Long-term effects of participation in a prenatal exercise intervention on body weight, body mass index and physical activity level

A 6-year follow-up study of a randomized controlled trial

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Abstract

Background: Growing evidence supports that physical activity and exercise during pregnancy is favourable for the mother, with persisting benefits in the postpartum period. However, there is scant knowledge of the effect of a prenatal exercise program on long-term health and lifestyle habits.

Objectives: This 6-year follow-up study of a randomized controlled trial had two aims: 1) compare body weight, weight retention and body mass index (BMI) in the intervention group and control group, and 2) evaluate effects on physical activity level and recreational exercise.

Materials and methods: Out of 105 participants initially randomized to either an intervention group, n=52 (twice weekly group-exercises and physical activity counselling) or control group, n=53 (standard prenatal care), 80 women (76.2 %) participated in the present long-term follow-up study, performed in a general community in Oslo, Norway. Data were collected via a standardized telephone interview based on the baseline protocol and a modified Physical Activity and Pregnancy Questionnaire (PAPQ). Body weight at 6 year follow-up was self-reported (kg), and calculation of current BMI (kg/m2) was based on self-reported weight and measured height at study inclusion. Investigators were unaware of the original randomization at the time of the interviews. Analyses of covariance were used to examine the difference in change in body weight and BMI between the groups. Even though the MET-values were not normally distributed, differences were examined using a two-sided independent sample t-test due to a large sample size (n ≥30).

Results: At 6 years follow-up there were no differences in mean BMI (kg/m2) (24.0±3.8 vs. 24.8±4.0, p=0.37), physical activity level (4167±2638 vs. 3925±3075 MET-min/week, p=0.67) or recreational exercise (630±1290 vs. 720±1005 MET-min/week, p=0.88) between the intervention and control group, respectively. Subgroup analysis of participants with high adherence during the intervention 6 years ago (≥24 prenatal exercise classes), showed a

positive intervention effect at long-term follow up in body weight (kg) (62.8 ±7.9 vs. 70.8 ±11.8, p=0.03) and BMI (kg/m2) (22.5±3.1 vs. 24.8 ±4.0, p=0.05), and none (vs. 11 in the control group) had gained ≥ 5kg compared to pre-pregnancy weight (p=0.02).

Conclusions: Women who adhered to the original prenatal exercise intervention demonstrated significantly lower body weight and BMI at 6-year follow-up. Otherwise, no long-term intervention effect was observed.

Trial registration: ClinicalTrials.gov: NCT00617149

Key words: BMI, body weight, exercise, physical activity, pregnancy, RCT

Introduction

Overweight and obesity is a significant health problem in the Western World, and the known risks of morbidity associated with an increased BMI, such as coronary heart disease, diabetes, breast and colon cancer - emphasize prevention of weight gain as an important public health issue [1]. Some studies have found that especially women of reproductive age have a greater risk of substantial weight gain compared with men of all ages and older women [2,3]. Pregnancy is a risk period for significant weight gain in women, and not achieving pre-pregnancy body weight postpartum may be an important contributor to later obesity among women [4].

A large proportion of the adult population is physically inactive or insufficiently physical active [5]. During pregnancy, physical activity level tend to decline even further [6-9]. Hence, pregnancy may be a critical period for onset of inactivity in women [10]. In addition, studies have shown that parous women are less active than other women in the same age group [11,12]. As such, the postpartum period is a life stage characterized not only by weight retention, but also by decrease of personal freedom and less time to participate in regular exercise.

Being pregnant is however, considered an ideal time for behavior modification [13], and studies have shown that pregnant women may be particularly receptive to health information [14,15]. Regular exercise throughout pregnancy also increases the likeliness of maintaining activity levels after giving birth [16].

The Pregnancy Exercise Intervention was a randomized control trial (RCT) evaluating the effects of a supervised, twice weekly aerobic dance program and intensive physical activity counselling on gestational weight gain in inactive nulliparous women. We have previously reported that participants attending regularly ($\geq$ 24 sessions in 2^{nd} and 3^{rd} trimester),

significantly reduced maternal weight gain compared with the control group, and none exceeded the IOM weight gain recommendations. Weight retention 6-8 weeks postpartum was also significantly lower in this group [17].

