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Effect of regular exercise on prevention of excessive weight gain in pregnancy: a randomised controlled trial

Lene A. H. Haakstad and Kari Bø

Norwegian School of Sport Sciences, Department of Sports Medicine,
Ullevål Stadion, Oslo, Norway.

Short title: Exercise to prevent weight gain in pregnancy

Key words: Adherence, Aerobic exercises, Obesity, Overweight, Randomised controlled trial

Correspondence:

Lene A. H. Haakstad, Ph.D, Associate Professor, Norwegian School of Sport Sciences,
Department of Sports Medicine, P.O Box 4014, Ullevål Stadion, 0806 Oslo, Norway. Tel:
+47 23 26 20 00. Fax +47 22 23 42 20. E-mail: lene.haakstad@nih.no

ABSTRACT

Objectives: To assess whether a 12-week supervised exercise-programme with an additional 30 minutes of moderate self-imposed physical activity on the non-supervised week days prevents excessive weight gain in pregnancy, as well as postpartum weight retention.

Methods: One hundred and five sedentary, nulliparous pregnant women with a mean age of 30.7 ± 4.0 years and a pre-pregnancy body mass index of $23.8 \pm 4.3 \text{ kg/m}^2$ were randomised to either an exercise group (EG, n=52) or a control group (CG, n=53). The exercise programme consisted of 60 min supervised aerobic dance and strength training for 60 minutes, at least twice per week for a minimum of 12 weeks.

Results: Drop-out rates were 19% and 21% in the EG and CG, respectively. Fewer women in the EG than in the CG exceeded the Institute of Medicine recommendations; however, only EG participants who attended 24 exercise sessions (n=14) differed significantly from controls ($p=0.006$) with regard to weight gain during pregnancy (11.0 ± 2.3 vs. 13.8 ± 3.8 kg, $p<0.01$) and postpartum weight retention (0.8 ± 1.7 vs. 3.3 ± 4.1 kg, $p<0.01$).

Conclusions: Regular participation to aerobic dance exercise can contribute to significantly reduce weight gain during pregnancy.

INTRODUCTION

Obesity is a serious health problem. The risks of morbidity associated with being overweight - such as coronary heart disease, diabetes, breast and colon cancer - emphasise the need for its prevention^{1,2}. Pregnancy is as a rule associated with considerable weight gain; maternal

weight gain greater than that recommended by the Institute of Medicine (IOM, USA; <http://www.iom.edu/>) is an important contributor to later obesity among women^{3,4}.

Excessive weight gain during pregnancy is a risk factor for hypertension, gestational diabetes, pre-eclampsia, macrosomia, stillbirth, and peripartal complications^{5,6}. Haakstad et al.⁷ observed that 32% of women with a normal pre-pregnancy body mass index ($BMI \leq 26$) and 51% of those overweight (pre-pregnancy $BMI > 26$) gained more weight during pregnancy than the 15.9 kg and 11.4 kg, respectively, that are currently the upper limits of recommended weight gain. This is in accordance with new data concerning US women, which show that approximately 40% of normal-weight and 60% of overweight women gained too much weight during pregnancy⁸.

Currently, healthy pregnant women are advised to have moderate intensity physical activity for a minimum of 15 minutes, three to five times a week⁹. Randomised controlled trials (RCTs) suggest that physical activity and exercise are important to enhance weight loss and prevent weight regain in adults^{10,11}. However, the effect of exercise during pregnancy on weight gain is still unclear. A recent Cochrane review found no difference between exercisers and non-exercisers¹². This is in agreement with the systematic reviews of Siega-Riz et al.¹³ and Birdsall¹⁴, both concluding that few studies examined exercise as a determinant of maternal weight gain. These authors emphasised the need for high quality RCTs in this area. They listed limitations of the previous trials including small sample sizes, lack of randomisation, high drop-out rates, and non-blinding of assessors.

The research hypothesis of the present study was: Regular attendance at aerobic dance exercises twice a week and unsupervised moderate physical activity on the remaining week-

days can significantly reduce excessive weight gain during pregnancy in previously inactive women.

METHODS

Design

This study was an assessor-blinded randomised controlled trial to evaluate the effects of a 12-week exercise programme including 60 minutes of supervised aerobic dance performed at least twice a week, on weight gain in nulliparous pregnant women. The latter were advised to have moderate self-imposed physical activity on the remaining week-days.

