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## Lifestyle intervention in obese infertile women

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# Determinants of successful lifestyle change during a six-month preconception lifestyle intervention in infertile obese women: secondary analysis of a randomized trial

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## Abstract

**Background:** Improving lifestyle is difficult and most interventions induce modest changes in target behaviors. Within the intervention arm of a lifestyle intervention trial we aimed to identify determinants for successful lifestyle change and program completion.

**Methods:** We used data of 289 obese infertile women from the intervention arm of a randomized controlled trial. The preconception six-month lifestyle intervention program consisted of dietary counseling, increased physical activity and individualized behavioral modification. We operationalized lifestyle change as successful weight loss (reduction of  $\geq 5\%$  of the original body weight or a BMI  $\leq 29$  kg/m<sup>2</sup>), weight loss in kilograms, a reduction in energy intake and an increase in the number of steps. Logistic and mixed effects regression analyses were performed to identify independent determinants of success during the intervention.

**Results:** Women with higher scores on external eating behavior had a higher probability of successful weight loss (OR 1.07, 95%CI 1.02 to 1.13). Women with a higher BMI and previous support by a dietician had a lower probability of successful weight loss (OR 0.91, 95%CI 0.83 to 1.00 and OR 0.53, 95%CI 0.28 to 0.98, respectively). On average, women who received previous support by a dietician lost 0.93 kg less weight (0.01 to 1.85kg) than women without a history of support. Women with a higher self-efficacy level had a lower mean energy intake relative to women with the lowest self-efficacy level ( $P < 0.01$ ). There was a trend in women with increased readiness to change towards taking more daily steps ( $P = 0.05$ ). The readiness to change towards weight loss was associated with completion of the intervention ( $P = 0.04$ ), with women in the action phase having a higher probability of completing the intervention compared to women in the maintenance phase.

**Conclusions:** Despite the large variation in lifestyle change and weight loss, and the many determinants assessed, few determinants were associated with lifestyle change. The most consistent determinants for lifestyle change in obese infertile women were: not previously receiving dietetic support and readiness to change. We still lack sufficient knowledge on determinants of successful lifestyle change. This knowledge is needed to improve future efforts to help people improve their lifestyle and thereby lose weight.

## Background

In 2000, the World Health Organization declared obesity a pandemic and one of the most important current public health problems.<sup>1,2</sup> Overweight and obesity are major risk factors for a number of chronic diseases, including diabetes, cardiovascular diseases and cancer.<sup>3</sup> <sup>4</sup> In the Netherlands in 2012, 6% of women aged 20 to 29 years and 10% of those aged 30 to 39 years were obese.<sup>5</sup> In the United States 37% of women of reproductive age were obese in 2013-2014<sup>6</sup>. In women, obesity is associated with higher rates of infertility, lower pregnancy rates, higher rates of obstetric complications<sup>7-9</sup> and it negatively affects maternal future health as well as health of the offspring.<sup>10</sup>

To decrease the risks of obesity-related diseases, treatment consisting of lifestyle optimization, through a comprehensive program of lifestyle modification, is recommended.<sup>10-13</sup> However, lifestyle change has been proven to be difficult and most lifestyle interventions have been shown to induce only modest changes in target behaviors.<sup>13-15</sup> Furthermore, treatment success is reduced because of the relatively high non-completion rates of intervention programs.<sup>16,17</sup> The preconception period seems to be a time in which women are particularly receptive to advice on diet and lifestyle. Studies have shown that interventions aimed at smoking cessation are more successful in women who intend to become pregnant.<sup>18, 19</sup> Potential beneficial effects on the health of a future child have been reported to be an important motivator for women to change their lifestyle.<sup>20</sup> In addition, psychosocial and behavioral variables have been shown to influence lifestyle change success.<sup>21, 22</sup> Further knowledge on determinants of success or failure to achieve lifestyle change through lifestyle intervention programs is important, since this could assist in designing more individualized interventions.<sup>13</sup>

We conducted the LIFEstyle study, a randomized controlled trial (RCT) including 577 infertile obese women, comparing the effects of a six-month preconception lifestyle intervention preceding infertility treatment to prompt infertility treatment.<sup>17</sup> The intervention was effective in changing lifestyle and inducing weight loss. However 22% of women did not complete the intervention.<sup>17</sup> The purpose of the current study, using prospectively collected data within the intervention arm of the RCT, was to investigate determinants of successful lifestyle change and completion of the intervention program in obese infertile women.

## Methods

This study used data of the LIFEstyle study, which was a multicenter RCT in obese infertile women (Body-Mass Index [BMI]  $\geq 29$  kg/m<sup>2</sup>) aged between 18 and 39 years. The design and main results of the LIFEstyle study have been reported previously.<sup>17,23</sup> For the current study we only used the data of women randomized to receive the intervention (N=289).

### Lifestyle intervention

During the LIFEstyle study, women in the intervention group participated in a six-month structured lifestyle intervention program, which was aimed at a weight loss of at least 5% of the original body weight. When the target weight reduction was met, or when BMI had decreased to below 29 kg/m<sup>2</sup>, or after completion of the six-month program, couples were eligible for infertility treatment.

The lifestyle program consisted of a combination of dietary counseling, an increase in physical activity and an individualized behavioral modification plan.<sup>11, 24, 25</sup> Four individual consultations at the local hospital were planned in the first three months of the intervention and two additional sessions in the last three months. In between, four consultations by telephone or e-mail were scheduled. Trained intervention coaches who had a degree in nursing or dietetics guided participants. Coaches used a standardized software module to minimize practice variation. Information, including body measurements, energy intake and physical activity, was captured in this system. Participants were advised to consume a healthy diet with a caloric reduction of approximately 600 kilocalories (kcal) per day compared to their habitual energy intake, but not below 1200 kcal/day. Besides the consultations, participants received feedback on food and energy intake on a daily basis using a web-based food diary "Eetmeter" of the Netherlands Nutrition Center.<sup>26</sup> In addition, participants were advised to be moderately intense physically active (60-85% of maximum heart rate frequency) for at least 30 minutes two to three times a week and to increase physical activity in daily life by taking 10,000 steps per day monitored by a pedometer (Yamax Digi-Walker SW 200, Develing International®, Bunschoten, The Netherlands). A diary was kept on these physical activities to establish self-monitoring. During the intervention, individual goals were evaluated, participants received feedback from the intervention coaches and goals were adapted if necessary.

### Lifestyle change and completion of the intervention program

In this exploratory analysis we aimed to identify determinants of lifestyle change and completion of the intervention program. We operationalized lifestyle change using the following dichotomous and continuous outcomes: successful weight loss, continuous

weight loss, change in daily energy intake and change in daily number of steps during the intervention program. Successful weight loss was defined as weight loss of at least 5% of original body weight or reaching a BMI  $\leq 29.0$  kg/m<sup>2</sup> within the six-month intervention period, as this was also the aim of the intervention program. Weight loss in kilograms was also evaluated as a continuous outcome. Since weight loss is the result of the balance between energy intake and energy expenditure, we also analyzed the continuous variables 'change in mean energy intake in kilocalories per day', as measured by the web-based "Eetmeter"<sup>26</sup> and 'change in the mean number of steps per day', as measured by the pedometer. All changes were calculated using the difference between baseline consultation and the last consultation during the intervention. When a woman became pregnant during the intervention period, subsequent continuous outcome measurements were censored from the longitudinal analysis.

In addition, we investigated determinants of completion of the lifestyle intervention. Women were considered to have completed the intervention when they did not miss more than two consecutive coaching sessions or finalized the intervention at six months independent of the amount of weight loss. When a woman became pregnant or achieved successful weight loss, the intervention was also considered completed.

### **Determinants of lifestyle change**

Possible determinants of lifestyle change and data of questionnaires were all assessed at baseline and categorized into several domains, namely:

- *Demographic characteristics:* age, ethnicity, education level, socioeconomic status (SES) and smoking of the woman were based on medical records. The SES was based on the postal code using the status score from 2010, developed by the Netherlands Institute for Social Research.<sup>27</sup> This score reflects the social status of a neighborhood, compared to other neighborhoods in the Netherlands. A positive score represents a higher socioeconomic status, relative to the Dutch overall average of 0 (range -5.27 – 2.15).
- *Infertility characteristics:* duration of infertility in months, nulliparity, presence of anovulation, male factor infertility or unexplained infertility were retrieved from medical records.
- *Anthropometric and weight characteristics:* BMI in kg/m<sup>2</sup>, waist in cm and waist-hip ratio were measured by the intervention coach. Highest and lowest body weight over a period of the last ten years, highest weight ever, weight variability in kg (calculated

using the highest and lowest body weight during the past ten years) and the number of previous weight loss attempts during the last five years were all retrospectively questioned.

