to evaluate the propensity to overeat more accurately and to assess appetite sensations, but also to evaluate dietary intakes and eating patterns more precisely.

Although no significant change was observed in dietary intakes and eating patterns on a group basis, heterogeneity in responses was observed. For example, within the HAES group, changes in the proportion of energy intake consumed after 5:00 pm varied from -39.4% to 24.3% in response to the intervention. This heterogeneity in responses prompted us to pursue our analyses aiming at putting into correlation changes in eating behaviors with changes in dietary variables and eating patterns. As previously observed in other studies[8,9], it was found that decreases in hunger and external hunger were associated with a decrease in overall energy intake, which suggests that women who decreased the most their hunger score in response to the HAES intervention are the ones who are more susceptible to better regulate their total daily energy intake. These findings suggest that changes in eating behaviors are concretely related to some changes in food intakes in a beneficial manner specifically in response to a HAES approach. Also, our results showed that within the HAES group, eating behaviors might be associated with eating patterns with a trend for a negative association between changes in hunger and changes in the proportion of energy intake from breakfast. Finally, additional analyses revealed that within the HAES group, all changes according to dietary intakes and eating patterns were maintained 6 months following the end of the intervention, which suggests that women achieved changes but were also able to maintain these during follow-up (data not shown). Taken together, these results suggest that

women who respond the most to a HAES intervention by decreasing hunger would experience a greater decrease in overall energy intake, which might be in part explained by a more important increase in proportion of energy intake consumed at breakfast.

This study has some limitations. It is possible that the presence of underreporting in restrained eaters[29] as well as potential desirability bias may have compromise the accuracy of the assessment of food intake. Moreover, because of the current inconsistencies in the literature about meal and snack definitions[30] and the manner of determining two distinct eating occasions[31-33], comparisons between studies and interpretation of our results for eating patterns is more difficult. However, some characteristics of the design of this study are important strengths that need to be considered. First, this study is a randomized control trial. Second, dietary intakes were assessed with food records which allowed the determination of eating patterns. Third, women were tested during the follicular phase of their menstrual cycle to control for potential impact of hormonal variation on nutritional variables. Also, our study brings original knowledge. In fact, no study had yet investigated how a HAES intervention aiming at promoting healthy eating behaviors and giving education about food and nutrition could influence dietary intakes and eating patterns in overweight women. Finally, it is worth mentioning that HAES approach promotes healthy eating behaviours without dieting, and obviously does not seem to have negative impact on dietary quality nor body weight.

In summary, our results showed that a HAES intervention seems to have no specific impact on dietary variables and eating patterns but suggest that women who will respond the most to the HAES intervention by decreasing hunger would also show a greater decrease in overall energy intake. The trend towards a more pronounced weight loss during the HAES program suggests that

on the long term, such an approach could be efficient for a healthy body weight management even though it is not the primary goal targeted in this approach.

Conflict of Interest Statement and Statement of Authorship

All authors have participated sufficiently in the work to take public responsability for the content of the paper and have read and approved the final manuscript. Authors report no conflict of interest.

Contribution

V.L. analyzed the data and wrote the manuscript. V.P. supervised the study, collected the data and reviewed the manuscript. C.B. supervised the study and reviewed the manuscript. L.C. supervised the study, collected the data and reviewed the manuscript. A.T. reviewed the manuscript. S.L. designed the study, supervised the study and reviewed the manuscript.