Participants

Participants were recruited via health personnel (physicians, midwives), articles and advertisement in newspapers, websites for pregnant women, flyers and word of mouth. Interested women telephoned or mailed the principal investigator (LH). At the first phone contact, the aims and implications of the study were explained and it was verified whether the eligibility criteria were satisfied. Nulliparous women whose pre-pregnancy exercise levels did *not* include participation in a structured exercise programme (> 60 minutes once per week), with in addition brisk walking (>120 minutes per week) for the past six months, were eligible for the trial. Other inclusion criteria were the ability to read, understand and speak Norwegian, and a duration of pregnancy of at most 24 weeks. Exclusion criteria were a history of more than two miscarriages, severe heart disease (including symptoms of angina, myocardial infarction or arrhythmias), persistent bleeding after 12 weeks of gestation, multiple pregnancy, poorly controlled thyroid disease, pregnancy-induced hypertension or pre-eclampsia, and other diseases that could interfere with participation¹⁵. Women unable to attend weekly exercise classes were also ineligible.

We wished to recruit 50 women in each group, which would give 85% power and an alpha of 5%, allowing detection of a difference in maternal weight gain between the two groups of 3 kg, assuming that the standard deviation of weight gain was 5 kg. These figures were conservatively based on findings in a previous study ⁷. Participants came from the city of Oslo. In total, 105 women were recruited to the trial from September 2007 to March 2008. Participants gave written consent; they received no financial compensation. All follow-up procedures were completed by November 2008. A flow chart (Figure 1) illustrates the course of events, including drop-outs and reasons for withdrawals. Some women who might be lost to the test after the intervention, could re-enter the study at the postpartum examination.

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The procedures were in accordance with the World Medical Association Declaration of Helsinki. The project was approved by the National Committee for Medical Research Ethics, Southern Norway, Oslo, Norway (reference number S-05208). The Norwegian Social Sciences Data Services (NNT) provided licence to store and register individual health information (reference number 17804/2/KH). The study is listed in the Clinical Trials.gov Protocol Registration System (NCT00617149).

Randomisation

An independent person involved in neither the exercise classes nor in the assessment, assigned the participants to either an *exercise group* (EG) or a *control group* (CG) according to a simple (not block) computerised randomisation programme. The women were not stratified by BMI before randomisation. Participants were requested not to reveal group

allocation to the principal investigator (LH). The principal investigator was not involved in training the women and was blinded to group allocation when assessing the outcome measures, plotting and analysing the data.

Exercise programme

The exercise programme consisted of supervised sessions of aerobic dance exercises for 60 minutes, taking place at least twice a week, for a minimum of 12 weeks. The women had the opportunity to participate in aerobic dance exercise classes three times a week, if they so wished. Since most participants were working full time, the sessions took place in the evening. Each started with five minutes warm-up, followed by 35 minutes of aerobic dance, including cool-down. This was followed by 15 minutes of strength-training with a special focus on the deep abdominal stabilisation muscles (internal oblique and the transverse abdominal muscle), pelvic floor, and back muscles. The last five minutes were devoted to stretching, relaxation and body awareness exercises. The aerobic dance routine included low-impact exercises (no jumping or running) and step-training (use of an elevated platform). The exercise-programme was based on the American College of Obstetricians and Gynecologists (ACOG) exercise prescription¹⁶, and all aerobic activities were performed at moderate intensity measured by ratings of perceived exertion at 12-14 (somewhat hard) on the 6-20 Borg's rating scale¹⁶. The exercise programme was choreographed and led by certified aerobic instructors. Each session was attended by a maximum of 25 participants.

In addition to joining the scheduled aerobic classes, all women in the EG were asked to have 30 minutes of moderate self-imposed physical activity on the remaining week-days. They were also advised to incorporate short bouts of activity into their daily schedules (e.g., walking instead of using the car for short distances and using the stairs instead of the

elevator). Adherence to the exercise classes was controlled by the instructors, and the self-imposed daily activity was registered in a personal training diary.

Control participants were asked not to change their usual physical activity pattern, and were neither encouraged nor discouraged from exercising. At follow-up, after the intervention period, women in the CG were asked the same questions about their physical activity and exercise during pregnancy as women in the EG. This was also done to ensure that the primary investigator was 'blind' to the treatment received. The CG did not complete a training diary.