- *Metabolic characteristics.* Degree of insulin resistance was quantified using the homeostasis model assessment of insulin resistance (HOMA-IR). This model was defined as fasting insulin concentration in  $\mu\text{U/mL}$  multiplied by fasting glucose concentration in  $\text{mmol/L}$  divided by 22.5.<sup>28</sup> Presence of metabolic syndrome was identified using the 2001 revised National Cholesterol Education Program Adult Treatment Panel (rNCEP ATP III) criteria.<sup>29</sup>
- *Psychosocial characteristics.* Quality of Life (QoL) was assessed with the Short Form-36 (SF-36) questionnaire,<sup>30, 31</sup> which measures overall physical and mental QoL. The readiness to change was based on the transtheoretical model of Prochaska and DiClemente.<sup>32</sup> This model describes five stages of change; 1) precontemplation, 2) contemplation, 3) preparation, 4) action and 5) maintenance. The readiness to change towards weight loss was derived from the following question: 'Are you trying to lose weight?', with possible answer categories ranging from: 1) 'No, and I am not planning to do so in the coming six months' to 5) 'Yes, I'm already trying to lose weight for more than six months. The readiness to change towards physical activity was derived from the answer categories ranging from: 1) 'At the moment I am not physically active at a regular basis and I do not intend to start in the near future' to 5) 'During the past year I engaged in an intense workout at least three times a week'. Previous support in losing weight (either by dietician or partner) or receiving no support were derived asking whether the following statements were applicable: 'I received help from a dietician', 'I received help from my partner' or 'I did not receive any support'. Self-efficacy, using the question 'I think I'll manage to reach my goal weight, when I'm trying to lose weight' and body satisfaction, using the statement 'I am satisfied with my own body weight', were answered on a 5-point Likert scale. We assessed three subscales of the Dutch Eating Behavior Questionnaire (DEBQ):<sup>33</sup> emotional eating, external eating, and restrained eating. Emotional eating is described as: eating in response to emotional arousal states such as fear anger or anxiety. External eating: eating in response to external food cues such as sight and smell of food. Restraint eating: overeating after a period of slimming when the cognitive resolve to diet is abandoned.<sup>33</sup>
- *Diet and physical activity characteristics:* Mean energy intake in kcal per day was estimated using a web-based food diary of the Netherlands Nutrition Center and mean steps per day were monitored using a pedometer. Meeting the recommendations for

fruit and vegetable intake were based on the Dutch Guidelines for a healthy diet 2006,<sup>34</sup> which advises a minimal recommended fruit and vegetable intake of 200 grams per day of which a maximum of 100 grams of fruit could be substituted by 1 glass of fruit juice. Dietary intake was assessed using a Food Frequency Questionnaire (FFQ). The first part of the FFQ was based on the standardized questions on food consumption used for the Public Health Monitor in the Netherlands.<sup>35</sup> The FFQ comprised 37-items including questions on type of cooking fat, type of bread, frequency of breakfast use, frequency of consumption and portion size of vegetables, fruits, fruit juices, snacks, sugar containing and alcoholic beverages, and creamer and sugar in coffee and tea. To assess the total amount of moderate to vigorous physical activity and if participants met the Dutch guidelines for physical activity, the validated Short Questionnaire to Assess Health-enhancing physical activity questionnaire (SQUASH) was used.<sup>36</sup> Based on the Ainsworth's compendium of Physical activities<sup>37</sup>, activities were subdivided into 2-<4 Metabolic Equivalent of Task (MET, light), 4-< 6.5 MET (moderate), and  $\geq 6.5$  MET (vigorous). These cut-off points were chosen based on the Dutch physical activity guideline.<sup>38</sup>

- *Partner characteristics:* age, BMI, ethnicity and smoking behavior of the partner were based on medical records.

### Statistical analyses

Descriptive statistics are given as  $n$ , %, median and interquartile range (IQR) where appropriate. We examined the data regarding determinants and outcomes for plausibility, excluding outliers from further analyses. We omitted outliers in mean energy intake (< 500 and > 5000 kcal per day) and steps (> 40 000 steps per day). In addition, all continuous variables used as determinants were screened for outliers and improbable values were omitted.

Univariate logistic regression analyses were performed in order to identify determinants of the dichotomous outcomes. The results of the logistic regression analyses are reported as the odds ratio (OR) with the corresponding 95% confidence interval (CI). Mixed effects regression analysis was performed to identify determinants of lifestyle change on the repeated measurements of the continuous outcomes (weight, energy intake and number of steps). Mixed effects regression analysis handles non-independent data, such as repeated measurements, and in contrast to ANOVA analysis it is not limited to complete-case analysis. We performed baseline correction by introducing the baseline measurement of the dependent variable as a covariate in the mixed effects regression models and we included a random intercept. Since pregnancy is known to affect body weight and energy

intake, we censored weight measurements of women with an ongoing pregnancy from the conception date onwards. The results of the mixed model analyses are reported as estimated marginal means (EMM) and 95% CI and indicate mean change throughout the intervention period.

To identify independent determinants of lifestyle change or completion of the intervention program, all determinants with a p-value < 0.05 were entered in the multivariate binary logistic regression model or multivariate mixed effects regression model. Since our analyses are exploratory we did not adjust for multiple testing. All analyses were performed using IBM SPSS Statistics (version 22.0; SPSS Inc, Chicago, IL).

## Results

Baseline characteristics of women in the intervention group are shown in Table 1.

**Table 1.** Baseline characteristics of 289 women randomized to the intervention group of the LIFEstyle RCT

	N	LIFEstyle Intervention Program
Age female (years; mean ± SD)	289	29.7 ± 4.5
Non-Caucasian (yes; N; %)	289	33 (11.4)
Education level (N; %)	276	
primary school		17 (6.2)
secondary education		66 (23.9)
intermediate vocational education		135 (48.9)
higher vocational education and university		58 (21.0)
Socioeconomic status score* (median, IQR)	230	-0.53 (-1.24 – 0.38)
Current smoker (yes; N; %)	285	76 (26.3)
Baseline BMI (kg / m <sup>2</sup> ; median; IQR)	288	36.1 (33.4 – 38.6)
Age partner (years; mean ± SD)	289	33.5 ± 6.1
Smoking partner (yes; N; %)	286	117 (40.9)
Baseline BMI partner (kg/m <sup>2</sup> ; median, IQR)	247	27.7 (24.4 – 31.0)

\* Socioeconomic status score (Netherlands Institute for Social Research (SCP)) in 2010 relative to Dutch average of 0, a higher score represents a higher socioeconomic status. RCT: Randomized Controlled Trial. BMI: Body Mass Index. IQR: Interquartile range.

### Determinants of successful weight loss

Loss of ≥5% of the original body weight or reaching a BMI ≤ 29 kg/m<sup>2</sup> was achieved by 94/289 (33%) women within six months after randomization, of which 92 women reached

≥5% weight loss and 12 women reached a BMI ≤ 29 kg/m<sup>2</sup> (not mutually exclusive). BMI, previous support by a dietician in losing weight, external eating behavior and smoking of the partner were significantly associated with successful weight loss in the univariate logistic regression analyses (Additional Table S1) and were therefore included in the multivariate model (Table 2). The multivariate logistic regression model showed that women with higher scores on external eating behavior had a higher probability of successful weight loss (OR 1.07, 95%CI 1.02 to 1.13). Women with a higher BMI and previous support by a dietician had a lower probability of successful weight loss (OR 0.91, 95%CI 0.83 to 1.00 and OR 0.53, 95% CI 0.28 to 0.98, respectively).

**Table 2.** Determinants of successful weight loss in 289 women randomized to the intervention group

Determinants	OR (95% CI) Univariate	P	OR (95% CI) Multivariate:	p
BMI (kg/ m <sup>2</sup> )	0.90 (0.83 – 0.97)	<b>0.01</b>	0.91 (0.83 – 1.00)	<b>0.05</b>
Previous support by a dietician	0.52 (0.29 – 0.92)	<b>0.03</b>	0.53 (0.28 – 0.98)	<b>0.04</b>
External eating (units in DEBQ)	1.05 (1.00 – 1.10)	<b>0.03</b>	1.07 (1.02 – 1.13)	<b>&lt;0.01</b>
Smoking partner	0.53 (0.31 – 0.91)	<b>0.02</b>	0.63 (0.34 – 1.19)	0.15

Results of uni- and multivariate logistic regression analyses on determinants of successful weight loss. Successful weight loss is defined as loss of ≥5% of original body weight or reaching a BMI ≤29kg/m<sup>2</sup>. ORs indicate the odds of successful weight loss given the determinant is present. OR: Odds Ratio BMI: Body Mass Index. DEBQ: Dutch Eating Behavior Questionnaire.

### Determinants of weight loss (as continuous variable)

Mean weight loss was -5.20 kg (95%CI -5.72 to -4.68) at six months after randomization compared to the baseline visit (P < 0.001). BMI, duration of infertility, past number of weight loss attempts, readiness to change towards weight loss and previous support by a dietician were significantly associated with the magnitude of weight loss in the univariate mixed effects regression model (Additional Table S2) and were therefore included in the multivariate mixed effects regression model (Table 3).

In the multivariate mixed effects regression model previous support by a dietician was the only independent determinant of continuous weight loss. Women who had previous support by a dietician lost 0.93 kg less weight during the intervention period (95% CI 0.01 to 1.85 kg) than women who did not receive support.

