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Gestational weight gain and body composition changes in relation to physical activity during pregnancy

Degree Project in Medicine

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Abstract

Gestational weight gain and body composition in relation to physical activity during pregnancy.

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Background: Excessive gestational weight gain (GWG) is associated with adverse outcomes for mother and child; caesarean delivery, hyperglycaemia, macrosomia, postpartum weight retention and overweight/obesity. Exercise during pregnancy is associated with a lower risk of excessive GWG and other potential benefits.

Aims: To investigate the relationship between GWG and fat mass change (ΔFM) with self-reported measures of physical activity.

Methods: Data was obtained as a part of the Pregnancy Obesity Nutrition and Child Health Study (PONCH). 124 women (BMI = 18.5-24.9) completed three visits during pregnancy (trimester (T) 1, 2 and 3). Visits included questionnaires about lifestyle, measuring body composition by air-displacement plethysmography, blood samples, and an interview about physical activity (type of training, how many times/week and for how long, level of activity, and mode of transportation). T-test and linear regression (adjusted for covariables) were used to analyse association between physical activity and GWG.

Results: Strength training was negatively associated with GWG ($P<0.001$ Beta=-0.33), ΔFM ($P=0.001$ Beta=-0.30) and fat percentage change (ΔF%) ($P=0.01$ Beta=-0.24) from T1 to T3 adjusted for mothers age, parity, educational level and weight in T1.

Women reporting ≥150 min/week of strength and/or cardiovascular training had a lower GWG (9.17kg vs 11.66kg), ΔFM (4.22kg vs 6.54kg) and ΔF% (2.32% vs 4.43%) than women that did not. Women that reported active transport to/from work experienced less GWG (10.2kg vs 11.8kg) than women that did not. Women reporting higher levels (3-4) of activity in leisure time had a lower GWG and ΔFM than women reporting level 0-2 ($P<0.05$).

Conclusions: In normal-weight women, strength training, high levels of physical activity and active transportation during pregnancy could reduce GWG and ΔFM.

Key words: gestational weight gain, body composition, physical activity.

Background

Obesity

One of the greater challenges of today is the rise of overweight and obesity (Overweight; BMI 25 to 30kg/m^2, obesity; BMI>30 kg/m^2) [1]. Despite many efforts to understand the mechanisms of this epidemic, the prevalence of obesity and related diseases continue to grow. A meta-analysis published in 2014 found at least six countries where obesity rates exceeded the fifty percent mark among women [2]. Data from Statistics Sweden/Statistiska Centralbyrån (SS/SCB) shows that the average weight of Swedish women is higher than ever [3]. Approximately 4 out of 10 women start their pregnancy overweight or obese in Sweden today [4] and during the last three years this number has kept on increasing [5]. Obesity is less common in the young population, but it is within the younger population that obesity rates have increased the most. Overweight or obesity among both sexes aged 16-29 have doubled between 1980 and now [3].

Physical activity

Several risk factors for poor health are both associated with, and thought to contribute to, obesity. One of these risk factors is physical inactivity. As the prevalence of high BMI has increased over the last decades, so has physical inactivity. Physical inactivity is thought to be

the cause of a large portion of the increase in high BMI, but it is also an independent risk factor for the development of disease itself, for example diabetes mellitus type 2 (DMT2), regardless of BMI, age, sex or ethnicity [6]. Women with parents who have DMT2 generally have a larger risk of developing DMT2 themselves, suggesting a genetic component [7]. Yet not all women with genetic risk factors develop DMT2. All women, especially those women with genetic predisposition for DMT2, will greatly reduce their risk if they are physically active [7]. Therefore, physical inactivity could potentially be an environmental trigger for developing DMT2, regardless of the hereditary component [7].

Physical activity is associated with a lowered risk of cardiovascular disease [8] regardless of presence of other known metabolic risk factors such as dyslipidaemia, DMT2, obesity, hypertension, inflammation and insulin resistance. These findings suggest that regardless of metabolic profile, everyone benefits from an active lifestyle. Physical inactivity also seems to increase the risk of certain diseases that are not primarily thought to be metabolically driven. One example is breast cancer, where the risk is estimated to increase by 20-50% [9].

Gestational weight gain

In Swedish health care there is no official recommendation regarding gestational weight gain (GWG). The American guidelines from The Institute of Medicine (IOM), updated 2009 [10], are however often used as a reference. The IOM guidelines recommend women how much weight to gain depending on their pre-pregnancy BMI. Underweight women (pre-pregnancy BMI under 18.5 kg/m^2) are recommended to gain within 12.5 – 18 kg. Normal weight women (pre-pregnancy BMI between 18.5 – 24.9 kg/m^2) are recommended to gain within 11.5-16 kg. Overweight women (pre-pregnancy BMI 25.0 – 29.9 kg/m^2) are recommended to gain within 7-11.5 kg. Obese women (pre-pregnancy BMI over or = 30.0 kg/m^2) are recommended to gain within 5-9 kg. Excess GWG is defined as weight gain above these guidelines and today almost 50% of women are estimated to gain more weight than recommended [11-13].

Weight gain during pregnancy consists of several components; the fetus, placenta, amniotic fluid, uterus, maternal blood volume, mammary glands and maternal adipose tissue [12]. Total body water typically increases between 5-8 liters during pregnancy [14] and the composition of lean tissue changes [14]. Women with normal pre-pregnancy BMI and with GWG within IOM guidelines gain on average 3.8 ± 3.4 kg in fat mass during pregnancy [15]. It is thought that excessive GWG consists of extra fat mass, and not lean mass, as excessive gainers have a similar lean mass gain when compared to adequate weight gainers [16].

Excessive GWG increases the risk for several adverse neonatal outcomes, such as large for gestational age (LGA) and macrosomia [12]. A cohort study with approximately 45,000 women showed that women that gained more than IOM guidelines were three times more likely to have an infant with macrosomia and nearly twice as likely to have an infant with hypoglycaemia or hyperbilirubinemia than women that gained the recommended amount [17]. GWG over IOM guidelines is also associated with low 5-min Apgar score, seizure, hypoglycaemia, polycythemia and meconium aspiration syndrome [18]. GWG below IOM guidelines is associated with babies born small for gestational age (SGA) [18] and also hypoglycemia and hyperbilirubinemia [17]. Gaining more weight during pregnancy than recommended is further associated with increased risk of caesarean delivery [12]. There is no strong evidence of excessive GWG and development of gestational diabetes (GDM) [19], but the data is conflicting [11], suggesting that the timing of the weight gain (in which trimester it is gained) and what the weight gain consists of is important [20].

Weight that was gained during pregnancy, but not lost after birth is considered postpartum weight retention (PPWR). Prevalence of PPWR is not fully charted but is thought to be significant, in one study 75% of the women were heavier one year postpartum than they were pre-pregnancy [21]. PPWR is thought to contribute considerably to the risk of obesity within one year postpartum and PPWR is also a predictor for overweight 15 years later [22].

Gestational weight gain is one of the most important factors for predicting post-partum weight retention [23-25]. Mean PPWR is higher in groups with excessive GWG, and risk of having PPWR of 5 kg or more are higher among excessive gainers [26, 27]. Preventing excessive GWG is therefore a crucial part of preventing obesity and its complications later in life [22, 28, 29].

Recommendations of physical activity during pregnancy

Historically, pregnant women have not been advised to be active. One of the first official recommendations guidelines for exercise during pregnancy came 1985, and had a strict heart rate limit at <140 beats/min, and a duration limit at 15 min [30]. Pregnancy was considered a fragile state, and women were advised to reduce their physical activity in general. Health professionals were afraid of adverse effects for the fetus. It was suggested that exercise would redirect blood flow from the uterus to skeletal musculature, thus potentially compromising oxygen and nutrition delivery to the fetus, leading to fetal hypoxia and growth restriction [31]. This theory, and many others like it, have never been proven. Multiple studies have shown that placental blood flow is not compromised by moderate physical activity [32], but rather that regular exercise improves the blood flow and function of the placenta [33].