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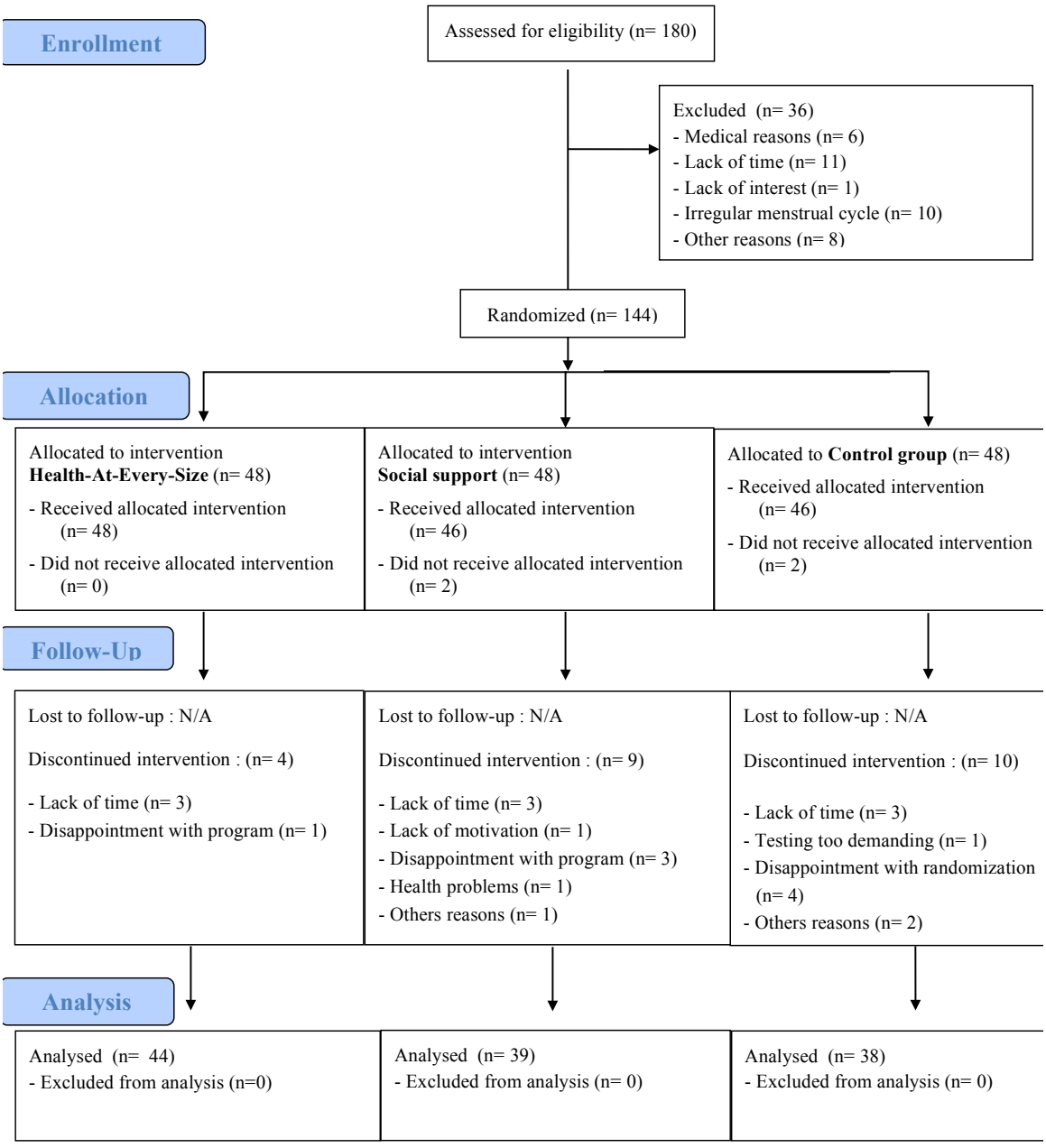

Figure 1: Study Design

Table 1. Characteristics of women included in the study at baseline (n=140)

	Means± SD	**Minimum**	**Maximum**
Age (years)	42.4 ± 5.6	28.0	51.0
Body weight (kg)	80.3 ± 9.3	61.2	106.5
Waist circumference (cm)	93.4 ± 8.2	76.8	112.0
BMI (kg/m^2)	30.4 ± 3.0	25.0	37.5
Energyintake (kcal) [a]	2016 ± 447	871	3484
Lipid (% energy)	34.2 ± 5.1	20.8	46.6
Carbohydrate (% energy)	47.2 ± 5.4	34.5	62.8
Protein (% energy)	17.5 ± 3.4	9.1	30.5
Alcohol (% energy)	3.3 ± 3.4	0	16.8
Fibers (g)	20.7 ± 6.8	8.8	51.9
Calcium (mg)	895 ± 339	280	2 291
Sodium (mg)	3 049 ± 944	1 089	7 414
Mealfrequency (n/d)	2.9 ± 0.3	2.0	3.7
Snack frequency (n/d)	2.4 ± 1.7	0	10.3
Energy from breakfast (% energy)	20.0 ± 7.0	2.6	40.7
Energy from lunch (% energy)	26.8 ± 8.0	7.2	56.3
Energy from dinner (% energy)	36.6 ± 9.8	0	60.9
Energy from snacks (% energy)	16.1 ± 11.6	0	75.0
Energy after 5:00 pm (% energy)	42.5 ± 9.9	14.6	61.7
Energy from snacks after 5:00 pm (% energy)	7.6 ± 7.4	0	45.2

SD= Standard deviation.

[a]Some participants did not complete the 3-day food record (n=7).

Table 2. Eating behaviors at baseline within each group

	HAES	**SS**	**Control**
Eating behaviors	Mean ± SD	Mean ± SD	Mean ± SD
Dietary restraint	9.5 ± 3.6	8.8 ± 4.2	8.0 ± 3.9
Disinhibition	9.7 ± 3.1	8.8 ± 2.7	9.3 ± 3.0
Hunger	5.5 ± 3.9	5.6 ± 3.3	5.6 ± 3.2

SD= Standard deviation.

Eating behaviors:

Baseline : HAES group, n= 48; SS group, n= 46; control group, n= 46.

Post-intervention (t=4) : HAES group, n= 44; SS group, n= 39; control group, n= 38.