### Determinants of energy intake

During the intervention, women reduced their mean energy intake per day by 472 kilocalories (95% CI -536 to -409) at six months after randomization compared to the baseline visit (P < 0.01). Self-efficacy and the age of the partner were significantly associated with changes in energy

**Table 3.** Determinants of weight loss in kilograms in 289 women randomized to the intervention group

Determinants	EMM kg (95% CI) Univariate	<i>p</i>	EMM kg (95% CI) Multivariate	<i>p</i>
BMI ( <i>kg/m</i> <sup>2</sup> )	0.25 (0.08 – 0.42)	0.01	0.07 (-0.13 – 0.28)	0.48
Duration of infertility ( <i>months</i> )	0.02 (0.00 – 0.03)	0.03	0.02 (-0.00 – 0.04)	0.08
Number of weight loss attempts in past 5 years	<i>n.a.</i>	<b>&lt;0.01</b>	<i>n.a.</i>	0.67
none	[ <i>ref</i> ]	[ <i>ref</i> ]	<i>n.a.</i>	
1 attempt	0.80 (-1.08 – 2.69)	0.40	[ <i>ref</i> ]	[ <i>ref</i> ]
2 – 3 attempts	0.49 (-1.25 – 2.23)	0.58	-0.80 (-2.21 – 0.61)	0.27
4 – 5 attempts	0.76 (-1.10 – 2.62)	0.42	-0.87 (-2.44 – 0.71)	0.28
> 5 attempts	2.27 (0.58 – 3.96)	<b>0.01</b>	0.43 (-0.97 – 1.83)	0.55
Readiness to change: weight loss	<i>n.a.</i>	<b>&lt;0.001</b>	<i>n.a.</i>	0.15
precontemplation	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>
contemplation	-2.21 (-6.73 – 2.30)	0.34	-1.84 (-6.40 – 2.72)	0.43
preparation	-1.12 (-2.36 – 0.12)	0.08	-0.17 (-1.56 – 1.23)	0.82
action	-1.90 (-2.80 – -0.99)	<b>&lt;0.001</b>	-1.11 (-2.14 – -0.08)	0.03
maintenance	[ <i>ref</i> ]	[ <i>ref</i> ]	[ <i>ref</i> ]	[ <i>ref</i> ]
Previous support by a dietician	1.36 (0.47 – 2.25)	<b>&lt;0.01</b>	0.93 (0.01 – 1.85)	<b>0.05</b>

Results of uni- and multivariate mixed effects regressions models on determinants of weight loss. With correction for baseline BMI and including a random intercept. A negative number indicates additional weight loss, a positive number indicates less weight loss. EMM: Estimated Marginal Means. BMI: Body Mass Index. *n.a.*: not applicable.

intake in the univariate mixed effects regression model (Additional Table S2), and were therefore included in the multivariate mixed effects regression model (Table 4). In the multivariate mixed effects regression model, for each year increase in the age of the partner, the daily energy intake increased with 8 kcal (95%CI 3 to 13). Furthermore, self-efficacy was significantly associated with energy intake ( $p < 0.01$ ), i.e. women with the highest self-efficacy on the Likert-scale had decreased mean energy intake relative to women with the lowest self-efficacy level ( $P < 0.01$ ).

### Determinants of number of steps

Women increased their mean number of steps per day by 3230 steps (95% CI 2540 to 3921) at six months after randomization compared to the baseline visit ( $P < 0.01$ ). Readiness to change towards physical activity, degree of insulin resistance and presence of metabolic syndrome were significantly associated with number of steps in the univariate mixed effects regression model (Additional Table S2) and were therefore included in the multivariate mixed effects regression model (Table 4).

**Table 4.** Determinants of energy intake and number of steps in 289 women randomized to the intervention group

Determinants of energy intake	EMM (95% CI) x 100 kcal	<i>p</i>	EMM (95% CI) x 100 kcal	<i>p</i>
	Univariate		Multivariate	
Self-efficacy	<i>n.a.</i>	0.01	<i>n.a.</i>	<0.01
extremely unlikely	[ref]	[ref]	[ref]	[ref]
unlikely	-3.31 (-7.48 – 0.87)	0.12	-3.14 (-7.20 – 0.92)	0.13
do not know / neutral	-2.75 (-6.65 – 1.15)	0.17	-1.87 (-5.71 – 1.96)	0.34
likely	-2.41 (-6.31 – 1.50)	0.23	-1.58 (-5.42 – 2.26)	0.42
extremely likely	-3.75 (-7.69 – 0.19)	0.06	-2.89 (-6.76 – 0.98)	0.14
Age partner ( <i>years</i> )	0.06 (0.02 – 0.11)	<b>0.01</b>	0.08 (0.03 – 0.13)	<b>&lt;0.01</b>
Determinants of number of steps	EMM (95% CI) x 1000	<i>p</i>	EMM (95% CI) x 1000	<i>p</i>
	steps Univariate		steps Multivariate	
Readiness to change: physical activity	<i>n.a.</i>	<b>0.04</b>	<i>n.a.</i>	<b>0.05</b>
precontemplation	-0.18 (-2.37 – 2.00)	0.87	-0.97 (-3.15 – 1.20)	0.38
contemplation	-0.35 (-1.45 – 0.76)	0.53	-0.62 (-1.68 – 0.45)	0.25
preparation	0.03 (-1.04 – 1.11)	0.95	0.04 (-1.01 – 1.09)	0.94
action	1.23 (0.09 – 2.37)	<b>0.04</b>	0.93 (-0.18 – 2.04)	0.10
maintenance	[ref]	[ref]	[ref]	[ref]
Insulin resistance	0.19 (0.02 – 0.37)	<b>0.03</b>	0.12 (-0.04 – 0.28)	0.15
Metabolic syndrome	1.05 (0.32 – 1.78)	<b>&lt;0.01</b>	0.58 (-0.27 – 1.42)	0.18

Results of uni- and multivariate mixed effects regressions models on determinants of energy intake and the number of steps. With correction for baseline energy intake or steps and including random intercept. A negative number indicates a decrease in the intake of kcal/steps, a positive number indicates an increase the intake of kcal/steps. EMM: Estimated Marginal Means. *n.a.*: not applicable.

The readiness to change towards physical activity was significantly associated with the daily number of steps ( $P = 0.05$ ), with a trend towards more steps in women who were increasingly ready to change, compared to women in the maintenance stage of change.

### Determinants of completion of the lifestyle intervention

In total 226 (78%) women completed the lifestyle intervention. Current smoking, nulliparity, the readiness to change towards weight loss, restrained eating behavior and BMI of the partner were significantly associated with completion of the intervention program in the univariate logistic regression analyses (Additional Table S3) and were therefore included in the multivariate model (Table 5). The multivariate logistic regression model showed that only the readiness to change towards weight loss was independently associated with completion of the lifestyle intervention ( $P = 0.04$ ), with women in the action phase having a

**Table 5.** Determinants of completion of the lifestyle intervention program in 289 women randomized to the intervention group

Determinants	OR (95% CI) Univariate	<i>p</i>	OR (95% CI) Multivariate:	<i>p</i>
Current smoker	0.55 (0.30 – 0.99)	<b>0.05</b>	1.70 (0.76 – 3.76)	0.19
Nulliparous	2.02 (1.03 – 3.93)	<b>0.04</b>	1.07 (0.99 – 1.16)	0.08
Readiness to change: weight loss	<i>n.a.</i>	<b>0.01</b>	<i>n.a.</i>	<b>0.04</b>
precontemplation	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>
contemplation	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>
preparation	0.43 (0.19 – 1.00)	<b>0.05</b>	0.40 (0.15 – 1.09)	0.07
action	1.93 (0.90 – 4.15)	0.09	1.78 (0.74 – 4.26)	0.20
maintenance	[ref]	[ref]	[ref]	[ref]
Restrained eating (DEBQ)	1.07 (1.02 – 1.12)	0.01	1.05 (0.98 – 1.12)	0.14
BMI partner	1.07 (1.00 – 1.14)	<b>0.04</b>	1.07 (0.99 – 1.16)	0.08

Results of uni- and multivariate logistic regression analyses on determinants of completion. ORs indicate odds for completion of the lifestyle intervention program as defined by not missing  $\geq 2$  consecutive sessions given the determinant is present. DEBQ: Dutch Eating Behavior Questionnaire. N.a.: not applicable.

higher probability of completing the intervention program, and women in the preparation phase having a lower probability of completing the intervention program compared to women in the maintenance phase.

## Discussion

### Main findings

Despite the many factors we assessed as possible determinants of successful lifestyle change in obese infertile women, only few were associated with lifestyle change. However, a higher score on external eating behavior, a lower pre-intervention BMI and no previous support by a dietician were associated with successful weight loss of  $\geq 5\%$  of original body weight or achieving a BMI  $\leq 29$  kg/m<sup>2</sup>. In addition, women without previous support by a dietician lost more weight than women who did have previous support by a dietician. Women with younger partners reduced their energy intake more than women with older partners, and women with a higher level of self-efficacy had decreased energy intake relative to women with the lowest self-efficacy level. The readiness to change towards physical activity was significantly associated with the daily number of steps, with a trend towards more steps in women who were increasingly ready to change, compared to women who were in the maintenance stage of readiness to change. Furthermore, women in the action phase of readiness to change towards weight loss were more likely to complete the lifestyle

intervention whereas women in the preparation phase were less likely to complete the intervention, compared to women in the maintenance phase.