Outcome measures

Participants were examined three times during the study period. The first visit was between 12 and 24 weeks of gestation (baseline examination), the second at week 36-38 (after the intervention), and the last one 6-12 weeks after delivery (postpartum examination). Each visit lasted about 60-75 minutes. The main outcome measures were maternal weight gain and the proportion of women whose weight gain exceeded the IOM recommendations¹⁷. Maternal weight gain was defined as the difference between self-reported pre-pregnancy weight and the weight measured upon completion of the intervention period (pregnancy week 36.6 ± 0.95). Height and body weight were measured in light clothing and without shoes using a digital beam scale. Classification of maternal weight gain and pre-pregnancy BMI (kg/m^2) was done according to recommendations from the IOM¹⁷: 12.5-18.0 kg weight gain for underweight women (pre-pregnancy BMI < 18.5), 11.5-16.0 kg weight gain for normal weight women (pre-pregnancy BMI of 18.5-24.9), 7.0-11.5 kg weight gain for overweight women (pre-pregnancy BMI of 25.0-29.9), and 5.0-9.0 kg weight gain for obese women (pre-pregnancy BMI ≥ 30).

Secondary outcome measures were the mean skin-fold thickness (defined in the next sentence) and the postpartum weight retention. Skin-fold thickness was assessed by Holtain Caliper (Holtain Ltd., Crymych, UK), measuring left side skinfold thickness over the triceps, abdomen and thigh. Each measurement was done twice. The mean value of the two measurements was computed. If the two skinfold assessments differed by more than 2 mm, the skinfold was measured a third time and the mean of the three values was calculated¹⁸. Weight measured at the postpartum examination was compared with self-reported pre-pregnancy weight to compute weight retention.

Other data concerning the pregnancy were obtained from a maternity card and interviews with the participants. The baseline questionnaire covered demographic information (e.g., age, pregnancy week, smoking habits, education, occupation), assessment of daily life, physical activity and sedentary behaviour (at work, transportation and household). The questionnaire had been validated with a portable activity monitor¹⁹. In addition, pregnancy complications such as pelvic girdle and low back pain, urinary and fecal incontinence, high blood pressure, pre-eclampsia, nausea, and fatigue were recorded⁷.

Statistical analysis

The principal analysis was done on an intention-to-treat basis (ITT). Missing values were replaced with the mean value (maternal weight gain) or the percentage change in the mean value (skin-fold thickness and weight postpartum) of the group concerned. Average maternal weight gain was compared between the two groups and the possible difference was tested using a two-sided independent sample t-test. The group differences in proportion of participants gaining weight in excess of the IOM guidelines was tested by using the two-sided χ^2 -test. Spearman's rho was used for correlations on ordinal scaled variables. In accordance

with the recommendations of Irwin et al.²⁰, per-protocol analysis was based on adherence to \geq 80% of the recommended exercise sessions (\geq 19 exercise sessions). In addition, we compared women attending 24 exercise sessions (exercise twice a week) with the CG. Level of statistical significance was set at $p < 0.05$.

RESULTS

One hundred and five nulliparous women were randomised to either the EG (n=52) or the CG (n= 53). The majority of the participants were from Norway (n=94), and the others from Sweden, Poland, Russia, Chile, Iran, Burundi, and Uganda. There were no statistically significant differences in background variables between the EG and CG prior to the intervention, at mean gestation week 17.7 ± 4.2 (Table 1).

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Two women had a pre-pregnancy BMI < 18.5, and 11 had a BMI exceeding 30. These 13 women were classified as either normal weight or overweight, and corresponding weight gain recommendations were used in the statistical analysis as done in other studies in this population^{21,22}.

Ten women in the EG (19%) and 11 women in the CG (21%) were lost to the examination after the intervention. Two were excluded due to twin birth or poorly controlled thyroid disease after the first assessment. Drop-outs (n=11) were primarily due to pregnancy-related diseases (Figure 1).