In Sweden it is currently recommended by FYSS (Physical activity as prevention and treatment of disease) [34] that physical activity level should try to be maintained during the pregnancy, both for strength- and aerobic training. The women who were inactive before their pregnancy are encouraged to start training, but at a low level of intensity and then slowly progress. The goal is a minimum of 150 minutes, distributed over at least 3 days, of moderate intensity aerobic training every week. Women who were already active before pregnancy can maintain their level of training intensity during pregnancy. In addition to aerobic training, strength training for all the major muscle groups should be performed at least 2 times per week. The muscles of the pelvic floor should be trained every day. Lastly, if the woman is

sedentary for longer periods of time, short breaks with light movement should be taken regularly.

According to self-reported data from 2018, approximately 64% of the Swedish population aged 16-84 years, report that they meet the recommended guidelines of 150 minutes of physical activity every week [35]. 18% of women and 25% of men reported sedentary behaviour more than 10h/day [36]. Pregnant women tend to decrease their physical activity [32] and in reality it seems that very few women reach the recommended amount of 150 min/week of moderate intensity aerobic training during pregnancy [37]. One study of 247 women from U.S.A showed that only 23.4 % of pregnant women reported (by questionnaire) to meet those recommendations [38]. In Denmark (Danish Health and Medicines Authority) recommended amount of physical activity during pregnancy is higher (210 min/week). In one study, based on a questionnaire in the first trimester, 38% of women met the recommendations in early pregnancy [39]. Discrepancies between self-reported data and objectively measured data are large. A study of 215 women reveals that 117/215 women met the recommendations of 150 min/week when using self-reported data, and only 18/215 women met the recommendations when using data objectively measured by accelerometer [40].

Potential benefits of physical activity during pregnancy

Several different meta-analyses and randomized controlled trials [41, 42] with an exercise and/or diet intervention have shown that exercise and/or diet were associated with reduction in excessive GWG [43-47]. This effect is present in all BMI-groups [46]. However, there are also many studies with exercise programs that have failed to detect a reduction in GWG. According to a systematic review looking at training dosage and effect on weight gain, only 8 out of 21 exercise interventions studies achieved significant reductions in GWG [48]. The

review tried to answer if training dose could affect weight gain, but the data was too small to draw any conclusions.

Considering the effect of exercise on DMT2 in nonpregnant women[49], exercise during pregnancy should reduce the risk of GDM. Exercise, especially when performed consistently and throughout the entirety of the pregnancy, is associated with reduced risk of GDM as well as excessive GWG [43, 50]. This association is stronger in obese and overweight women [51]. Engaging in regular physical activity three to twelve months prior to pregnancy is also associated with a lower risk of GDM, showing a dose-response association (vigorous exercise was associated with larger decrease in risk) [52]. Exercise is thought to lessen the risk for GDM by several different mechanisms that all help to reduce insulin resistance [53].

Other potential benefits of physical activity during pregnancy are a reduction in risk of caesarean [44-46], urinary incontinence [54] and pregnancy induced hypertension [44]. A meta-analysis from 2017 including 5075 pregnant women showed that women that were randomized to 30-60 min of cardio vascular training 2-7 times/week had a lower incidence of gestational hypertensive disorders [55]. The same meta-analysis also showed that caesarean delivery decreased by 16% among the women that exercised.

A few studies exist on physical activity during pregnancy and mental wellbeing of the mother. A prospective cohort from 2018 included 578 women and recorded self-assessed quality of life (QOL) and training [56]. That study found that women that met IOM exercise guidelines (150 min/week) reported higher QOL during pregnancy and postpartum than women that did not meet the guidelines.

The majority of studies have focused on aerobic training. A meta-analysis of 61 randomised controlled trials, found that a combination of resistance and aerobic training during pregnancy was the most beneficial for maternal health [54], both compared to only aerobic, and only

resistance training. There is evidence that strength training during pregnancy is perfectly safe for mother and child [57-59], however the studies are too few to asses if strength training possesses any additional benefits opposed to just aerobic exercise.

Walking is a popular activity during pregnancy and is one type of training that has been seen to increase as the pregnancy progresses [60]. A few studies have found that low intensity training (for example walking) is effective in preventing excessive GWG, improving glucose regulation and reducing insulin requirement in obese women with GDM [61].

A number of studies show no difference in birth weight between active and non-active mothers [62] [63]. Studies that do find differences in birth weight suggests that maternal physical activity have a protective effect on birth weigth, by reducing the risk of LGA and SGA [64]. Reduced birth weight associated with physical activity has been seen, but birth weights are almost always within normal range with no increased risk of SGA [65, 66]. It may be that maternal physical activity reduces infant fat-mass, but at the same time increases or maintains infant's fat-free mass, thus regulating birth weight [67, 68].

Physical activity during pregnancy helps to modulate metabolic factors, such as glucose tolerance, fasting insulin and adiposity, in offspring in mice[69]. Effects in human children are less studied but a retrospective study from 2015 showed a significant negative association between physical activity during pregnancy and child obesity at age 8 years [70].

Potential risks of physical activity during pregnancy

Metabolic changes during pregnancy lead to increased metabolic rate, which in turn elevates internal body temperature (IBT). During the first trimester an occurrence of IBT of more than 39.0 °C in the mother is thought to cause birth defects, as it is known to do in animal studies with rats, guinea pigs and mice [71]. This worry has shaped decades of guideline recommendations regarding pregnant women and exercise. Evidence to support this caution remains absent, as no correlation between exercise and birth defects has been found. The

reason for this absence is thought to be twofold: IBT is more strictly regulated during pregnancy, and, there is an increased ventilation and blood flow to the skin, which increases evaporation of excess heat [34]. This is supported by the fact that it seems to be highly uncommon for women to attain an IBT of 39.0 °C or more. A review from 2018, including 12 studies and 347 women, studied the IBT of pregnant women who were either exercising, bathing in hot water, or sauna bathing. The highest core temperature recorded in this review was 38.3°C, in other words 0.7 °C below the suggested teratogenic threshold [72]. Thus, increases in temperature are not to be seen as a reason not to be active, but a reason to stay hydrated and cool while exercising.

Another potential concern with excersise during pregnancy is risk of pretermlabour. A systematic review from The Cochrane institute 2015 concluded that the sientific evidence to support or dismiss bedrest as a way to prevent preterm labour was too small and that each case should be judged individually concerning pros and cons of bedrest [73]. Since 2015 new studies have been published. A secondary analysis of 300 women with confirmed (by transvaginal ultrasound) shortened cervix showed that women whom had reported excersise ≥ 2 times/week for ≥20 min/time had no increased risk of preterm delivery (delivery before 37 weeks of gestation) when compared to women whom reported exercisting < 2 times/week for <20 min/time [74]. Women in the exercise group had a 32% risk reduction of preterm delivery compared to the women in the control group, though this difference was not statistically significant. A metaanalysis of randomized controlled trials and cohort studies from 2017 further supports this by showing that leisure time physical activity during pregnancy was assosiated with a lower risk of preterm delivery [43]. A new case-control study from 2019 also showed that maternal exercise during pregnancy lowered the risk of preterm delivery, especially when the training dosage was moderate to high [75]. Still, more

studies are needed on the safety of exercise during pregnancy in certain groups with high risk of preterm labour and delivery [76].

A real concern in trimester two and three are activities that bear risk of contracting direct physical injury to the belly. Activities such as sky diving, horseback riding, and contact sports (rugby, martial arts etc), should be avoided during later stages of pregnancy.

Active transportation

Pregnancy has been shown to be associated with a decrease in active transportation to and from work/school [77]. One study found that women that continued with their active mode of transportation in pregnancy gained less in GWG than women that converted to a less active form of transportation early in pregnancy [78].