### **Strengths and limitations**

A major strength of our study is that it is the first study on determinants of lifestyle change including obese infertile women. The participants were of reproductive age and, except for their obesity, were generally in good health. Previous studies mainly focused on older obese patients with obesity-related comorbidities, such as hypertension or diabetes and therefore our study fills a gap in literature. Another strength is the prospectively collected wide range of determinants, including reproductive, metabolic, psychosocial and partner characteristics. Since we used data of the intervention arm of a RCT the possibility of selection bias, often found in observational studies of lifestyle interventions, was eliminated.

We used a robust statistical method, mixed effects regression models, to analyze the continuous longitudinal outcomes. This method takes the within person dependency of the data into account and does not rely on complete case data, so we were able to use all available data points.

Limitations of our study should be noted. Although we used several validated questionnaires, some of the determinants we investigated originated from single questions. Therefore some constructs that were investigated in our study, such as self-efficacy, may have limited validity. Furthermore, our RCT was not set up for analyses of determinants of lifestyle change within the intervention group and therefore type II errors might have occurred. Hence, our findings need to be replicated in other studies.

### **Interpretation**

Women who had previous support from a dietician had a ~50% lower change of successful weight loss, compared to women without prior support. It is possible that women in our study represent a selection of women who failed to lose weight after having been previously counseled about healthy lifestyle options. They could therefore be less susceptible to a repetition of the support offered during our lifestyle intervention program. Possibly, these women may have other underlying causes for their obesity, such as low self-esteem or previous trauma and therefore need different types of support.<sup>39,40</sup> The finding that previous counseling by a dietician has negative effects on weight loss is in line with existing literature, showing that fewer previous weight loss attempts and less previous dieting are predictors of successful weight loss.<sup>41</sup>

A large body of evidence exists on the association between lower SES, lower education level and an increased risk of becoming overweight and obese.<sup>42-45</sup> In our study population, neither educational level nor SES was identified as a determinant of lifestyle change. This suggests that the efficacy of the lifestyle intervention program is equally effective for women of lower and higher SES. Our findings are in agreement with literature suggesting that high self-regulation skills and high self-efficacy are associated with a reduction in energy intake and increased physical activity.<sup>21</sup> One of the determinants of increased energy intake was a higher age of the partner. It is difficult to place this finding into context, although it is known that obesity, dietary and general health behaviors tend to cluster between spouses and within families.<sup>46</sup> We found no literature on spousal concordance of determinants of lifestyle change, therefore, this result may be a spurious finding. Remarkably, women in the action phase of readiness to change were both more likely to increase their number of steps and to complete the intervention program compared to women in the maintenance phase (which is the highest level of readiness to change). Hypothetically, for women in the maintenance phase of readiness to change a ceiling effect may exist, limiting their ability to improve any further. Furthermore, our results are in line with a review in which readiness to change was found to be positively associated with physical activity.<sup>47</sup> Thus, it is important to assess readiness to change and incorporate motivational counseling into consultations with health care providers and lifestyle interventions.<sup>48</sup>

## Conclusions

Despite the large variation in lifestyle change and weight loss, and the many factors assessed, only few determinants were associated with lifestyle change. The most consistent determinants for lifestyle change in obese infertile women were not receiving previous support by a dietician and readiness to change. We still lack sufficient knowledge on determinants of successful lifestyle change. This knowledge is needed to improve future efforts to help people improve their lifestyle and thereby lose weight.

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**Table S1.** Determinants of successful weight change

Category	Determinant	N	Successful weight loss (median, IQR or N, %)	Unsuccessful weight loss (median, IQR or N, %)	Odds ratio (95% CI)	p
<i>Demographic characteristics</i>	Age female (years)	262	30.2 (26.9 – 33.4)	29.7 (26.0 – 33.1)	1.02 (0.97 – 1.08)	0.41
	Non-Caucasian	262	10 / 94 (10.6)	19 / 168 (11.3)	0.93 (0.42 – 2.01)	0.87
	Education level	251			1.32 (0.95 – 1.84)	0.10
	primary school		4 / 92 (4.3)	7 / 159 (4.4)	[ref]	[ref]
	secondary education		18 / 92 (19.6)	45 / 159 (28.3)	0.70 (0.18 – 2.69)	0.60
	intermediate vocational education		45 / 92 (48.9)	77 / 159 (48.4)	1.02 (0.28 – 3.69)	0.97
	higher vocational education and university		25 / 92 (27.2)	30 / 159 (18.9)	1.46 (0.38 – 5.56)	0.58
<i>Socioeconomic status score<sup>1</sup></i>	Socioeconomic status score <sup>1</sup>	209	-0.51 (1.11)	-0.56 (1.24)	1.04 (0.82 – 1.31)	0.76
	Current smoker	262	22 / 93 (23.7)	44 / 166 (26.5)	0.86 (0.48 – 1.55)	0.61
<i>Infertility characteristics</i>	Duration of infertility (months)	262	24.0 (16.0 – 36.0)	21.0 (14.0 – 38.8)	1.00 (0.99 – 1.01)	0.60
	Nulliparous	250	69 / 87 (79.3)	136 / 163 (83.4)	0.76 (0.39 – 1.48)	0.42
	Anovulatory	261	38 / 93 (40.9)	78 / 168 (46.4)	0.80 (0.48 – 1.33)	0.39
	Male factor infertility	261	23 / 93 (24.7)	38 / 168 (22.6)	1.12 (0.62 – 2.04)	0.70
	Unexplained infertility	261	31 / 93 (33.3)	48 / 168 (28.6)	1.25 (0.72 – 2.16)	0.42
<i>Anthropometric and weight characteristics</i>	BMI (kg/m <sup>2</sup> )	261	35.5 (33.1 – 37.3)	36.6 (33.9 – 39.0)	0.90 (0.83 – 0.97)	<b>0.01</b>
	Waist circumference (cm)	258	106.0 (100.0 – 112.0)	108.0 (102.0 – 115.0)	0.98 (0/96 – 1.01)	0.19
	Waist/hip ratio	256	0.87 (0.83 – 0.91)	0.85 (0.81 – 0.90)	1.29 (0.88 – 1.91) <sup>a</sup>	0.20
	Highest weight in past 10 years (kg)	230	106.00 (98.0 – 115.0)	110.50 (99.8 – 120.0)	0.99 (0.97 – 1.00)	0.09
	Highest weight ever	220			0.82 (0.63 – 1.06)	0.13
	same as current weight		20 / 84 (23.8)	35 / 136 (25.7)	[ref]	[ref]
	1 – 5 kg above current weight		38 / 84 (45.2)	40 / 136 (29.4)	1.66 (0.82 – 3.37)	0.16
	6 – 10kg above current weight		14 / 84 (16.7)	27 / 136 (19.9)	0.91 (0.39 – 2.11)	0.82

Table S1. Continued

Category	Determinant	N	Successful weight loss (median, IQR or N, %)	Unsuccessful weight loss (median, IQR or N, %)	Odds ratio (95% CI)	P
<i>Anthropometric and weight characteristics</i>	> 10 kg above current weight		12 / 84 (14.3)	34 / 136 (25.0)	0.62 (0.26 – 1.46)	0.27
	Weight variability in past 10 years <sup>3</sup> (kg)	225	28.0 (20.0 – 35.8)	31.0 (22.0 – 40.0)	0.99 (0.97 – 1.01)	0.16
	Number of weight loss attempts in past 5 years	233			0.83 (0.68 – 1.02)	0.07
	none		8 / 89 (9.0)	8 / 144 (5.6)	[ref]	[ref]
	1 attempt		15 / 89 (16.9)	19 / 144 (13.2)	0.79 (0.24 – 2.60)	0.70
	2 – 3 attempts		25 / 89 (28.1)	36 / 144 (25.0)	0.69 (0.23 – 2.10)	0.69
<i>Metabolic characteristics</i>	4 – 5 attempts		14 / 89 (15.7)	22 / 144 (15.3)	0.64 (0.19 – 2.09)	0.64
	> 5 attempts		27 / 89 (30.3)	59 / 144 (41.0)	0.46 (0.16 – 1.35)	0.46
	Insulin resistance (HOMA-IR)	229	2.9 (1.9 – 3.9)	3.0 (2.1 – 4.4)	0.90 (0.78 – 1.05)	0.18
	Metabolic syndrome	211	45 / 83 (54.2)	71 / 138 (51.4)	1.12 (0.65 – 1.93)	0.69
<i>Psychosocial characteristics</i>	Quality of Life <sup>4</sup>					
	physical component (score)	219	53.2 (48.7 – 55.3)	51.6 (45.0 – 55.6)	1.01 (0.99 – 1.04)	0.35
	mental component (score)	219	52.9 (46.4 – 56.0)	52.9 (45.4 – 55.5)	1.01 (0.98 – 1.04)	0.48
	Readiness to change: weight loss	229			0.78 (0.54–1.12)	0.18
	precontemplation		0 / 87	0 / 142	n.a.	
	contemplation		1 / 87 (1.1)	1 / 142 (0.7)	2.03 (0.12 – 33.7)	0.62
	preparation		16 / 87 (18.4)	20 / 142 (14.1)	1.63 (0.74 – 3.60)	0.23
	action		41 / 87 (47.1)	62 / 142 (43.7)	1.35 (0.74 – 2.44)	0.33
	maintenance		29 / 87 (33.3)	59 / 142 (41.5)	[ref]	[ref]
	Readiness to change: physical activity	230			1.23 (0.96 – 1.57)	0.10
precontemplation		0 / 87	7 / 143 (4.9)	n.a.	n.a.	