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Mean adherence rates are based on registrations done by the aerobic instructors and all the women in the EG. However, four women never showed up and, as already mentioned, one woman was excluded because of twins. Hence, the mean adherence to the exercise classes was 17.0 ± 12.5 out of 24 prescribed exercise sessions, with 21 women (40%) attending 80% or more of the recommended exercise sessions (≥ 19 supervised exercise sessions). The remaining 31 women (60%) participated in less than 80% of the exercise sessions. Fourteen women had 100% exercise adherence and completed two exercise sessions per week with a total of 24 exercise sessions. Adherence to exercise classes was not associated with pre-pregnancy BMI. Sixty-two percent of the women in the EG returned their training diaries and reported daily minutes with physical activity and exercise. Excluding low intensity activity and the scheduled aerobic classes, the results showed a mean weekly exercise time of 90 ± 73 minutes of moderate exercise, with sixteen women (31%) adhering to the pregnancy exercise guidelines of minimum 15 minutes of moderately intense exercise, three to five times a week. In addition to participation in the aerobic exercise classes, walking was the most common exercise mode, followed by cross-country skiing, bicycling, strength training, swimming and aerobic dance. Adherence to the exercise protocol was not affected by commonly reported pregnancy complaints such as nausea, fatigue, urinary incontinence, pelvic-girdle pain or low-back pain.

Eighteen of 53 women (34%) in the CG reported they had started to exercise regularly, defined as having a moderately intense recreational physical activity of at least 20 minutes duration once a week, after the baseline test. Six CG women were exercising at moderate intensity at least twice a week for 60 minutes, which was the prescribed intervention dosage

for the EG. None of the exercises performed by the CG were supervised as opposed to the EG.

Maternal weight gain

At completion of the intervention (pregnancy week 36.6 ± 0.95), no difference in maternal weight gain was seen between the EC and the CG. Women attending 24 exercise sessions reduced maternal weight gain compared to women attending less exercise sessions and compared to the CG. Table 2 summarises the results of maternal weight gain of the ITT, per protocol and analyses of women attending 24 exercise sessions. Excluding the women who exercised regularly in the CG (n=6) did not change the ITT results.

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Recommendations of the Institute of Medicine

As shown in Table 3, the proportion of women in the EG gaining more weight than recommended by the IOM did not differ from that in the CG. Yet, no women attending 24 exercise sessions exceeded the IOM recommendations.

Analyses of pre-pregnancy BMI categories and weight gain after the intervention period showed a significant difference only between normal weight women belonging to the EG who had attended all 24 exercise sessions and their counterparts in the CG ($p < 0.01$). In both groups, there was a trend for pre-pregnancy overweight women ($BMI \geq 25$) to have gained less weight than normal weight women ($BMI < 25$) ($p = 0.06$).

Skin-fold thickness

At baseline, measures of skin-fold thickness from nine women were not taken. Four participants were uncomfortable with the measurements and five more were overweight or obese, and estimation of skin-fold thickness of the thigh was not done due to the limitation of the size of the caliper. After the intervention period, the mean of skin-fold thickness measured at three sites did not differ between the EG (from 23.2 ± 5.1 mm to 23.0 ± 4.8 mm) and CG (from 23.2 ± 5.5 mm to 23.5 ± 5.6 mm) ($p=0.38$). Per-protocol and analysis of attendance to all 24 exercise sessions did not change the ITT results.

Postpartum weight retention

According to ITT analysis, mean postpartum weight was 71.1 ± 11.9 kg and 71.7 ± 14.4 kg, and mean weight retention was 3.3 ± 3.9 kg and 3.3 ± 4.1 kg ($p=0.93$) in the EG and CG, respectively. When postpartum examination took place, the mean intervals of time elapsed since delivery were 7.1 ± 1.6 weeks in the EG and 8.1 ± 1.5 weeks in the CG ($p=0.005$). The difference in postpartum weight was statistically significant ($p=0.001$) only between women in the EG having attended 24 exercise sessions (0.8 ± 1.7 kg) and those in the CG (3.3 ± 4.1 kg). Postpartum weight retention was positively correlated with weight gain during pregnancy in both the EG ($r=0.60$, $p<0.001$) and the CG ($r=0.75$, $p<0.001$). The average postpartum weight loss was similar in both groups, ranging from 10.1 kg to 11.9 kg, with no effect of pre-pregnancy BMI category or group allocation.

No side effects or injuries of the exercise programme were reported. One woman in the CG gave birth prior to 37 weeks' gestation. There were no miscarriages in either group.

DISCUSSION

Only women attending all sessions of the prescribed exercise programme significantly reduced their weight gain during pregnancy compared to women in the control group and none of the former exceeded the IOM weight gain recommendations. Weight retention 6-8 weeks postpartum was also significantly lower among women who had attended the 24 exercise classes. The difference between the groups in mean of skin-fold thickness was not statistically significant.