Specific objectives

The main goal of this study was to investigate the relationship between different self-reported measures of physical activity and GWG and body composition changes. The physical activity measures were 1) amount and type of training (low intensity, cardiovascular or strength training), 2) achievement of the recommended dose of training, 3) estimation of activity level at work or at leisure time, and 4) use of active transport.

Methods

Ethics

The study was approved by the Regional Ethical Review Board in Gothenburg (Dnr 402-08). All women received oral and written information about the study and gave informed written consent before enrolment.

Study design

Data for this study was collected between April 2009 and February 2016 as part of the Pregnancy Obesity Nutrition and Child Health study (PONCH) [79]. PONCH is a prospective longitudinal study of pregnant Swedish women, with a randomized dietary intervention.

Inclusion criteria for the current study were self-reported BMI between 18.5-24.9 kg/m^2, age between 20-45 years, non-diabetic, of European decent, no use of neuroleptic drugs, no breast-implants (because of breast implants causing difficulty with measuring correct body composition with air-displacement plethysmography [80]). No women that reported eating a vegetarian or vegan diet were included. The study included three visits during pregnancy, in trimester 1 (T1, gestational weeks 8-12), trimester 2 (T2, gestational weeks 24-26) and trimester 3 (T3, gestational weeks 35-37). Visits took place after an overnight fast and included completion of questionnaires about dietary intake and lifestyle habits, measuring body composition, blood samples, and a short oral interview about training, mode of transportation and overall activity level. The women were randomized into dietary intervention or control groups, matched for age, BMI and parity. Women in the intervention group were given dietary guidance by a registered dietitian [79], other aspects of their visits were the same as the control group. There were no differences in study outcomes between control and intervention groups for the present study, and the data for both groups have therefore been pooled. All visits took place at Sahlgrenska University Hospital, Gothenburg, Sweden.

Recruitment and exclusion

Midwifes at six local maternity care centres (Mödravårdcentral, MVC) in Gothenburg region received information about the study and were asked to give information to pregnant woman at their clinic, in their first trimester. The women that were interested were given oral and written information, and all women signed a consent form before entering the trial. All women included were living in Västra Götaland region of Sweden. Originally 212 women were recruited. 172 women completed a T1 study visit. Only women with a complete data set of physical activity reporting in all trimesters and body composition measuring in trimester 1 and 3 were included for analysis. 7 women were excluded because of incomplete activity questionnaires. 12 women were excluded because they did not complete body composition

measurements in T1 or T3. 69 women dropped out of the study. Drop-outs were mainly due to tiredness, stress, living too far away from Sahlgrenska University Hospital, but also miscarriage. 1 woman was excluded after developing gestational diabetes. After exclusions, 124 women remained eligible for analysis.

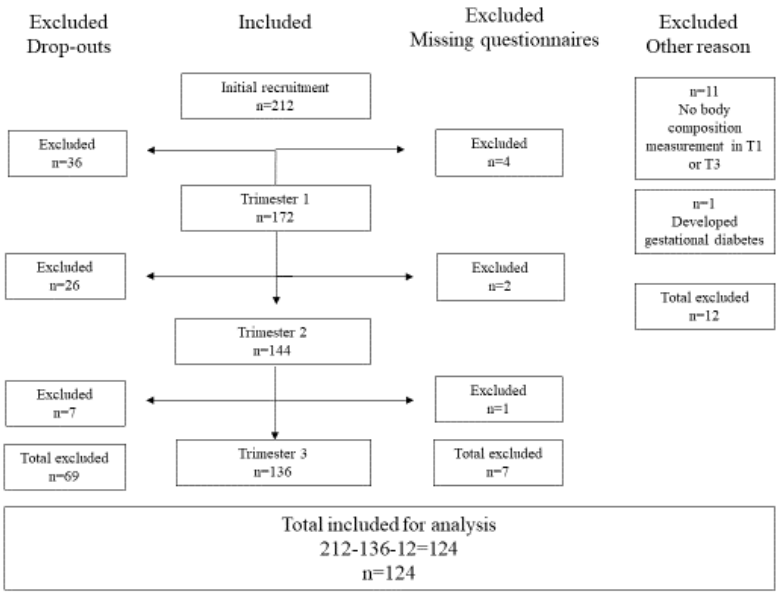

Figure 1. Exclusion flow chart

214 women were recruited by inclusion- and exclusion criteria. 69 women dropped out of the study. Drop-outs were mainly due to tiredness, stress, living too far away from Sahlgrenska University Hospital, but also miscarriage. 124 women completed the study, with all three trimester visits, filling out all questionnaires, and taking body composition measurements in trimester 1 and trimester 3.

Body composition measurements

Body composition was measured and calculated by air-displacement plethysmography using the Bod Pod Gold Standard system (Bod Pod 2007 A, Life Measurement, Concord, CA, software versions 4.2.0 and 5.2.0.) using gestational-age specific equations, as is thought to be the most exact method for estimating body composition and body fat percentage in pregnant women [81]. Participants were weighed in only underwear and a bathing cap to cover the hair. Height was measured to the nearest 0.5 cm, weight with four digits on the BodPod scale, and BMI calculated (BMI=weight/height^2). Two measurements in the Bod Pod were made, and if

the two measurements showed inconsistency the Bod Pod asked for a third measurement. The Siri equation [82], corrected for increased hydration of fat free mass during trimester 1, 2, and 3, respectively was used to calculate body fat percent and body composition. Gestational weight gain (GWG), gestational fat-mass gain (ΔFM), gestational fat-free mass gain (ΔFFM) and body fat percentage change (ΔF%) were calculated using body composition measurements from study visits in T1 and T3 (T3-T1).

Physical activity

The women were interviewed about their physical activity over the last year (at the T1 visit), or since the last visit (at T2 and T3 visits). First, they were asked if they performed any training, and if so, they were asked what, how many times per week and for how long. Then the women were asked about their mode of transportation to work and in leisure time. Active transportation was defined as walking or bicycling, non-active transportation was defined as talking the car or public transportation-options. The women were asked to rank their level of physical activity during work on a scale from 0-4 (0= no work, 1=inactive and 4=very active). Then they were asked to grade their physical activity level during leisure time on a scale from 1-4 (1=inactive and 4=very active). These questions were based on questionnaires used in the Swedish Obesity Study (SOS) [83], see appendix 1. Because participants had to be fasting when taking the blood tests, they were offered breakfast (2 cheese sandwiches and one can of carbonated water) when being asked about their physical activity.

Data

When asked about planed physical activity the women's answers were diverse. Planed physical activity included everything from light walking, to team activities such as European soccer, bicycling, swimming, gym-classes, running, weight training, tennis, etc. Type of planed physical activity was organized into larger, but still homologous, categories. After evaluating a large portion of the answers, a pattern emerged, and it was deemed reasonable to put every type of planed physical activity into one of three categories.

Low intensity training; consisting of walking indoors or outdoors, and special mom water training classes - activities that can be performed while still holding a conversation. Cardiovascular training; consisting of tennis, jogging, treadmill, swimming, football practice, and most fitness classes (i.e. Zumba, aerobics) - activities that typically make you sweat and breath fast. Strength training; consisting of strength training at the gym or the fitness class body pump. Often women would report planed physical activity belonging to more than one of the groups. Moderate to hard exercise were defined as min/week of cardiovascular or strength training.

Statistical methods

For organisation and analysis, Excel and the statistical program SPSS (IBM SPSS Statistics 25 Data Editor) were used. To obtain information about frequency and means, calculations in SPSS using Frequencies was used. The outcome-variables gestational weight gain, fat mass, fat-free mass, and bodyfat percentage change from trimester 1 visit to trimester 3 visit were all normally distributed data when looking at their frequency histograms.

Women meeting recommended amount of 150 min/week of moderate to hard exercise were compared to women not meeting recommendations. For all training categories, groups were formed of women that performed that type of training and women that did not. For all training categories, the highest quartile was also calculated to create groups that represented the top 25% (the highest quartile) that were compared to the rest, 75%. For these group comparisons (i.e. those that reported training vs those that reported no training, the highest quartile vs the rest and those that reached 150 min/week vs the rest), independent T-test was used. Comparisons were made at each trimester visit, and also from combined data of all trimesters.