Table S1. Continued

Category	Determinant	N	Successful weight loss (median, IQR or N, %)	Unsuccessful weight loss (median, IQR or N, %)	Odds ratio (95% CI)	P
<i>Psychosocial characteristics</i>	contemplation		21 / 87 (24.1)	41 / 143 (28.7)	0.57 (0.25 – 1.33)	0.19
	preparation		31 / 87 (35.6)	43 / 143 (30.1)	0.81 (0.36 – 1.80)	0.60
	action		18 / 87 (20.7)	33 / 143 (23.1)	0.61 (0.26 – 1.46)	0.27
	maintenance		17 / 87 (19.5)	19 / 143 (13.3)	[ref]	[ref]
	Previous support in weight loss					
	by dietician	208	30 / 78 (38.5)	71 / 130 (54.6)	0.52 (0.29 – 0.92)	<b>0.03</b>
	by partner	208	43 / 78 (55.1)	76 / 130 (58.5)	0.87 (0.50 – 1.54)	0.64
	no social support	208	32 / 78 (41.0)	40 / 130 (30.8)	1.57 (0.87 – 2.81)	0.13
	Self-efficacy	228				0.24
	extremely unlikely		1 (1.1)	0 (0.0)	n.d.	n.d.
	unlikely		2 (2.1)	4 (2.4)	0.60 (0.10 – 3.67)	0.56
	do not know / neutral		27 (28.7)	67 (39.9)	0.49 (0.23 – 1.04)	0.06
	likely		37 (39.4)	48 (28.6)	0.93 (0.44 – 1.96)	0.86
	extremely likely		19 (20.0)	23 (13.7)	[ref]	[ref]
	Body satisfaction	233				0.39
	no, never		0 (0.0)	1 (0.6)	n.d.	n.d.
	no, mostly not		4 (4.3)	2 (1.8)	2.78 (0.59 – 13.11)	0.20
	sometimes, sometimes not		15 (16.0)	16 (9.5)	1.96 (0.87 – 4.40)	0.11
	yes, mostly		35 (37.2)	51 (30.4)	1.43 (0.79 – 2.58)	0.23
	yes, always		35 (37.2)	73 (43.5)	[ref]	[ref]
	Dutch Eating Behavior Questionnaire					
	emotional eating (13–65 points)	251	37.0 (29.0 – 44.0)	36.0 (25.0 – 44.0)	1.00 (0.98 – 1.03)	0.65
	external eating (10–50 points)	252	29.0 (25.0 – 32.5)	27.5 (23.0 – 32.0)	1.05 (1.00 – 1.10)	<b>0.03</b>
	restrained eating (10–50 points)	253	31.0 (28.0 – 36.0)	31.0 (28.0 – 35.0)	1.02 (0.98 – 1.06)	0.37

Table S1. Continued

Category	Determinant	N	Successful weight loss (median, IQR or N, %)	Unsuccessful weight loss (median, IQR or N, %)	Odds ratio (95% CI)	P
<i>Diet and physical activity characteristics</i>	Mean energy intake (kcal/day)	210	1976 (1600 – 2200)	1870 (1598 – 2100)	1.00 (0.95 – 1.06) <sup>b</sup>	0.94
	Mean steps (day)	227	5525 (3641 – 7480)	6000 (4000 – 8000)	0.95 (0.87 – 1.04) <sup>c</sup>	0.25
	Frequency of breakfast use (days/week)	180	7 (5 – 7)	7 (5 – 7)	1.00 (0.89 – 1.13)	0.95
	Vegetable intake (grams/day)	238	111 (79 – 159)	114 (86 – 163)	0.99 (0.95 – 1.03) <sup>d</sup>	0.68
	Fruit intake (grams/day)	238	114 (54 – 171)	86 (57 – 171)	1.01 (0.98 – 1.04) <sup>d</sup>	0.45
	Meeting recommendations vegetable intake <sup>5</sup>	238	15 / 90 (16.7)	28 / 148 (18.9)	0.86 (0.43 – 1.71)	0.66
	Meeting recommendations fruit intake <sup>5</sup>	238	20 / 90 (22.2)	30 / 148 (20.3)	1.12 (0.59 – 2.13)	0.72
	Meeting recommendations fruit and juice intake <sup>6</sup>	238	28 / 88 (31.8)	39 / 146 (26.7)	1.28 (0.72 – 2.29)	0.40
	Meeting recommendations fruit- and vegetable intake <sup>5</sup>	234	8 / 88 (9.1)	11 / 144 (7.6)	1.21 (0.47 – 3.13) <sup>e</sup>	0.70
	Alcoholic beverages (units/day)	232	0.00 (0.00 – 0.18)	0.00 (0.00 – 0.18)	0.93 (0.48 – 1.80)	0.82
	Total moderate to vigorous physical activity (min/week)	219	311 (121 – 76)	360 (150 – 870)	1.00 (0.99–1.01)	0.64
	Meeting recommendations guideline physical activity	235	60 / 88 (68.2)	110 / 145 (75.9)	0.68 (0.38 – 1.23)	0.20
<i>Partner characteristics</i>	Age (years)	262	33.8 (29.6 – 37.4)	33.0 (29.9 – 36.7)	1.03 (0.98 – 1.07)	0.23
	BMI (kg/m <sup>2</sup> )	227	27.8 (24.7 – 31.0)	27.7 (24.5 – 31.5)	1.00 (0.96 – 1.06)	0.77
	Non-Caucasian	262	7 / 94 (7.4)	16 / 168 (9.5)	0.76 (0.30 – 1.93)	0.57
	Smoking	261	28 / 94 (29.8)	74 / 167 (44.3)	0.53 (0.31 – 0.91)	<b>0.02</b>

All determinants were assessed at baseline. Results of univariate logistic regression analyses. <sup>a</sup>Waist-hip ratio; per 0.10 increase. <sup>b</sup>Baseline calorie intake; per 100 kcal increase. <sup>c</sup>Baseline step counts; per 1000 steps increase. <sup>d</sup>Baseline vegetable and fruit intake; per 10 grams/day increase. <sup>e</sup>Total moderate to vigorous physical activity; per 30 min/week increase. <sup>f</sup>Socioeconomic status score (Netherlands Institute for Social Research (SCP)) in year 2010 relative to Dutch average of 0, a higher score represents a higher socioeconomic status. <sup>2</sup>Weight change during the first 1.5 months of the intervention program. <sup>3</sup>Calculated upon the highest and lowest weight in the past 10 years. <sup>4</sup>Measured by the Short-Form-36 Questionnaire. <sup>5</sup>Dutch Guidelines for a healthy diet 2006: minimal recommended fruit and vegetable intake 200 grams per day. <sup>6</sup>Dutch Guidelines for a healthy diet 2006: of minimal recommended fruit intake of 200 grams/day a maximum of 100 grams of fruit can be substituted by 1 glass of fruit juice daily. N.a.: not applicable.