Results from previous trials evaluating exercise during pregnancy and maternal weight gain are inconsistent and comparisons of results are difficult due to use of different designs, study populations, measurement methods to assess maternal weight gain, and intensity of the exercise programme. In addition, previous trials assessing the effects of supervised exercise focused on primary outcome measures other than maternal weight gain such as maintenance of fitness, feto-placental growth, and low back pain²³⁻²⁸. In the few intervention studies with maternal weight gain as the main outcome measure, there are only two RCTs, and they focused on lifestyle counselling, and combining diet and exercise, rather than on supervised training^{21,29}. To the best of our knowledge this is one of the first RCTs whose primary outcome is the effect of a supervised structured exercise programme and self-imposed physical activity according to ACOG guidelines¹⁶ on maternal weight gain.

Strengths of the present study were its randomised controlled design, the blinding of the assessor, and the use of a standardised exercise programme matching the ACOG recommendations¹⁶. In addition, this study was based on power calculations from a previous study⁷, and applied clinical outcome measures. The participants' adherence to the exercise protocol was monitored both by the instructors and via recordings in a training diary. A limitation of the study is that ten women in the EG (19%) and 11 women in the CG (21%)

were lost to follow-up immediately following the intervention. Also only 40% of the women in the EG attended 80% or more of the recommended exercise sessions. Finally, information on dietary habits that could have affected maternal weight gain was not collected. However, this was a RCT and changes in eating patterns should be equally distributed among the groups. Food records are often very detailed and time consuming for participants to fill in and for researchers to process. Hence, this would have meant a heavier burden for the participants. In addition, the IOM emphasises the complexity of identifying changes in energy intake in pregnant women³⁰.

The present RCT was affected by withdrawals and drop-outs. Hence, missing data due to participants' refusal to complete outcome assessments and missed appointments may have reduced the power of the study and the ability to draw clear conclusions. Imputation techniques never compensate for or exactly reproduce missing data. On the other hand, the possible bias associated with the drop-outs was probably minor, as there were only small differences between the EG and the CG with regard to reasons why the women did not want to continue participating in the study and drop-out rates. In addition, there were no statistically significant differences in background variables between the EG and the CG prior to the intervention, at mean gestation week 17.7 ± 4.2 .

As recommended by Armijo-Olivo et al.³¹, we also performed 'per protocol' analyses, defined as analyses of findings pertaining to women having participated in 80% or more of the recommended exercise sessions, on the one hand, and to 'women attending all 24 exercise sessions', on the other hand. This type of analysis may provide an answer with regard to the efficacy of the treatment, but it may also overestimate the magnitude of the effect due to selection bias. Indeed, participants who exercised as prescribed may have differed from those

who did not. Hence, conclusions from the ‘per protocol’ analysis cannot be generalised to other pregnant women or settings.

Pregnant women are currently encouraged to exercise moderately three to five times a week^{9, 16, 32}. We assumed that it was easier to recruit previously sedentary women and to achieve high adherence among them with exercises taking place twice weekly. However, all women in the EG had the opportunity to attend three exercise classes per week. Additionally, women allocated to the EG were asked to have 30 minutes of moderate self-imposed physical activity (e.g., brisk walking) on the other week-days. Unfortunately, we could not verify whether the women concerned acted according to instructions, as only few reported adherence in their exercise diaries. In the general adult population 60 minutes of daily moderate intensity activity is needed to prevent unhealthy weight gain³³. Hence, more physical activity than recommended in this RCT could have been envisioned.

Certified aerobic instructors were leading the class and stressed the importance of adherence to the exercise protocol. Why only 40% attended at least 80% of the recommended exercise sessions is difficult to understand. However, a fitness class of 60 minutes held twice a week, including endurance training for 40 minutes, is demanding, and sedentary women such as those this study targeted may not be highly motivated to comply. In addition, one must find the time to exercise. Some of the previous studies concerning sedentary pregnant women showed low adherence to exercise programmes^{23,34,35}. The interviews after the intervention period revealed that some women in the CG had started exercising regularly after enrolment. This type of bias has been referred to as the ‘Avis effect’³⁶. Low adherence in the EG and increased physical activity level in the CG may have confounded our findings and resulted in

a much smaller difference in maternal weight gain between the two groups than had been expected.