To look at correlations between amount of reported time training (min/week) and weight and body composition changes, a linear regression model that adjusted for co-variables (parity, mothers educational level, mothers age in T1 and weight/fat mass/fat-free mass/body fat

percentage in T1) was used. Cochran's test was used to evaluate if percentage of women that reported training changed during pregnancy. Results in text are reported as mean ± SD. P-values < 0.05 were deemed significant.

Nine women had no educational level recorded and we used mean imputation for the missing data points. Two women had missing answers for level of activity at work in trimester 2, but both women had complete answers from trimester 1 and 3. Level of activity for the women with the missing data points were filled in with the level of activity at work which that specific woman had reported in the other two trimesters, in both cases this was level 1.

Results

Subject characteristics

Table 1 displays subject characteristics. According to BMI at T1 visit, 0.8% (1/124) of the women had BMI <18.5 kg/m^2 (BMI 18.40 kg/m^2) and therefore was classified as underweight [84]. Average parity (number of births prior to the current pregnancy) was low with the majority having had no previous children. Educational level was high. A large majority reported the highest possible educational level and no women reported an educational level lower than 3 or more years of Swedish gymnasium (equal to secondary school) (table 1).

Weight, fat mass, fat-free mass and body fat percentage all increased from T1 to T3 (P<0.001). Ten out of 124 (7.3%) women gained >16kg (IOM guidelines for GWG) from T1 visit to T3. Most women gained in FM from T1 to T3, but 2/124 women lost FM. 8/124 (6.5%) registered a decrease in F% from T1 to T3 (ΔF%). Women reporting the highest quartile of strength training at all trimester visits had lower parity than the rest (0.32±0.60 for the highest quartile compared to 0.61±0.68 for the rest, P=0.03). The same difference was seen between women reporting the highest quartile of total amount of average training at all trimester visits (0.16±0.37 for the highest quartile compared to 0.67±0.70 for the rest, P<0.01).

Table 1. Subject characteristics, weight and body composition

Subject characteristics	Mean ± SD
Age T1 (years)	31 ± 3
Parity (0/1/2) %	55.6/34.7/9.7
Educational level (2/3/4) %	8.1/1.4/81.5
T1 BMI kg/m2	22.1 ± 1.5
T1 Weight	62.4 ± 6.3
GWG	11.5 ± 3.0
T1 FM	16.78 ± 4.1
ΔFM	6.4 ± 2.8
T1 FFM	45.6 ± 4.7
ΔFFM	5.1 ± 2.1
T1 F%	26.7 ± 5.4
ΔF%	4.4 ± 3.1

Educational level 0 = Elementary school, 1= 2 years or less of Swedish gymnasium. 2= 3 years or more of Swedish gymnasium. 3= less than 3 years of university studies. 4= 3 or more years of university studies.

Abbreviations: T1= measurement at trimester 1 visit. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

Training

Training was common amongst the women (figure 2), with 75% reporting training in T1, 77% in T2 and 65% in T3. Almost half (47%) of the group reported some sort of training in all trimesters. The percentage of women reporting low intensity training increased in every trimester, from 35% in T1, 48 in T2 and to 50% in T3 (Cochran's test P=0.007). An inverse relationship was reported with cardiovascular training, which decreased every trimester, from 47% in T1, to 35% in T2, and 28% in T3 (Cochran's test P=0.001). 15% reported doing cardiovascular training during all three trimesters. The number of women reporting strength training peaked in trimester 2 at 39%, with 31% in trimester 1, and 24% in trimester 3. 18% of the women reported strength training in all trimesters.

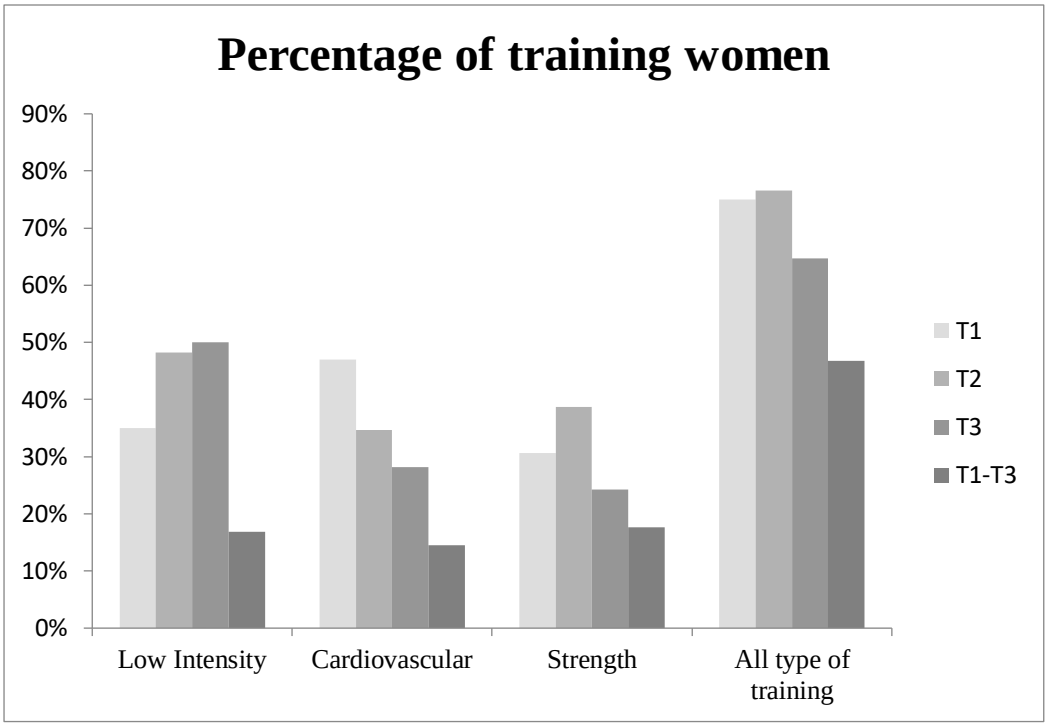

Figure 2. Percentage of the women that reported training at each trimester visit. Abbreviations: TX= trimester X visit. T1-T3; women that reported training at all trimester visits.

Table 2 displays average training (min/week) for women that reported that specific type of training (low intensity, cardiovascular or strength) in each trimester. Women that did not report any training was not included in the calculation of the mean and median. The range in training time was large between the women in all training forms, for example, in T2 maximum and minimum amount of low intensity training was reported to be 20 and 1050 min/week respectively. Corresponding values for cardiovascular training was 10-400 min/week, and for strength training 10-240 min/week in T2.

Total reported low intensity training during all trimester visits correlated strongly with total amount of all reported training during all visits (Spearman's correlation; $P<0.01$ $R=0.68$). Total reported amount of strength training during all trimester visits correlated positively with total reported amount of cardiovascular training during all trimester visits (Spearman's correlation $P<0.01$ $R=0.34$). Both reported strength and cardiovascular training was positively

correlated with total amount of reported training. Reported amount of low intensity training was not correlated to reported strength or cardiovascular training.

Table 2. Average min/week training, only women reporting training included

Training (min/week)												
	T1 visit				**T2 visit**				**T3 visit**			
	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max
Low Intensity	162	135	20	600	194	128	20	1050	164	138	20	630
Cardiovascular	150	113	10	851	99	60	10	400	119	154	20	840
Strength	112	105	15	300	91	65	10	240	114	90	15	240
All types of training	213	150	20	851	216	168	20	1050	224	186	30	975

Abbreviations: TX visit= reported at trimester X visit.

Training and change in weight and body composition

When comparing the women that reported any type of training at a specific trimester-visit, to the women that did not report any training in that specific trimester-visit, there was no difference in GWG, ΔFM, ΔFFM or ΔF%. Equally, there was no difference between women that reported some type of training at all trimester-visits, compared to the women that did not report training at every trimester-visits.