Ideally, being exposed to participation in a lifestyle or physical activity intervention during pregnancy should lead to increased motivation for further regular exercise after childbirth. Studies investigating physical activity as an intervention towards excessive gestational weight gain mostly end their follow-up period after six to 12 months [18,19], and we have not been able to find long-term studies in this population. Thus, this 6-year follow-up study of a randomized controlled trial had two objectives: 1) compare body weight, weight retention and BMI between women randomized to intervention and control; and 2) evaluate sustained effects of the original intervention on physical activity level and recreational exercise.

Methods

Setting and participants

Detailed study methods and results from the Pregnancy Exercise Intervention have been published previously [17,20-23]. In summary, a total of 105 women from the city of Oslo were recruited to the trial from spring 2008 (February – April). Nulliparous women whose pre-pregnancy physical activity levels did not include participation in a structured exercise program (>60 minutes of moderate to vigorous physical activity per week), were eligible for the trial. Other inclusion criteria were ability to read, understand and speak Norwegian, and to be within their first 24 weeks of pregnancy. Exclusion criteria were severe heart disease, pregnancy induced hypertension, history of more than two miscarriages, persistent bleeding after week 12 of gestation and poorly controlled thyroid disease, pre-eclampsia and other diseases that could interfere with participation [24]. In addition, all women not able to attend weekly exercise classes were ineligible.

The present follow-up was conducted as a 50-minute standardized telephone interview from March 2015 to October 2015. All the interviews were done by two investigators only, ensuring that questions were asked in the same manner and order, both blinded to group allocation during data-collection. Out of the 105 initially randomized, 80 (76.2%) gave a written consent and participated in the 6-year follow-up. Of these, five completed the protocol and questions by e-mail, due to inability to participate in the telephone interview. None of the participants had received any specific education on physical activity following their first pregnancy and participation in the Pregnancy Exercise Intervention. A complete flow chart of the participants has been published previously [17,23]. Fig. 1 shows a Consort diagram with respect to this long-term analysis.

Intervention

From the time of randomization until delivery, the intervention participants had access to twice-weekly supervised group sessions, each lasting 60 minutes. Since most participants were working full time, the exercise groups were arranged in the evening. The exercise program was tailored for pregnancy and followed contemporary guidelines [24], including 10 minutes of warm-up, 35 minutes of cardiovascular exercise at moderate intensity, and at the end 15 minutes of strength training with a special focus on the deep abdominal stabilization muscles (internal oblique and the transverse abdominal muscle), pelvic floor and back muscles. In accordance with recommendations for physical activity during pregnancy, all women in the intervention group were encouraged to include 30 minutes of moderate self-imposed physical activity on the remaining days of the week [24]. More details of the group-exercises and physical activity counselling program is published in Haakstad et al. [17].

Control

Participants in the control group, as well as in the intervention group, received routine prenatal care in accordance with Norwegian standards, including eight routine prenatal contacts and one second-trimester ultrasound examination (The Norwegian Directorate of Health, 2018). Prenatal care is free of charge in Norway and provided through alternating visits with midwives and physicians.

There was no financial compensation to the participants, but all examinations and exercise sessions, as well as physical activity counselling were free of charge.

Outcome measures

Primary outcomes were bodyweight, weight retention and BMI. Secondary outcomes included weekly physical activity level and recreational exercise.

Body weight, weight retention and BMI

In the original study pre-pregnancy body weight was self-reported. Given that most women only gain little weight during the 1st trimester and to reduce possible bias regarding self-report, body weight at baseline was used as a control variable. Weighing was done in light clothing and without shoes using a digital beam scale to the nearest 0.1 kg. Height was measured with a fixed stadiometer to the nearest 0.5 cm. Body weight at 6-year follow-up was self-reported (kg), and calculation of current BMI (kg/m^2) was based on self-reported weight and measured height.