Clapp et al.²⁶ demonstrated that exercise reduces weight gain during pregnancy. The exercise volume of our study was lower than in the aforementioned study²⁶, suggesting that also a less demanding programme may be effective for previously sedentary women. Both studies focused on weight-bearing moderate intensity exercises of about 60 minutes, which have higher energy costs than other activities (e.g., cycling), and exercise of less duration and intensity. The moderate intensity of the exercise classes in the present study matched the ACOG guidelines¹⁶ and can easily be achieved in most aerobic classes or by walking briskly. However, the present study showed that it is difficult to motivate former sedentary women to adhere to the ACOG exercise recommendations. Further studies on adherence strategies to improve pregnant women's compliance are warranted.

Excessive weight gain during pregnancy is a predictor of long-term weight gain^{4,37}. In this study weight gain during pregnancy and weight retention 6-12 weeks postpartum were significantly lower in women attending 24 exercise classes. Yet six weeks may be too soon to study the impact of exercise during pregnancy on long-term weight change. Early postpartum weight loss mainly represents loss of non-adipose tissue, including loss of placenta, amniotic fluid, and maternal blood volume⁴. Whether women earlier allocated to an EG would continue to exercise and thus control their weight in the long term, remains to be investigated. Participants in interventions tend to return to their old habits⁽³⁸⁻⁴⁰⁾. A long-term follow-up of the participants is now being planned.

RCTs are time consuming and require the cooperation of the participants. Pregnant women who volunteer for a study on exercise and maternal weight gain may have an interest and be more attentive to exercise and other health aspects such as weight gain than non-participants. The pregnant women we recruited were healthy nulliparae with a high educational level. Our findings, therefore, may apply only to similar groups.

Conclusions

Only women in the EG, who attended 24 exercise sessions of moderate intensity during the second and third trimesters of pregnancy, reduced their weight gain over this period and none of these exceeded the weight gain set by the IOM. Further studies on the effect of adherence strategies to enhance motivation for regular participation in general fitness classes during pregnancy are warranted.

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Table 1. Background variables in the exercise and control groups, at baseline examination, between 12 and 24 weeks' gestation. Means (with standard deviation, SD)[§] or number (and percentage)[#] (N=105). No difference between groups at baseline is statistically significant.

Detail	Exercise n= 52		Control n= 53	
Age (years) [§]	31.2	(SD: 3.7)	30.3	(SD: 4.4)
Gestational age (weeks) [§]	17.3	(SD: 4.1)	18.0	(SD: 4.3)
Married/cohabiting [#]	51	(98%)	52	(98%)
College/university education [#]	44	(85%)	45	(85%)
Sedentary occupation [#]	37	(71%)	36	(68%)
Sicklisted [#]	10	(19%)	13	(25%)
Daily smoker [#]	2	(4%)	1	(2%)
Pregnancy complaints [#] (nausea, fatigue, urinary incontinence, pelvic-girdle pain, low- back pain)	20	(39%)	20	(38%)
Height (m) [§]	1.69	(SD: 0.1)	1.69	(SD: 0.1)
Pre-pregnancy weight (kg) [§]	67.9	(SD: 11.4)	68.4	(SD: 14.6)
Weight at baseline examination (kg) ^{§,*}	71.8	(SD: 11.4)	72.7	(SD: 14.3)
Pre-pregnancy BMI (kg/m ²) [§]	23.8	(SD: 3.8)	23.9	(SD: 4.7)
Pre-preg BMI \geq 25 [§]	13	(SD: 25.0)	14	(SD: 26.4)

* Measured by means of a digital beam scale.

Table 2. Maternal weight gain during pregnancy in the exercise and control groups (mean and SD), analysed by intention to treat (ITT), per protocol ($\geq 80\%$ of exercise sessions), and analyses of attendance at 24 exercise sessions.

ITT –analysis				
	<i>Exercise</i> (n= 52)	<i>Control</i> (n=53)	<i>Difference</i> (kg)	<i>p-value</i>
Maternal weight gain (kg)*	13.0 (4)	13.8 (4)	0.8	0.31
Per protocol analysis				
	<i>Exercise</i> (n= 21)	<i>Control</i> (n=53)	<i>Difference</i> (kg)	<i>p-value</i>
Maternal weight gain (kg)	12.5 (4)	13.8 (4)	1.3	0.23
Attendance at 24 exercise sessions				
	<i>Exercise</i> (n= 14)	<i>Control</i> (n=53)	<i>Difference</i> (kg)	<i>p-value</i>
Maternal weight gain (kg)	11.0 (2)	13.8 (4)	2.8	0.01

* Maternal weight gain = weight measured after the intervention (pregnancy week 36.6 \pm 0.95) minus self-reported pre-pregnancy weight around the time of the last menstruation.