Specific type of training

There was no detected difference in GWG or body composition changes (ΔFM, ΔFFM and ΔF%) from T1 to T3 between women that reported low intensity training and women reporting no low intensity training at either of the trimester-visits. No difference was found between women reporting cardiovascular training and women reporting no cardiovascular training at either of the trimester-visits.

Women reporting strength training at their T3 visit (table 3) had a lower GWG (10.45kg ± 3.16kg**)** and ΔFM (5.44kg ± 3.25kg) from T1 to T3 than women reporting no strength training at their T3 visit (GWG: 11.80kg ± 2.83kg, ΔFM: 6.67kg ± 2.56kg). There was no difference in weight or body composition change from T1 to T3 between women reporting strength training at their T1 or T2 visits and women reporting no strength training at these visits.

Table 3. Strength training at T3 visit, Independent t-test

Strength training		Yes			No			T-test	
		Mean	SD	N	Mean	SD	N	P	T
T3 visit	GWG	**10.45**	**3.16**	30	**11.80**	**2.83**	94	**0.03**	**-2.21**
	ΔFM	**5.44**	**3.25**		**6.67**	**2.56**		**0.03**	**-2.14**
	ΔFFM	5.01	2.44		5.13	1.94		0.79	-0.27
	ΔF%	3.66	3.89		4.67	2.84		0.13	-1.54

Abbreviations: T3= measurement at trimester 3 visit. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

The highest quartile of training women

Women that reported ≥120 min/week of low intensity training (highest quarter) at their T2 visit had a higher GWG than women that reported < 120 min/week of low intensity training at their T2 visit (table 3). Women that reported ≥124 min/week in average at all trimester visits also had a higher GWG and ΔFM than women that reported <124 min/week in average at all trimesters of low intensity training (table 4).

There was no difference in weight gain or body composition changes between women that reported the highest quarter of cardiovascular training time/week, and the rest, at either of their trimester visits.

Women that reported ≥15 min/week of strength training (highest quarter) at their T3 visit had a lower GWG and ΔFM than women that reported <15 min/week of strength training at their T3 visit (table 4). No other difference in weight gain or body composition changes between the highest strength training quarter and the rest was seen at either trimester visits.

There was no difference in weight gain or body composition changes between women that reported the highest quarter of total training time/week (low intensity, cardiovascular and strength training combined) and the rest, at either of their trimester visits.

Table 4. The highest quartile of training women.

		Quartile								
		75%				25%				
		N	Min/week	Mean	SD	N	Min/week	Mean	SD	P
Low Intensity Training										
T1 visit	GWG	87	<60	11.31	2.58	37	>=60	11.86	3.71	0.35
	ΔFM			6.28	2.57			6.60	3.26	0.56
	ΔFFM			5.03	2.24			5.26	1.58	0.58
	Δ F%			4.40	3.13			4.48	3.20	0.90
T2 visit	**GWG**	91	<120	**11.16**	**2.68**	33	>=120	**12.35**	**3.50**	**0.05**
	ΔFM			6.12	2.86			7.07	2.45	0.09
	ΔFFM			5.04	2.10			5.28	1.96	0.57
	ΔF%			4.23	3.42			4.95	2.13	0.16
T3 visit	GWG	93	<139	11.25	2.79	31	>=139	12.14	3.36	0.15
	ΔFM			6.12	2.75			7.13	2.79	0.08
	ΔFFM			5.13	2.17			5.01	1.71	0.78
	ΔF%			4.21	3.24			5.07	2.76	0.18
T1, T2 and T3 visit	**GWG**	93	<124	**11.09**	**2.58**	31	>=124	**12.76**	**3.69**	**0.04**
	ΔFM			**6.08**	**2.72**			**7.25**	**2.83**	**0.04**
	ΔFFM			5.01	2.11			5.38	1.93	0.39
	ΔF%			4.20	3.27			5.08	2.64	0.18
Strength Training										
T1 visit	GWG	91	<60	11.42	2.58	33	>=60	11.63	3.84	0.78
	ΔFM			6.50	2.54			6.03	3.37	0.41
	ΔFFM			4.92	2.00			5.60	2.18	0.11
	Δ F%			4.65	3.03			3.79	3.38	0.18
T2 visit	GWG	91	<60	11.68	2.74	33	>=60	10.92	3.47	0.21
	ΔFM			6.57	2.54			5.82	3.33	0.18
	ΔFFM			5.10	1.91			5.09	2.46	0.98
	ΔF%			4.67	2.87			3.75	3.74	0.15
T3 visit	**GWG**	94	<15*	**11.80**	**2.83**	30	>=15*	**10.45**	**3.16**	**0.03**
	ΔFM			**6.67**	**2.56**			**5.44**	**3.25**	**0.03**
	ΔFFM			5.13	1.94			5.01	2.44	0.79
	ΔF%			4.67	2.84			3.66	3.89	0.13
T1, T2 and T3 visit	GWG	93	<41,25	11.65	2.76	31	>=41.25	10.96	3.47	0.26
	ΔFM			6.51	2.54			5.97	3.46	0.35
	ΔFFM			5.13	1.97			4.99	2.38	0.74
	ΔF%			4.58	2.88			3.94	3.82	0.33

Abbreviations: 25%= highest quartile of training women. 75%= the rest. TX visit= measurement at trimester X visit. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at

*trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%). *For strength training reported at T3 visit there was not enough women reporting strength training to compare the highest 25% to the rest (the highest quarter was still 0 min/week). 15 min/week represents the highest 23.4% instead.*

Regression analysis

Regression analysis between amount of training (min/week) and GWG and body composition changes from T1 to T3 (adjusted for mothers age, parity and weight/fat mass/fat-free mass/body fat percentage in T1) is shown in table 5. Low intensity training at the T1 visit was positively associated with GWG from T1 to T3. The association with GWG and ΔFM was also present when looking at average reported low intensity training during all visits (table 5). No other association between low intensity training and GWG and body composition changes were significant (table 5).

Reported cardiovascular training at the T2 visit was negatively associated with ΔFFM from T1 to T3. The association between cardiovascular training and ΔFFM was also present when looking at average reported cardiovascular training during all visits (table 5).

Reported strength training at the T3 visit was negatively associated with GWG, ΔFM and ΔF% from T1 to T3 (table 5). Reported strength training at the T2 visit was also negatively associated with GWG. The same negative association between strength training and GWG and ΔFM were present when looking at average reported strength training during all visits (table 5).

Table 5. Regression analysis

Type of training (min/week)		T1 visit		T2 visit		T3 visit		T1, T2 and T3 visit	
		P	Beta	P	Beta	P	Beta	P	Beta
Low intensity training	**GWG**	**0.01**	**0.23**	0.34	0.09	0.11	0.15	**0.03**	**0.20**
	ΔFM	**0.01**	**0.23**	0.27	0.10	0.14	0.14	**0.03**	**0.20**
	ΔFFM	0.53	0.06	0.90	0.01	0.48	0.07	0.55	0.06
	ΔF%	0.09	0.14	0.52	0.05	0.41	0.07	0.18	0.11
Cardiovascular training	GWG	0.14	-0.14	0.18	-0.12	0.48	-0.06	0.11	-0.15
	ΔFM	0.90	-0.01	0.93	0.01	0.53	0.06	0.82	0.02
	ΔFFM	0.14	-0.14	**0.05**	**-0.18**	0.07	-0.16	**0.02**	**-0.21**
	ΔF%	0.76	-0.03	0.66	0.04	0.38	0.07	0.73	0.03
Strength training	**GWG**	0.75	-0.03	**0.01**	**-0.24**	**<0.001**	**-0.33**	**0.02**	**-0.22**
	ΔFM	0.39	-0.08	0.19	-0.13	**0.001**	**-0.30**	**0.04**	**-0.20**
	ΔFFM	0.39	0.08	0.18	-0.13	0.75	-0.03	0.79	-0.03
	ΔF%	0.18	-0.12	0.42	-0.07	**0.01**	**-0.24**	0.06	-0.17

Adjusted for parity, educational level, mothers age in trimester 1, and weight/fat mass/fat-free mass/fat percentage in trimester 1. Abbreviations: Beta= Standardized coefficient beta. TX visit= measurement at trimester X visit. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

150 min/week recommendation

Women that met the recommended amount of moderate to hard physical activity (for this analysis cardio vascular and strength training was included, but not low intensity training) were 26% in trimester 1, 19% in trimester 2, 12% in trimester 3, and 9% met the recommendation in all three trimesters (figure 3).