Physical activity

Physical activity level was assessed by 19 questions, addressing the full range of physical activity (transportation, occupation, household/childcare activities, and recreational exercise). The eight questions concerning recreational exercise, defined as vigorous leisure-time physical activity/sport at least 30 min once a week, included mode of activity, duration and frequency. Perceived intensity was measured with two different scales. The Borg scale was used for exercise intensity, whereas e.g. household activities was rated on a scale from 0-10, where 0 represented "no feeling of exertion" and 10 represented "very strenuous". Hence, higher scores represented greater average intensity, with the following categorization: low level: 0–3, moderate level: 4–6, and high level: 7–10. A complete questionnaire form (in Norwegian) can be provided on request.

Metabolic equivalent of task (MET) was used to calculate total level of physical activity and current exercise level. One MET is defined as 1 kcal/kg/hour, corresponding to the energy cost of sitting calmly, which for an average individual is equivalent to an oxygen uptake of 3.5 ml/kg/min. MET values of activities range from 0.9 (sleeping) to 23 (high speed running: 22.5 km/h) [25].

As recommended by Kuy et al. [26], total physical activity weekly were categorized into three main groups: low active (600-3999 MET minutes), moderately active (4000-7999 MET minutes) and highly active (≥8000 MET minutes), whereas recreational exercise weekly was categorized as low (<449 MET-minutes), moderate (450-885 MET-minutes) and high (≥900 MET-minutes). To reduce risk of maternal health problems, the current guidelines for physical activity recommend achieving a minimum of 600 MET-minutes per week from moderate to vigorous physical activity, consistent with 150 minutes of moderate intensity physical activity (≥ 4 MET). As such, all physical activity reported as moderate (3-5.9 METs) and vigorous (≥ 6), was matched with the MET-value [25] and added with the duration of the activity (in minutes). To calculate weekly level of moderate to vigorous physical activity, the three arenas (transportation, work and household) was combined, multiplied with five and added to time spent exercising.

Ethics approval and consent to participate

All the women signed informed consents, following the Helsinki declaration. The Regional Committee for Research Ethics in Medical and Health research, South-East Norway, approved the follow-up study and trial modifications (2014/2034/REK). The RCT is registered at ClinicalTrials.gov with ID NCT006171149.

Statistical analyses

All statistical analyses were conducted with SPSS Software V. 24 for Windows. Background variables and descriptive statistics are presented as means with standard deviation (SD) or number and percentage (%). MET-values are presented as median with interquartile range due to skewed data. The principal analysis was based on participants who completed the 6-year follow-up telephone interview (intervention group, n = 40; and control group, n = 40). In addition, we did a priory planned subgroup analysis, comparing participants with high adherence in the original study (≥24 prenatal exercise classes, n=14) with the control group (n = 40). Analyses of covariance were used to examine the difference in change in body weight and BMI between the groups. The current values for body weight and BMI was set as the dependent variable, and baseline values were set as covariates. For body weight, gestational weight gain was also set as a covariate in the linear regression model. We did not include number of children as a covariate, as this was equally distributed in the intervention and control group. Even though the MET-values were not normally distributed, differences were examined using a two-sided independent sample t-test due to a large sample size (n ≥30) [27].

Results

Study population and adherence

There were no differences in demographic characteristics between the intervention and control group at trial inclusion [17] or at 6-year follow-up. Missing participants in the intervention group (12/52, 23.1%) and control group (13/53, 24.5%) were not significantly different from those who participated. Including the index pregnancy, the women had overall given birth twice, with the following distribution of one, two and three children: 13.7%, 58.8% and 27.5%. Mean age was 38.2 ±3.9, and 90 % were still living with the father of their firstborn child. Two women in the control group were pregnant with their third child during the time of the interview.

Among the intervention group, four women never showed up and one woman was excluded because of twins. Registered attendance varied between 1 and 55, with a mean of 17.0 ± 12.5. Fourteen participants had high adherence and completed ≥24 prenatal exercise classes. Adherence to exercise classes was not associated with pre- pregnancy BMI [17].