Table 3. Institute of Medicine (IOM) categories of maternal weight gain after the intervention in the exercise and control groups (n and %), analysed by intention to treat (ITT), per protocol ($\geq 80\%$ of exercise sessions), and analyses of attendance at 24 exercise sessions

	ITT-analysis		
	<i>Exercise</i> (n= 52)	<i>Control</i> (n=53)	<i>p-value</i>
Exceeded IOM recommendations	17 (33)	20 (38)	0.59
Within IOM recommendations	35 (67)	33 (62)	
	Per protocol analysis		
	<i>Exercise</i> (n= 21)	<i>Control</i> (n=53)	
Exceeded IOM recommendations	4 (19)	20 (38)	0.12
Within IOM recommendations	17 (81)	33 (62)	
	Attendance at 24 exercise sessions		
	<i>Exercise</i> (n= 14)	<i>Control</i> (n=53)	
Exceeded IOM recommendations	-	20 (38)	0.006
Within IOM recommendations	14 (100)	33 (62)	

Figure legend

Figure 1: Trial profile showing the flow of participants through the randomised controlled trial.

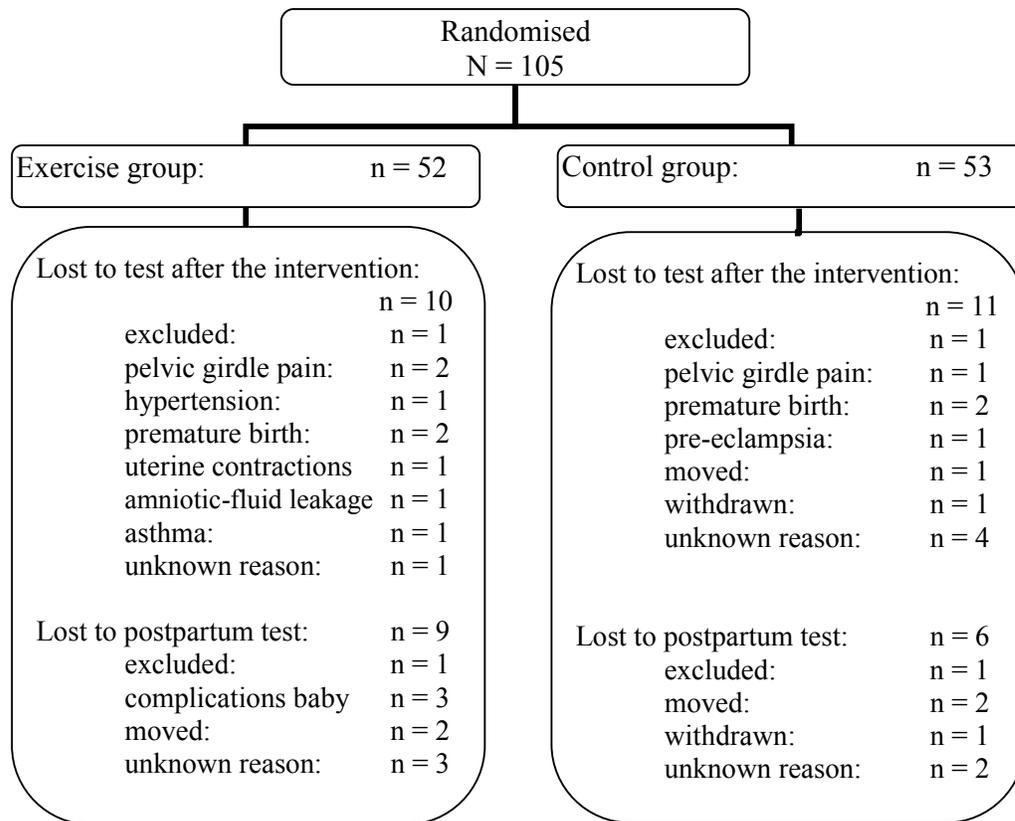


Figure 1.