**Table S2.** Determinants of continuous weight change, calorie intake and step counts

Category	Determinant	Weight change		Energy intake		Number of steps	
		Effect size, kg (95% CI)	<i>p</i>	Effect size, x 100 kcal (95% CI)	<i>p</i>	Effect size, x 1000 steps (95% CI)	<i>p</i>
<i>Demographic characteristics</i>	Age female (years)	0.04 (-0.04 – 0.12)	0.35	0.06 (-0.00 – 0.12)	0.06	0.01 (-0.09 – 0.07)	0.81
	Non-Caucasian	0.62 (-0.61 – 1.85)	0.32	0.34 (-0.64 – 1.33)	0.49	-0.79 (-1.94 – 0.36)	0.18
	Education level		0.11		0.91		0.22
	primary school	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
	secondary education	-0.47 (-2.28 – 1.35)	0.61	-0.48 (-2.19 – 1.23)	0.58	1.05 (-0.98 – 3.08)	0.31
	intermediate vocational education	-1.14 (-2.86 – 0.59)	0.20	-0.42 (-2.08 – 1.24)	0.62	0.94 (-1.04 – 2.91)	0.35
	higher vocational education and university	-1.65 (-3.49 – 0.19)	0.08	-0.59 (-2.31 – 1.12)	0.50	1.76 (-0.30 – 3.82)	0.09
	Socioeconomic status score <sup>1</sup>	-0.32 (-0.70 – 0.06)	0.10	0.10 (-0.15 – 0.34)	0.45	-0.18 (-0.53 – 0.16)	0.29
	Current smoker	-0.12 (-0.98 – 0.75)	0.79	-0.34 (-0.97 – 0.30)	0.30	-0.25 (-1.07 – 0.58)	0.56
	<i>Infertility characteristics</i>	Duration of infertility (months)	0.02 (0.00 – 0.03)	<b>0.03</b>	0.01 (-0.00 – 0.03)	0.06	-0.01 (-0.03 – 0.01)
Nulliparous		-0.17 (-1.21 – 0.88)	0.75	-0.10 (-0.82 – 0.61)	0.78	0.01 (-0.98 – 1.00)	0.99
Anovulatory		0.42 (-0.34 – 1.19)	0.28	-0.24 (-0.79 – 0.30)	0.38	0.07 (-0.65 – 0.80)	0.84
Male factor infertility		0.18 (-0.72 – 1.07)	0.70	0.02 (-0.58 – 0.62)	0.95	0.06 (-0.77 – 0.89)	0.89
Unexplained infertility		-0.33 (-1.17 – 0.50)	0.79	0.09 (-0.50 – 0.67)	0.77	-0.22 (-0.99 – 0.56)	0.59
<i>Anthropometric and weight characteristics</i>	BMI (kg / m <sup>2</sup> )	0.25 (0.08 – 0.42)	<b>0.005</b>	0.04 (-0.04 – 0.12)	0.29	-0.05 (-0.15 – 0.06)	0.38
	Waist circumference (cm)	0.04 (-0.01 – 0.10)	0.10	-0.00 (-0.03 – 0.03)	0.95	-0.01 (-0.05 – 0.03)	0.55
	Waist / hip ratio	-0.10 (-0.69 – 0.49) <sup>a</sup>	0.74	-0.28 (-0.70 – 0.13) <sup>a</sup>	0.18	0.06 (-0.51 – 0.63) <sup>a</sup>	0.84
	Highest weight in past 10 years (kg)	0.04 (-0.02 – 0.11)	0.21	0.01 (-0.01 – 0.03)	0.41	-0.01 (-0.03 – 0.01)	0.47
	Highest weight ever		0.13		0.98		0.24
	same as current weight	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
	1 – 5 kg above current weight	-0.60 (-1.74 – 0.54)	0.30	-0.01 (-0.74 – 0.707)	0.72	-0.93 (-1.90 – 0.05)	0.06
6 – 10kg above current weight	-0.16 (-1.50 – 1.18)	0.82	-0.01 (-0.88 – 0.86)	0.98	-0.21 (-1.33 – 0.92)	0.72	
> 10 kg above current weight	0.87 (-0.43 – 2.18)	0.19	-0.16 (-1.02 – 0.70)	0.98	-0.69 (-1.78 – 0.39)	0.21	

Table S2. Continued

Category	Determinant	Weight change		Energy intake		Number of steps	
		Effect size, kg (95% CI)	<i>p</i>	Effect size, x 100 kcal (95% CI)	<i>p</i>	Effect size, x 1000 steps (95% CI)	<i>p</i>
Anthropometric and weight characteristics	Weight variability in past 10 years <sup>3</sup> (kg)	-0.00 (-0.04 – 0.03)	0.80	-0.02 (-0.04 – 0.002)	0.09	0.02 (-0.00 – 0.05)	0.07
	Number of weight loss attempts in past 5 years		<b>0.003</b>				
	none	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
	1 attempt	0.80 (-1.08 – 2.69)	0.40	0.17 (-1.08 – 1.43)	0.79	0.74 (-0.87 – 3.36)	0.37
	2 – 3 attempts	0.49 (-1.25 – 2.23)	0.58	0.35 (-0.81 – 1.50)	0.56	-0.13 (-1.63 – 1.37)	0.86
	4 – 5 attempts	0.76 (-1.10 – 2.62)	0.42	0.51 (-0.71 – 1.74)	0.41	0.07 (-1.52 – 1.65)	0.93
> 5 attempts	2.27 (0.58 – 3.96)	<b>0.009</b>	0.56 (-0.55 – 1.68)	0.32	-0.10 (-1.56 – 1.37)	0.89	
Metabolic characteristics	Insulin resistance (HOMA-IR)	0.15 (-0.55 – 0.36)	0.15	-0.05 (-0.19 – 0.08)	0.44	0.19 (0.02 – 0.37)	<b>0.03</b>
	Metabolic syndrome	-0.21 (-1.08 – 0.65)	0.63	-0.17 (-0.74 – 0.39)	0.54	1.05 (0.32 – 1.78)	<b>&lt;0.01</b>
Psychosocial characteristics	Quality of Life <sup>4</sup>						
	physical component (score)	-0.04 (-0.09 – 0.00)	0.08	0.004 (-0.03 – 0.03)	0.80	0.02 (-0.01 – 0.06)	0.21
	mental component (score)	-0.04 (-0.09 – 0.01)	0.08	-0.01 (-0.05 – 0.02)	0.41	-0.02 (-0.06 – 0.03)	0.44
	Readiness to change: weight loss		<b>0.001</b>				0.51
	precontemplation	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>	<i>n.a.</i>
	contemplation	-2.21 (-6.73 – 2.30)	0.34	-0.25 (-4.12 – 3.62)	0.90	0.59 (-2.97 – 4.14)	0.75
	preparation	-1.12 (-2.36 – 0.12)	0.08	-0.42 (-1.28 – 0.43)	0.33	0.79 (-0.28 – 1.86)	0.15
	action	-1.90 (-2.80 – -0.99)	<0.001	-0.14 (-0.78 – 0.49)	0.66	0.41 (-0.40 – 1.21)	0.32
	maintenance	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
	Readiness to change: physical activity		0.40		0.87		<b>0.04</b>
	precontemplation	1.31 (-0.96 – 3.58)	0.26	-0.73 (-2.54 – 1.07)	0.42	-0.18 (-2.37 – 2.00)	0.87
	contemplation	1.29 (-0.02 – 2.60)	<b>0.05*</b>	-0.43 (-1.32 – 0.46)	0.34	-0.35 (-1.45 – 0.76)	0.53
preparation	0.86 (-0.40 – 2.12)	0.22	-0.33 (-1.17 – 0.52)	0.44	0.03 (-1.04 – 1.11)	0.95	
action	0.75 (-0.60 – 2.10)	0.28	-0.28 (-1.19 – 0.63)	0.54	1.23 (0.09 – 2.37)	<b>0.04</b>	
maintenance	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	

Table S2. Continued

Category	Determinant	Weight change		Energy intake		Number of steps		
		Effect size, kg (95% CI)	<i>P</i>	Effect size, x 100 kcal (95% CI)	<i>P</i>	Effect size, x 1000 steps (95% CI)	<i>P</i>	
<i>Psychosocial characteristics</i>	Previous support in weight loss	by dietician	1.36 (0.47 – 2.25)	<b>0.003</b>	0.47 (-0.13 – 1.06)	0.12	0.18 (-0.58 – 0.94)	0.64
		by partner	0.08 (-0.83 – 0.99)	0.87	0.30 (-0.31 – 0.91)	0.33	0.34 (-1.11 – 0.42)	0.37
		no social support	0.09 (-0.86 – 1.05)	0.85	-0.54 (-1.15 – 0.08)	0.09	0.13 (-0.67 – 0.91)	0.75
	Self-efficacy	extremely unlikely	[ref]	0.06	[ref]	<b>0.01*</b>	[ref]	0.52
		unlikely	2.64 (-4.30 – 9.58)	0.45	-3.31 (-7.48 – 0.87)	[ref]	[ref]	[ref]
		do not know / neutral	1.99 (-4.490 – 8.46)	0.55	-2.75 (-6.65 – 1.15)	0.12	0.53 (-4.97 – 6.03)	0.85
	Body satisfaction	likely	0.92 (-5.56 – 7.40)	0.78	-2.41 (-6.31 – 1.50)	0.17	1.23 (-3.81 – 6.03)	0.63
		extremely likely	0.49 (-6.03 – 7.01)	0.82	-3.75 (-7.69 – 0.19)	0.23	1.65 (-3.40 – 6.70)	0.52
		no, never	[ref]	0.39	[ref]	0.06	0.88 (-4.21 – 5.96)	0.73
	Dutch Eating Behavior Questionnaire	no, mostly not	-0.23 (-1.16 – 0.71)	[ref]	0.41 (-0.21 – 1.03)	0.47	[ref]	0.65
		sometimes, sometimes not	-0.20 (-1.52 – 1.11)	0.76	0.29 (-0.61 – 1.20)	[ref]	[ref]	[ref]
		yes, mostly	-0.58 (-3.16 – 2.00)	0.66	1.14 (-0.45 – 2.72)	0.19	-0.43 (-1.22 – 0.37)	0.29
		yes, always	6.19 (-0.23 – 12.61)	0.06	1.41 (-2.24 – 5.05)	0.52	0.12 (-0.87 – 1.21)	0.83
emotional eating (13-65 points)		-0.01 (-0.04 – 0.03)	0.82	0.02 (0.004 – 0.04)	0.16	0.77 (-1.46 – 2.98)	0.50	
external eating (10-50 points)		-0.01 (-0.08 – 0.05)	0.67	0.02 (-0.03 – 0.06)	0.45	-1.42 (-6.21 – 3.38)	0.56	
<i>Diet and physical activity characteristics</i>	restrained eating (10-50 points)	0.03 (-0.04 – 0.09)	0.43	-0.00 (-0.05 – 0.05)	0.11	-0.03 (-0.06 – 0.01)	0.11	
	Mean energy intake (kcal/day)	0.05 (-0.05 – 0.14) <sup>b</sup>	0.32	n.a.	0.53	-0.03 (-0.10 – 0.03)	0.24	
	Mean steps (day)	-0.06 (-0.18 – 0.05) <sup>c</sup>	0.27	-0.06 (-0.15 – 0.02) <sup>c</sup>	0.99	-0.05 (-0.01 – 0.12)	0.09	
	Frequency of breakfast use (days / week)	-0.09 (-0.27 – 0.09)	0.34	0.07 (-0.06 – 0.20)	n.a.	0.06 (-0.10 – 0.21)	0.47	
	Vegetable intake (grams/day)	-0.01 (-0.08 – 0.05) <sup>d</sup>	0.64	0.00 (-0.04 – 0.04) <sup>d</sup>	0.89	0.03 (-0.02 – 0.08) <sup>d</sup>	0.27	
	Fruit intake (grams/day)	-0.01 (-0.05 – 0.04) <sup>d</sup>	0.78	0.02 (-0.02 – 0.05) <sup>d</sup>	0.38	0.03 (0.01 – 0.07) <sup>d</sup>	0.10	
	Meeting recommendations vegetable intake <sup>5</sup>	0.28 (-0.79 – 1.35)	0.61	-0.07 (-0.80 – 0.67)	0.86	0.78 (-0.11 – 1.67)	0.09	