Long-term effect of the intervention

Body weight, weight retention and BMI

As shown in Table 2, no differences were found between the intervention and control group in current body weight, weight retention or BMI measurements. In subgroup analysis of participants with high adherence in the original study (≥24 prenatal exercise classes), a positive intervention effect was seen in body weight (kg) (62.8 ±7.9 vs. 70.8 ±11.8, p=0.03) and BMI (kg/m2) (22.5±3.1 vs. 24.8 ±4.0, p=0.05).

More than half of the participants had higher body weight (intervention: 57.5% and control: 57.9%, p= 0.97) at 6-year follow-up compared to pre-pregnancy. The proportion of women retaining 5 kg or more was similar in the two groups (intervention: 9 vs. control: 11). When analyzing women adherent with the exercise intervention, none had gained ≥ 5kg compared to pre-pregnancy weight, and as shown in Table 2, there was a difference in weight retention groups compared with the controls (p=0.02).

Physical activity level and recreational exercise

The intervention group had a higher level of daily (665±498 vs. 540±550 MET-min/day, p=0.60) and total weekly physical activity level (4167±2638 vs. 3925±3075 MET-min/week, p=0.67) than the control group, but the difference did not reach statistical significance (Table 3). Nor did we observe any difference when dividing the women into MET-groups. In total, 57.5% and 47.5% met the current recommendations for regular exercise (MET≥600 min/week) in the intervention and control group, respectively, compared with a low level at time of inclusion to the original study, where all were defined as physical inactive (<60 minutes of moderate to vigorous physical activity per week).

When comparing the group of women attending ≥ 24 exercise sessions during the original intervention, we observed a higher level of daily physical activity (846±489 vs. 540±550 MET-min/day, p=0.07) and total weekly physical activity (4905±2402 vs. 3925±3075 MET-min/week, p=0.28) compared with the control group.

Discussion

Growing evidence supports that prenatal lifestyle interventions, including physical activity and exercise is favorable for gestational weight gain, with persisting benefits in the postpartum period [28]. But, as far as we have ascertained, how long these benefits extend beyond the period of the active intervention, has not been evaluated. Our results showed an overall increase in recreational exercise from trial inclusion to 6-years postpartum, with 57.5% and 47.5% meeting the current recommendations for regular exercise (MET≥600 min/week) in the intervention and control group, respectively. Still, no between group differences were found, and the prenatal exercise intervention had little effect on current body weight, weight retention or BMI measurements. High adherence to original prenatal exercise classes, seemed however, to give a positive intervention effect, and these participants (n=14) demonstrated significantly lower body weight and BMI at 6-year follow-up. In addition, a higher level of daily physical activity and total weekly physical activity was observed in this group, but our study had limited statistical power to detect differences for these outcomes.

The Pregnancy Exercise Intervention was designed to evaluate whether a supervised, twice weekly aerobic dance program plus intensive physical activity counselling, delivered to groups, rather than to individuals, could optimize gestational weight gain and decrease weight retention. This type of intervention offers both advantages and disadvantages, and a greater long-term effect might have been found if the intervention components had been stronger, including implementation of behavior change techniques such as goal setting and use of the Stages of change tool within the Transtheoretical Model [29,30]. However, regular individual counselling is time consuming and needs the inclusion of highly qualified health professionals. Hence, it is both difficult and expensive to manage, as opposed to a group training setting, which may give an additional effect with respect to group cohesion and social support [31].

Unfortunately, in our RCT, only 14 participants attended the minimum recommended number of exercise sessions in the original trial. The reason for this lack of adherence is unclear; there is no data available regarding the reason for low participation. A fitness class of 60 min prescribed twice a week, combining cardiovascular exercise at moderate intensity and strength training, may be considered demanding. In addition, finding time to exercise is vital if an exercise program is to be followed. Exercise classes were at fixed time points, possibly excluding some participants for practical reasons. More flexible timetables for exercise classes and increased accessibility by public transport may increase adherence in future exercise interventions.