Women that reported meeting the recommended amount of physical activity at all trimester-visits increased less in GWG, ΔFM and ΔF% from T1 to T3 than women not meeting the criteria (table 6). No other significant difference in GWG, ΔFM, ΔFFM or ΔF% from T1 to T3 was observed for women meeting the recommendations at any of their trimester-visits.

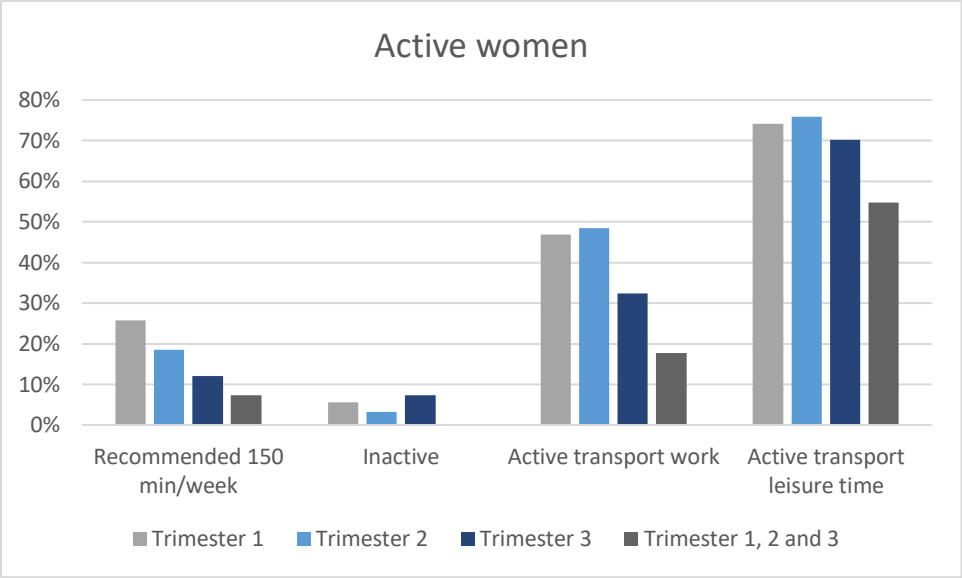

Figure 3. Frequency of activity measurements. Percentage of all women meting recommended 150 min/week, being inactive (inactive=women that did not report any regularly scheduled physical activity or any active transportation to work or in leisure time), reporting active transportation to/form work and in leisure time.

Table 6. Recommendations about physical activity

Recommended 150 min/week		Yes			No			T-test	
	T3-T1	Mean	SD	N	Mean	SD	N	P-value	T-value
T1, T2 and T3 visits	GWG	**9,17**	**3,89**	9	**11,66**	**2,81**	115	**0,01**	**-2,48**
	ΔFM	**4,22**	**4,16**		**6,54**	**2,59**		**0,02**	**-2,46**
	ΔFFM	4,94	1,53		5,11	2,10		0,82	-0,23
	ΔF%	**2,32**	**4,59**		**4,59**	**2,96**		**0,04**	**-2,12**

Yes= women meeting recommendations at all trimester visits. No= women not meeting recommendations at all trimester visits. Abbreviations: GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

Inactivity

Inactive women were defined as women that did not report any regularly scheduled physical activity or any active transportation to work or in leisure time. Inactivity was most commonly reported at the T3 visit (7%) and was lowest at the T2 visit (3%). No woman reported

complete inactivity during the entire pregnancy. No statistically significant difference in GWG, ΔFM, ΔFFM, or ΔF% was observed between the inactive women and the active.

Active transport

Almost half of the women reported active transport to/from work at their T1 and T2 visits (47% and 48% respectively). Active transport to/from work declined at the T3 visit to 32%. 18% (n=22) of the women reported using active transport to/from work at all trimester visits.

Women that reported using active transport to/from work at T1 and T2 visits increased less in GWG from T1 to T3 than women that did not report active transport to/from work at their T1 and T2 visits (table 7). Women that reported active transport to/from work at all their trimester-visits had lower GWG from T1 to T3 than women that did not report active transport to/from work at all their trimester-visits (table 7).

Majority of women reported active transport during leisure time at their visits (figure 3). Over half of the women (55%) reported using active transport in leisure time at all visit. There was no difference in GWG or body composition changes for women reporting using active transport at leisure time at either of their trimester visits.

Table 7. Active transport to /from work

Active transport to/from work									
			Yes			No		T-test	
		N	Mean	SD	N	Mean	SD	P	T
T1 visit	GWG	58	**10.9**	**2.9**	66	**12.0**	**2.9**	**0.05**	**-2.0**
	ΔFM		6.1	3.1		6.6	2.5	0.30	-1.0
	ΔFFM		4.8	2.1		5.3	2.1	0.16	-1.4
	Δ F%		4.4	3.7		4.5	2.6	0.91	-0.1
T2 visit	GWG	60	**10.9**	**2.6**	64	**12.0**	**3.2**	**0.04**	**-2.1**
	ΔFM		6.1	2.9		6.6	2.6	0.27	-1.1
	ΔFFM		4.8	2.0		5.4	2.1	0.14	-1.5
	ΔF%		4.4	3.6		4.4	2.7	0.95	0.1
T3 visit	GWG	40	11.0	2.8	84	11.7	3.0	0.20	-1.3
	ΔFM		5.8	3.3		6.6	2.5	0.14	-1.5
	ΔFFM		5.1	1.9		5.1	2.1	0.90	0.1
	ΔF%		4.0	4.0		4.6	2.6	0.39	-0.9
T1, T2 and T3 visit	GWG	22	**10.2**	**3.0**	102	**11.8**	**2.9**	**0.02**	**-2.3**
	ΔFM		5.1	3.9		6.7	2.4	0.08	-1.8
	ΔFFM		5.1	2.1		5.1	2.1	0.94	-0.1
	ΔF%		3.4	4.8		4.6	2.6	0.25	-1.2

Abbreviations: TX visit= measurement at trimester X visit. T1, T2 and T3 visit= active transportation at all trimester visits. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

Self-reported level of activity at work

Most women reported level 1 activity level at work, at all trimester visits (T1: 54%, T2:57% and T3:59%) (figure 4). Only 1% reported an activity level of 4 at T1 and T3 visits, and no women reported activity level 4 at the T2 visits. Level 0 represented women that did not work, and increased from 2% at visits in T1 and T2, to 9% at T3 visits. Level of activity at work was highly correlated (Spearman's correlation $P<0.01$ R=0.86-0.40) between the trimester visits. Level of activity in leisure time was highly correlated (Spearman's correlation $P<0.01$ R=0.85-0.45) at all trimester visits. Level of activity at work and in leisure time was however not correlated with each other.