Table S2. Continued

Category	Determinant	Weight change		Energy intake		Number of steps	
		Effect size, kg (95% CI)	p	Effect size, x 100 kcal (95% CI)	p	Effect size, x 1000 steps (95% CI)	p
<i>Diet and physical activity characteristics</i>	Meeting recommendations fruit intake <sup>5</sup>	-0.20 (-1.20 – 0.80)	0.69	0.45 (-0.24 – 1.15)	0.20	0.16 (-0.70 – 1.02)	0.72
	Meeting recommendations fruit and juice intake <sup>6</sup>	-0.32 (-1.22 – 0.59)	0.49	0.49 (-0.14 – 1.12)	0.12	0.24 (-0.53 – 1.01)	0.54
	Meeting recommendations fruit- and vegetable intake <sup>5</sup>	0.98 (-0.52 – 2.47)	0.20	0.87 (-0.15 – 1.89)	0.10	0.93 (-0.36 – 2.22)	0.16
	Alcoholic beverages (units / day)	0.42 (-0.61 – 1.45)	0.42	-0.57 (-1.22 – 0.09)	0.09	0.13 (-0.69 – 0.95)	0.75
	Total moderate to vigorous physical activity (min/week)	-0.00 (-0.02 – 0.02) <sup>e</sup>	0.80	-0.01 (-0.02 – 0.002) <sup>e</sup>	0.10	0.01 (-0.01 – 0.03) <sup>e</sup>	0.18
	Meeting recommendations guideline physical activity	-0.27 (-1.18 – 0.65)	0.56	-0.49 (-1.09 – 0.11)	0.11	0.25 (-0.53 – 1.04)	0.52
<i>Partner characteristics</i>	Age (years)	-0.00 (-0.06 – 0.06)	0.99	0.06 (0.02 – 0.11)	<b>0.01*</b>	0.01 (-0.06 – 0.05)	0.86
	Baseline BMI (kg / m <sup>2</sup> )	-0.03 (-0.11 – 0.04)	0.38	0.01 (-0.03 – 0.06)	0.60	-0.04 (-0.12 – 0.03)	0.25
	Non-Caucasian	-0.37 (-1.72 – 0.98)	0.59	0.82 (-0.34 – 1.99)	0.16	-0.50 (-1.85 – 0.86)	0.47
	Smoking	0.40 (-0.38 – 1.18)	0.31	-0.16 (-0.72 – 0.41)	0.59	-0.12 (-0.85 – 0.60)	0.74

All determinants were assessed at baseline. Results of univariate linear mixed models, with correction for baseline weight, calorie intake and steps linear.\*Statistically significant p-value in univariate mixed models. <sup>a</sup>Waist-hip ratio: per 0.10 increase. <sup>b</sup>Baseline calorie intake: per 100 kcal increase. <sup>c</sup>Baseline step counts: per 1000 steps increase. <sup>d</sup>Baseline vegetable and fruit intake: per 10 grams / day increase. <sup>e</sup>Total moderate to vigorous physical activity: per 30 min / week increase. <sup>1</sup> Socioeconomic status score (Netherlands Institute for Social Research (SCP)) in year 2010 relative to Dutch average of 0, a higher score represents a higher socioeconomic status. <sup>2</sup> Weight change during the first 1.5 months of the intervention program. <sup>3</sup> Calculated upon the highest and lowest weight in the past 10 years. <sup>4</sup> Measured by the Short-Form-36 Questionnaire. <sup>5</sup> Dutch Guidelines for a healthy diet 2006: minimal recommended fruit and vegetable intake 200 grams per day. <sup>6</sup> Dutch Guidelines for a healthy diet 2006: of minimal recommended fruit intake of 200 grams/day a maximum of 100 grams of fruit can be substituted by 1 glass of fruit juice daily. N.a.: not applicable.

Table S3. Determinants of completion of the lifestyle intervention

Category	Determinant	N	Completer/median, IQR or N, %	Non-completer (median, IQR or N, %)	Odds ratio (95% CI)	P
Demographic characteristics	Age female (years)	289	29.7 (26.6 – 33.5)	29.4 (24.9 – 32.0)	1.05 (0.98 – 1.12)	0.15
	Non-Caucasian	289	23 / 226 (10.2)	10 / 63 (15.9)	0.60 (0.27 – 1.34)	0.21
	Education level	276				0.08
	primary school		13 / 214 (6.1)	4 / 62 (6.5)	[ref]	[ref]
	secondary education		46 / 214 (21.5)	20 / 62 (32.3)	0.71 (0.21 – 2.44)	0.58
	intermediate vocational education		103 / 214 (48.1)	32 / 62 (51.6)	0.99 (0.30 – 3.25)	0.99
	higher vocational education and university		52 / 214 (24.3)	6 / 62 (9.7)	2.67 (0.66 – 10.9)	0.17
Socioeconomic status score <sup>1</sup>		230	-0.53 (-1.20 – 0.39)	-0.43 (-1.48 – 0.36)	1.01 (0.77 – 1.34)	0.93
	Current smoker	285	53 / 222 (23.9)	23 / 63 (36.5)	0.55 (0.30 – 0.99)	<b>0.05</b>
Infertility characteristics	Duration of infertility (months)	289	23.0 (15.0 – 36.3)	18.0 (14.0 – 36.0)	1.01 (0.99 – 1.02)	0.40
	Nulliparous	276	180 / 213 (84.5)	46 / 63 (73.0)	2.02 (1.03 – 3.93)	<b>0.04</b>
	Anovulatory	288	100 / 225 (44.4)	28 / 63 (44.4)	1.00 (0.57 – 1.76)	1.00
	Male factor infertility	288	56 / 225 (24.9)	11 / 63 (17.5)	1.57 (0.77 – 3.21)	0.22
	Unexplained infertility	288	68 / 225 (30.3)	18 / 63 (28.6)	1.08 (0.59 – 2.01)	0.80
Anthropometric and weight characteristics	BMI (kg / m <sup>2</sup> )	288	36.3 (33.5 – 38.3)	35.5 (33.3 – 38.8)	1.04 (0.95 – 1.13)	0.41
	Waist circumference (cm)	262	107.0 (102.0 – 113.0)	107.0 (99.0 – 115.0)	1.01 (0.98 – 1.05)	0.42
	Waist/hip ratio	280	0.86 (0.82 – 0.91)	0.88 (0.82 – 0.93)	0.71 (0.47 – 1.09)	0.12
	Highest weight in past 10 years (kg)	246	108.0 (98.0 – 119.0)	105.0 (95.0 – 119.0)	1.00 (0.99 – 1.03)	0.64
	Highest weight ever	235				0.36
	same as current weight		45 / 191 (23.6)	14 / 44 (31.8)	[ref]	[ref]
	1 – 5 kg above current weight		67 / 191 (35.1)	18 / 44 (40.9)	1.16 (0.52 – 2.56)	0.72