Table 3. Dietary intakes and body weight pre *vs* post intervention

	HAES	**SS**	**Control**	**Difference between groups**	
Variables	Mean ± SD	Mean ± SD	Mean ± SD	Effect	*P*
Body weight (kg) [b]				Time	0.0001
Baseline	78.8 ± 9.0	81.3 ± 10.0	80.8 ± 8.7	Group	0.2245
T=4 months	77.4 ± 8.4 [d]	80.5 ± 10.0	80.3 ± 9.1	Time x Group	0.1011
Energy intake (kcal) [c]				Time	0.0450
Baseline	2013 ± 531	2 029 ± 394	2 006 ± 399	Group	0.4949
T=4 months	1 998 ± 474	1 976 ± 365	1 830 ± 467	Time x Group	0.3329
Lipid (% energy)				Time	0.3508
Baseline	34.5 ± 5.5	33.5 ± 4.5	34.5 ± 5.1	Group	0.9465
T=4 months	34.8 ± 7.1	35.4 ± 4.7	34.0 ± 4.8	Time x Group	0.3328
Carbohydrate (% energy)				Time	0.4407
Baseline	47.3 ± 5.4	47.6 ± 5.0	46.8 ± 5.8	Group	0.9385
T=4 months	46.2 ± 7.0	47.0 ± 7.6	47.5 ± 5.9	Time x Group	0.5639
Protein (% energy)				Time	0.4906
Baseline	17.5 ± 3.5	17.3 ± 3.2	17.7 ± 3.5	Group	0.1507
T=4 months	17.7 ± 3.3	16.6 ± 3.4	18.9 ± 4.7	Time x Group	0.1438
Alcohol (% energy)				Time	0.7354
Baseline	3.0 ± 2.7	3.8 ± 4.3	3.0 ± 3.0	Group	0.2251
T=4 months	3.9 ± 3.5	3.3 ± 4.5	2.0 ± 2.5	Time x Group	0.0615
Fibers (g)				Time	0.5202
Baseline	21.6 ± 8.2	20.6 ± 6.7	19.9 ± 4.8	Group	0.4462
T=4 months	22.6 ± 8.8	21.3 ± 7.8	20.4 ± 6.5	Time x Group	0.9410
Sodium (mg)				Time	0.1865
Baseline	2977 ± 1077	3121 ± 885	3052 ± 851	Group	0.2418
T=4 months	2824 ± 574	3120 ± 699	2872 ± 914	Time x Group	0.5774
Calcium (mg)				Time	0.6728
Baseline	921 ± 399	897 ± 289	860 ± 318	Group	0.2480
T=4 months	968 ± 359	917 ± 307	792 ± 280	Time x Group	0.4213

SD= Standard deviation.

Body weight:

Baseline : HAES group, n= 48; SS group, n= 46; control group, n= 46.

Post-intervention (t=4) : HAES group, n= 44; SS group, n= 39; control group, n= 38.

Dietary variables:

Baseline : HAES group, n= 48 ; SS group, n= 46; control group, n= 39 .

Post-intervention (t=4) : HAES group, n= 42; SS group, n= 37 ; control group, n= 34.

[b] Some participants did not complete the testing.

[c] Some participants did not complete the 3-day food record.

[d] Significantly different from the baseline value.

Table 4. Eating patterns pre *vs* post intervention

	HAES	**SS**	**Control**	**Difference between groups**	
Variables	Mean ± SD	Mean ± SD	Mean ± SD	Effect	*P*
Meal frequency (n/d) [e]				Time	0.8665
Baseline	2.9 ± 0.3	2.9 ± 0.2	2.9 ± 0.2	Group	0.7468
T=4 months	3.0 ± 0.3	2.9 ± 0.2	2.9 ± 0.2	Time x Group	0.4694
Snack frequency (n/d)				Time	0.0004
Baseline	2.8 ± 2.0	2.2 ± 1.2	2.1 ± 1.7	Group	0.1072
T=4 months	2.2 ± 1.6	1.8 ± 1.1	1.7 ± 1.3	Time x Group	0.7615
Energy from breakfast (% energy)				Time	0.0275
Baseline	19.5 ± 6.8	19.6 ± 7.5	21.0 ± 6.7	Group	0.5953
T=4 months	21.3 ± 7.0	22.3 ± 5.7	22.1 ± 6.9	Time x Group	0.8149
Energy from snacks (% energy)				Time	0.0552
Baseline	18.4 ± 13.9	15.0 ± 8.7	14.5 ± 11.3	Group	0.4011
T=4 months	14.9 ± 10.6	13.4 ± 9.1	13.3 ± 11.0	Time x Group	0.4690
Energy after 5:00 pm (% energy)				Time	0.5672
Baseline	41.4 ± 10.3	42.2 ± 9.9	44.3 ± 9.5	Group	0.1310
T=4 months	40.3 ± 9.0	42.1 ± 10.0	43.6 ± 8.2	Time x Group	0.8933
Energy from snacks after 5:00 pm (% energy)				Time	0.2308
Baseline	8.4 ± 7.8	6.5 ± 5.5	7.9 ± 8.7	Group	0.4818
T=4 months	7.1 ± 7.3	5.9 ± 6.0	6.8 ± 7.6	Time x Group	0.7879