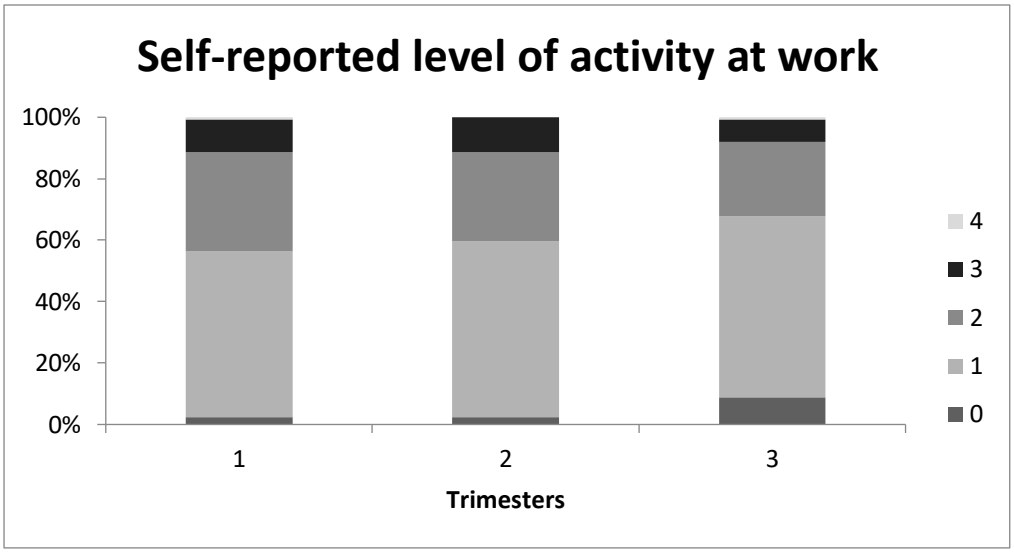

Fig 4. Self-reported level of activity at work

Activity level 0=not working. Level 1=the least active. Level 4=the most active.

Women that reported an activity level at work between 0-2 at their T1 visit had a lower GWG and ΔFM from T1 to T3, than women reporting an activity level at work between 3-4 (table 8). Women reporting an activity level at work between 0-2 at all trimester-visits (T1, T2 and T3) gained less in a ΔFM (from T1 to T3) compared to the women reporting an activity level at work between 3-4 at all trimester visits (table 8). No other difference in GWG or body composition changes from T1 to T3 were found between women reporting an activity level at work between 0-2 and women reporting an activity level at work between 3-4 (table 8).

Table 8. Self-reported level of activity at work, independent t-test.

Self-reported level of activity at work									
			0-2			3-4		T-test	
		N	Mean	SD	N	Mean	SD	P	T
T1 visit	GWG	110	**11.27**	**2.75**	14	**13.09**	**4.00**	**0.03**	**2.20**
	ΔFM		**6.20**	**2.70**		**7.76**	**3.14**	**0.05**	**2.00**
	ΔFFM		5.07	2.05		5.33	2.20	0.66	0.45
	ΔF%		4.34	3.19		5.11	2.71	0.39	0.87
T2 visit	GWG	110	11.39	2.57	14	12.12	5.15	0.61	0.52
	ΔFM		6.29	2.49		7.04	4.55	0.56	0.60
	ΔFFM		5.10	2.08		5.08	1.94	0.97	-0.04
	ΔF%		4.37	2.95		4.81	4.49	0.63	0.49
T3 visit	GWG	114	11.46	2.61	10	11.63	5.82	0.93	0.09
	ΔFM		6.34	2.43		6.73	5.62	0.84	0.21
	ΔFFM		5.12	2.10		4.90	1.63	0.75	-0.32
	ΔF%		4.43	2.91		4.30	5.31	0.90	-0.13
T1, T2 and T3 visit	GWG	120	11.43	2.94	4	12.87	3.46	0.34	0.96
	ΔFM		**6.29**	**2.75**		**9.02**	**2.72**	**0.05**	**1.96**
	ΔFFM		5.14	2.07		3.85	1.47	0.22	-1.24
	ΔF%		4.33	3.12		7.20	2.56	0.07	1.82

Activity level 0=not working. Level 1=the least active. Level 4=the most active. Abbreviations: TX visit= measurement at trimester X visit. T1, T2 and T3 visit=average level of activity at work at all trimester visits. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

Self-reported level of activity in leisure time

Most women reported an activity level of 2 during leisure time at all trimester visits (T1: 46%, T2: 70%, T3:66%) (figure 5). 39% of women reported level 3 during leisure time at T1 visits, but only 10% reported level 3 at T3 visits. Level of activity in leisure time was highly correlated (Spearman's correlation $P<0.01$ $R=0.85$-0.45) at all trimester visits. Level of activity at work and in leisure time was however not correlated with each other.

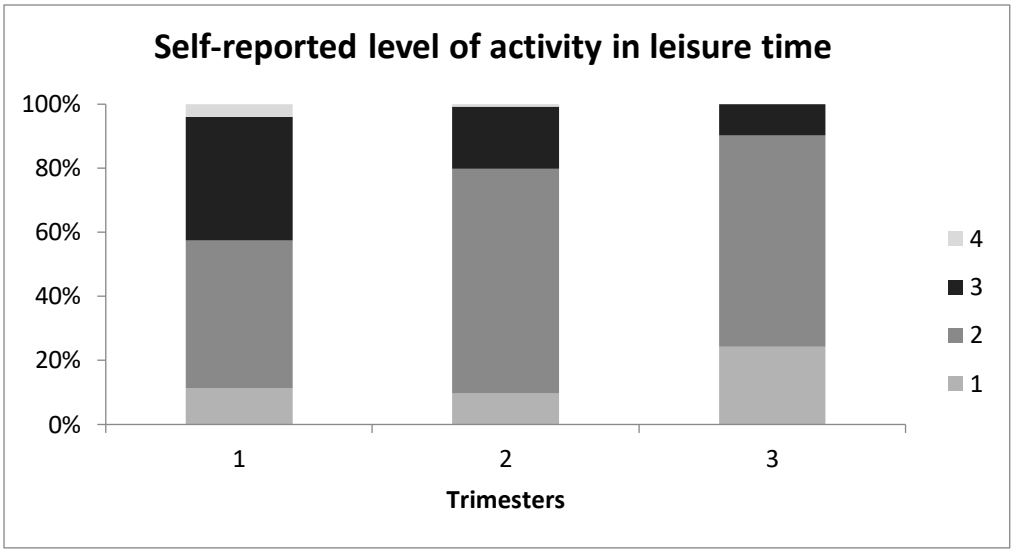

Figure 5. Self-reported level of activity in leisure time. Activity level 1=the least active. Level 4=the most active.

Women reporting an activity level in leisure time between 1-2 at their T2 visit ha a higher GWG and ΔFM from T1 to T3, than women reporting an activity level in leisure time between 3-4 at their T2 visit (table 9). The same results were found at T3 visits and for average activity level in leisure time at all trimester-visits (table 9).

Table 9. Self-reported level of activity in leisure time, independent t-test.

Self-reported level of activity in leisure time									
			1-2			3-4		T-test	
		N	Mean	SD	N	Mean	SD	P	T
T1 visit	GWG	71	11.70	2.76	53	11.17	3.20	0.33	-0.98
	ΔFM		6.53	2.56		6.17	3.06	0.47	-0.72
	ΔFFM		5.17	1.99		5.01	2.17	0.67	-0.43
	ΔF%		4.41	2.81		4.44	3.55	0.95	0.06
T2 visit	GWG	99	**11.85**	**2.87**	25	**10.00**	**2.88**	**0.005**	**-2.87**
	ΔFM		**6.61**	**2.62**		**5.44**	**3.24**	**0.06**	**-1.90**
	ΔFFM		5.24	1.95		4.56	2.43	0.15	-1.47
	ΔF%		4.50	2.80		4.11	4.26	0.58	-0.56
T3 visit	GWG	112	**11.71**	**2.83**	12	**9.26**	**3.32**	**0.01**	**-2.80**
	ΔFM		**6.56**	**2.62**		**4.63**	**3.65**	**0.02**	**-2.33**
	ΔFFM		5.15	2.10		4.63	1.62	0.41	-0.83
	ΔF%		4.57	2.97		3.09	4.32	0.12	-1.56
T1, T2 and T3 visit	GWG	112	**11.69**	**2.82**	12	**9.42**	**3.46**	**0.01**	**-2.59**
	ΔFM		**6.56**	**2.62**		**4.67**	**3.68**	**0.02**	**-2.28**
	ΔFFM		5.14	2.11		4.76	1.61	0.55	-0.60
	ΔF%		4.56	2.97		3.13	4.34	0.13	-1.51

Activity level 1=the least active. Level 4=the most active. Abbreviations: TX visit= measurement at trimester X visit. T1, T2 and T3 visit=average level of activity in leisure time at all trimester visits. GWG= gestational weight gain from T1 visit and T3 visit (kg). Δ= Difference between measuring at trimester 1 visit and trimester 3 visit (T3-T1). FM= fat mass (kg). FFM= fat-free mass(kg). F%= Fat percentage (%).