Ideally, being exposed to participation in a prenatal lifestyle or physical activity intervention should persist after childbirth, but in the present study access to group exercises ceased after delivery. Also, other studies investigating physical activity as an intervention towards gestational weight gain, mostly end their follow-up period after six to 12 months [18,19]. As for this 6-year follow-up, the thought was that pregnancy is a "teachable moment" [32], a period of biological, physiological, behavioral and social change, where the women may be more receptive to health information [14,15]. Hence, an intervention with prenatal exercise classes, as well as recommendations on daily physical activity, might take advantage of this natural redefining period, and as such give effects beyond the intervention period [32].

Long-term studies of RCTs to increase physical activity levels in other populations (obese, older adults, risk groups for coronary heart disease and school-based activity programs for children) have shown inconsistent results [33-35]. A systematic review from 2008, including 25 studies, found evidence for long-term increases in physical activity behavior and physical fitness targeting healthy adults [36].

In the present follow-up, regardless of group allocation, about 50% met the minimum level of >4000 MET-minutes/week of physical activity, which is higher than the average percentage of men and women in Norway (Norwegian Institute of Public Health, 2014). A cross-sectional study (Kan1) assessed physical activity objectively by accelerometer and found that only 20% of the Norwegian adult population did the same [5]. This level of physical activity in the present study represents a substantial increase from inclusion, when all participants were defined as physical inactive (<60 minutes of moderate to vigorous physical activity per week). Other exercise interventions have also found increased physical activity level at one-year follow-up measurements, irrespective of randomization to intervention or control group in previously low active older women [37,38]. On the other hand, most studies report a decline in physical activity level in the postpartum period and into motherhood [11,39], and that few (11-12.5%) start regular exercise routines after becoming mothers [39,40].

The Pregnancy Exercise Intervention was completed as a public health approach, reflecting a real-life setting, with all exercise sessions performed at the University fitness club, without any interference from the investigators. This gives our study high ecological validity. Although our results showed no long-term effect on current body weight, weight retention or BMI measurements, subgroup analyses of women who were adherent with the original prenatal exercise intervention (≥24 prenatal exercise classes), demonstrated significantly lower body weight and BMI at 6-year follow-up. This type of analysis may provide an answer to the efficacy of the treatment, but on the other hand may also overestimate the effect size due to selection bias, meaning that those exercising as prescribed differ from those who did not. Hence, conclusions from this analysis cannot be generalized to other pregnant women or settings.

Strengths and limitations

A strength of this study is that nearly 80% of the original participants, equally distributed in intervention and control group, were successfully re-contacted and interviewed at 6-year follow-up. The standardized interview, with detailed assessment of physical activity and recreational exercise, was based on the baseline and post-intervention questionnaire, previously validated with the ActiReg system [41]. The use of a telephone interview instead of a paper or an electronic survey, may have avoided misinterpretations of the questions. Furthermore, all the interviews were done by two investigators only, ensuring that questions were asked in the same manner and order, both blinded to group allocation during data-collection. Limitations of the study are self-reported measurement of body weight and physical activity, the small number of women being adherent with the original exercise intervention and the selective nature of the included population. The participants in the trial were predominantly white of Scandinavian origin, married and with a high educational level, all of which may limit the external validity of our results.

Conclusion

From a public health perspective, it is important that 50% of previously inactive women, regardless of randomization group, were currently participating in moderate to high level of recreational exercise 6 years after their first pregnancy. This suggest sustained lifestyle changes in our group of motivated women, thereby preventing the downward trend of decreased activity level during pregnancy and in the postpartum period. Subgroup analyses of women who were adherent with the original prenatal exercise intervention, demonstrated a significantly lower body weight and BMI at 6-year follow-up.

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Disclosure of interest

The authors report no conflict of interest and are alone responsible for the content and writing of the paper.

Data availability statement

Dataset may be available, please contact corresponding author.

Patient consent

All the women signed an informed consent form, following the Helsinki declaration.

Author contribution

LAHH and KB conceived the idea for the trial and wrote the protocol. IK was responsible for participant follow-up and data collection. LAHH supervised the project and outlined the manuscript. All authors read and corrected draft versions of the manuscript and approved the final version.

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Figure legend

Figure 1 CONSORT Flow Diagram