**Table S3.** Continued

Category	Determinant	N	Completer/median, IQR or N, %	Non-completer (median, IQR or N, %)	Odds ratio (95% CI)	P
<i>Anthropometric and weight characteristics</i>	6 – 10kg above current weight		39 / 191 (20.4)	5 / 44 (11.4)	2.43 (0.80 – 7.35)	0.12
	> 10 kg above current weight		40 / 191 (20.9)	7 / 44 (15.9)	1.78 (0.65 – 4.84)	0.26
	Weight variability in past 10 years <sup>3</sup> (kg)	241	30.0 (21.0 – 39.0)	30.0 (21.0 – 41.5)	1.00 (0.97 – 1.02)	0.80
	Number of weight loss attempts in past 5 years	250				0.58
	none		13 / 201 (6.5)	4 / 49 (8.2)	[ref]	[ref]
	1 attempt		29 / 201 (14.4)	6 / 49 (12.2)	1.49 (0.36 – 6.18)	0.59
	2 – 3 attempts		57 / 201 (28.4)	9 / 49 (18.4)	1.95 (0.52 – 7.32)	0.32
4 – 5 attempts		29 / 201 (14.4)	10 / 49 (20.4)	0.89 (0.24 – 3.38)	0.87	
> 5 attempts		73 / 201 (36.3)	20 / 49 (40.8)	1.12 (0.33 – 3.82)	0.85	
<i>Metabolic characteristics</i>	Insulin resistance (HOMA-IR)	247	2.90 (1.9 – 3.9)	2.8 (2.4 – 3.3)	0.91 (0.79 – 1.05)	0.19
	Metabolic syndrome	237	94 / 187 (50.3)	29 / 50 (58.0)	0.73 (0.39 – 1.38)	0.33
<i>Psychosocial characteristics</i>	Quality of Life <sup>4</sup>					
	physical component (score)	236	1.7 (46.3 – 55.5)	52.2 (46.9 – 54.7)	0.99 (0.96 – 1.03)	0.70
	mental component (score)	236	52.7 (46.7 – 56.0)	52.8 (42.4 – 56.3)	1.02 (0.98 – 1.05)	0.34
	Readiness to change: weight loss	246				<b>0.01</b>
	precontemplation		0 / 198 (0.0)	0 / 48 (0.0)	n.a.	n.a.
	contemplation		0 / 198 (0.0)	2 / 48 (4.2)	n.a.	n.a.
	preparation		24 / 198 (12.1)	14 / 48 (29.2)	0.43 (0.19 – 1.00)	<b>0.05</b>
action		99 / 198 (50.0)	13 / 48 (27.1)	1.93 (0.90 – 4.15)	0.09	
maintenance		75 / 198 (37.9)	19 / 48 (39.6)	[ref]	[ref]	

Table S3. Continued

Category	Determinant	N	Completer (median, IQR or N, %)	Non-completer (median, IQR or N, %)	Odds ratio (95% CI)	p
<i>Psychosocial characteristics</i>	Readiness to change: physical activity	249				
	precontemplation		5 / 198 (2.5)	6 / 51 (11.8)	0.12 (0.03 – 0.56)	0.08
	contemplation		52 / 198 (26.3)	14 / 51 (27.5)	0.55 (0.18 – 1.66)	0.007
	preparation		65 / 198 (32.8)	14 / 51 (27.5)	0.68 (0.23 – 2.06)	0.29
	action		42 / 198 (21.2)	12 / 51 (23.5)	0.52 (0.17 – 1.61)	0.50
	maintenance		34 / 198 (17.2)	5 / 51 (9.8)	<i>ref</i>	0.25
	Previous support in weight loss					
	by dietician	224	87 / 182 (47.8)	20 / 42 (47.6)	1.01 (0.52 – 1.97)	0.98
	by partner	224	105 / 182 (57.7)	26 / 42 (61.9)	0.84 (0.42 – 1.67)	0.62
	no social support	224	65 / 182 (35.7)	11 / 42 (26.2)	1.57 (0.74 – 3.32)	0.24
	Self-efficacy	245				
	extremely unlikely		0 / 197 (0.0)	1 / 48 (2.1)	<i>n.a.</i>	0.97
	unlikely		6 / 197 (3.0)	0 / 48 (0.0)	<i>n.a.</i>	<i>n.a.</i>
	do not know / neutral		83 / 197 (42.1)	22 / 48 (45.8)	0.71 (0.28 – 1.82)	0.48
	likely		71 / 197 (36.0)	18 / 48 (37.5)	0.75 (0.29 – 1.95)	0.55
extremely likely		37 / 197 (18.8)	7 / 48 (14.6)	<i>ref</i>	<i>ref</i>	
Body satisfaction	250					
no, never		91 / 201 (45.3)	25 / 49 (51.0)	<i>ref</i>	0.88	
no, mostly not		76 / 201 (37.8)	15 / 49 (30.6)	<i>n.a.</i>	<i>ref</i>	
sometimes, sometimes not		28 / 201 (13.9)	7 / 49 (14.3)	0.69 (0.13 – 3.75)	<i>n.a.</i>	
yes, mostly		5 / 201 (2.5)	2 / 49 (4.1)	1.10 (0.343 – 2.81)	0.67	
yes, always		1 / 201 (0.4)	0 / 49 (0.0)	1.39 (0.69 – 2.83)	0.84	
Dutch Eating Behavior Questionnaire						
emotional eating (13–65 points)	276	36.0 (27.0 – 44.0)	37.0 (25.8 – 45.0)	1.00 (0.98 – 1.03)	0.96	
external eating (10–50 points)	277	28.0 (24.0 – 32.0)	29.0 (25.0 – 33.0)	0.98 (0.93 – 1.03)	0.48	
restrained eating (10–50 points)	278	32.0 (28.0 – 36.0)	31.0 (26.0 – 33.0)	1.07 (1.02 – 1.12)	<b>0.01</b>	

Table S3. Continued

Category	Determinant	N	Completer (median, IQR or N, %)	Non-completer (median, IQR or N, %)	Odds ratio (95% CI)	P
<i>Diet and physical activity characteristics</i>	Mean energy intake (kcal/day)	213	1868 (1568 – 2200)	2000 (1687 – 2300)	0.96 (0.89 – 1.03)	0.28
	Mean steps (day)	230	6000 (4000 – 8000)	5250 (3500 – 7406)	1.04 (0.93 – 1.16)	0.46
	Frequency of breakfast use (days / week)	198	7.0 (5.0 – 7.0)	7.0 (3.0 – 7.0)	1.05 (0.92 – 1.19)	0.50
	Vegetable intake (grams/day)	259	114 (86 – 157)	100 (71 – 150)	1.02 (0.97 – 1.07)	0.50
	Fruit intake (grams/day)	259	100 (57 – 171)	71 (29 – 171)	0.99 (0.96 – 1.03)	0.67
	Meeting recommendations vegetable intake <sup>3</sup>	259	36 / 208 (17.3)	10 / 51 (19.6)	0.86 (0.39 – 1.87)	0.70
	Meeting recommendations fruit intake <sup>5</sup>	259	43 / 208 (20.7)	10 / 51 (19.6)	1.07 (0.50 – 2.30)	0.87
	Meeting recommendations fruit and juice intake <sup>6</sup>	259	62 / 204 (30.4)	11 / 51 (21.6)	1.59 (0.76 – 3.30)	0.22
	Meeting recommendations fruit- and vegetable intake <sup>5</sup>	255	16 / 203 (7.9)	4 / 50 (8.0)	0.98 (0.32 – 3.08)	0.98
	Alcoholic beverages (units / day)	253	0 (0 – 0.2)	0 (0 – 0.2)	0.93 (0.48 – 1.83)	0.84
	Total moderate to vigorous physical activity	238	330 (126 – 900)	390 (120 – 950)	1.00 (0.99 – 1.02)	0.59
	Meeting recommendations guideline physical activity	254	147 / 202 (72.8)	38 / 52 (73.1)	0.99 (0.50 – 1.96)	0.97
<i>Partner characteristics</i>	Age (years)	289	32.9 (29.7 – 36.6)	33.6 (29.6 – 38.2)	0.99 (0.94 – 1.03)	0.58
	BMI (kg / m <sup>2</sup> )	247	27.9 (24.5 – 31.7)	26.5 (24.1 – 29.1)	1.07 (1.00 – 1.14)	<b>0.04</b>
	Non-Caucasian	288	18 / 225 (8.0)	9 / 63 (14.3)	0.52 (0.22 – 1.23)	0.14
	Smoking	286	86 / 224 (38.4)	31 / 62 (50.0)	0.62 (0.35 – 1.10)	0.10

All determinants were assessed at baseline. Results of univariate logistic regression analyses. <sup>a</sup>Waist-hip ratio; per 0.10 increase. <sup>b</sup>Baseline caloric intake; per 100 kcal increase. <sup>c</sup>Baseline step counts; per 1000 steps increase. <sup>d</sup>Baseline vegetable and fruit intake; per 10 grams / day increase. <sup>e</sup>Total moderate to vigorous physical activity; per 30 min / week increase. <sup>f</sup>Socioeconomic status score (Netherlands Institute for Social Research (SCP)) in year 2010 relative to Dutch average of 0, a higher score represents a higher socioeconomic status. <sup>2</sup>Weight change during the first 1.5 months of the intervention program. <sup>3</sup>Calculated upon the highest and lowest weight in the past 10 years. <sup>4</sup>Measured by the Short-Form-36 Questionnaire. <sup>5</sup>Dutch Guidelines for a healthy diet 2006: minimal recommended fruit and vegetable intake 200 grams per day. <sup>6</sup>Dutch Guidelines for a healthy diet 2006: of minimal recommended fruit intake of 200 grams/day a maximum of 100 grams of fruit can be substituted by 1 glass of fruit juice daily. N.a.: not applicable.