Discussion

We found that women that reported strength training had a lower GWG and ΔFM than women that did not report strength training. Regression analysis further showed a dose-response effect where more reported strength training was associated with less GWG and ΔFM. Cardiovascular training was negatively associated with ΔFFM with no other significance found for cardiovascular training. Surprisingly, women that reported low intensity training during pregnancy had a higher GWG and ΔFM than women that did not report low intensity training. Also, in this case there was a dose-response where regression analysis showed that more reported low intensity training was associated with larger GWG and ΔFM.

There are very few available studies looking at different training types during pregnancy in relation to GWG and body composition. Two studies found that there was no difference in GWG between women receiving strength training intervention and control group [58, 63]. Most studies combine all types of training and compare with non-training women. Our findings suggest that a reason for the diversity in results from the studies combining all training may be that different forms of training yield different outcomes. Results from our study favour women that reported more minutes of training/week, emphasizing the importance of sufficient training dosage. The next step may be to randomize women to different forms of training and different dosages and measure weight and body composition to further investigate the different forms and dosages of training.

Reported low intensity training was not correlated to strength or cardiovascular training, but strongly correlated to total amount of training. Strength training was however correlated to cardiovascular training. We hypothesize those women reporting low intensity training (often consisting of walks) reported this training because they do not perform any other form of training. Women that reported cardiovascular training and strength training (often "going to the gym") possibly do not think of walks as training and did not report their walks. This form of reporting is probably the reason why we found that more low intensity training was associated with higher GWG and ΔFM. It may even be that strength training in this study is a marker for women that go to the gym and train any sort of training, and not necessarily a marker for strength training specifically. Another study fund low intensity training effective in lowering GWG in obese women with GDM [61]. Also a study in non-pregnant men and women showed that substituting sedentary time for light physical activity significantly lowered fasting insuline levels, participants with higher fasting glucose levels lowered their glucose more [85].

Women meeting recommended 150 min/week of physical activity during the whole of the pregnancy had a lower GWG, ΔFM and ΔF% than women that did not meet the recommendations. Another study (self-reported physical activity and GWG) showed significant difference in GWG between women meting the recommendations and women that did not meet the recommendations [86].

There was no difference between active and inactive women (women reporting no training, active transportation or high activity at work or leisure time). This result might be explained by the small number of women being inactive each trimester, but also that no women were inactive the whole pregnancy.

Women reporting the highest quartile of strength training at all trimester visits had lower parity than the rest. The same difference was seen between women reporting the highest

quartile of total amount of average training at all trimester visits. This suggests that women with fewer children prior to the current pregnancy trained more. The results for the regression analysis of low intensity training and strength training were, however, significant after adjusting for parity. There was no difference in weight gain or body composition changes between women that reported the highest quarter of total training time/week (low intensity, cardiovascular and strength training combined) and the rest. This could partially be explained by women reporting a high amount of low intensity training gaining more weight and women reporting high amount of strength training gaining less in weight, thus cancelling each other out in the group of high-volume trainers.

The big decline in active transport to/from work in trimester 3 is partially explained by some women starting maternity leave and therefore not working at all in trimester 3. Women reporting active transportation to/from work during pregnancy had a lower GWG than women that did not report active transportation. These results are in line with current research showing that women that continue active transportation during pregnancy have lower GWG than women that switch to inactive transportation [78]. Active transportation is also an independent predictor for lower BMI and fat mass, both in men and women (non-pregnant) compared with non-active transportation [87]. Many women change their transportation from active to non-active early in pregnancy [77]. Switching from active to non-active transportation is associated with an increase in BMI, and reversely switching from a non-active to active transportation is associated with a decrease in BMI (in men and non-pregnant women) [88].

Women that reported a higher activity level at work had a higher GWG and ΔFM than women reporting a lower activity level at work. Inversely; women that reported high activity level in leisure time had a lower GWG and ΔFM than women reporting lower activity level in leisure time. Level of activity at work was highly correlated between the trimester visits. This makes

it reasonable to believe that women that reported high activity level at work did that throughout pregnancy. Level of activity in leisure time was also highly correlated at all trimester visits. Level of activity at work and in leisure time was however not correlated with each other. This suggests that women who reported high activity level at work, were not the same women that reported high activity level in leisure time. It may be that women experiencing a physically demanding work environment are less prone to seek out physical activity in leisure time and that the total amount of activity therefore is reduced.

Strengths and limitations

Weight was measured objectively and not self-reported which makes for a more reliable measurement. Body composition was assessed with the gold standard method of air displacement plethysmography at three separate occasions and we regard that as a strength of this study. One disadvantage with these measurements is that we will not capture the complete gestational weight gain for the pregnancy and therefore we cannot compare our measurements, in absolute numbers, to recommendations for GWG or other studies that used total GWG. Our study only included women with normal BMI and therfore our results might be not appliable to women belonging to any other BMI category. Because our study had many different measurements for physical activity and body composition, we had a numerous amount of analyses, which makes the results more susceptible to false positive significances. We could have used a Bonferroni correction, but all analyses showed the same results and that suggests that the results are true, and not a by-product of many analyses, so we choose not to correct.

A limitation of this study is lack of an objective form of measuring training and physical activity. Self-reported physical activity is known to overestimate time spent in moderate to vigorous activity, and to underestimate time spent sedentary compared to objectively measured data in non-pregnant men and women [89]. According to a Norwegian study self-

reported and objectively measured physical activity in pregnant women have a significant positive correlation of moderate strength (Pearson correlation co-efficient r=0.19-0.37) [90]. When comparing self-reported to pedometer-determined exercise and behaviours in pregnant women it was found that pedometer-determined data classified more women as sedentary and low active than self-reported data [91]. A study that compared physical activity measured by the Pregnancy Physical Activity Questionnaire (PPAQ) with directly measured physical activity using Actical ® accelerometers found that PPAQ significantly overestimates physical activity [92].This means that our results are much more applicable to self-reported physical activity than objectively measured physical activity.

Another aspect of self-reported and non-controlled data is control over other aspects that could affect weight gain, such as diet. There might be that the women gaining less weight and fat mass (the women reporting more strength training) had a more favourable diet that was lower in calories that contributing or accounted for the whole lesser weight gain.

Current recommendations about physical activity are at large based on self-reported data and if we are aware of the limitations, self-reported physical activity is more available in the clinical setting and contains valuable information that could help predicting future metabolic complications [89].

Conclusions and implications

The results from our study proposes that stength training could be the prefered way of training for regulating GWG and body composition for normal weight women during pregnancy. Active transportation to/from work constitutes a regular way of staying active through pregnancy and battling inactvity on workdays. Encouraging women early in pregnancy (e.g. at the first prenatal care visit) to continue with active transportation and keep up regular training sessions, pressing on the health benefits and addressing any concerns, may be a way of preventing excessive GWG.

Hur viktuppgång och kroppssammansättning vid graviditeten påverkas av fysisk aktivitet under graviditeten

Att röra på sig regelbundet är viktigt för alla, även för gravida. Förut var man ofta rädd för att träning skulle påverka graviditeten negativt, men forskning har visat att rörelse under graviditet är väldigt bra och säkert både för foster och mamman. Att träna regelbundet under graviditeten verkar både vara kopplat till lägre risk för att gå upp för mycket i vikt, men också ha flera andra fördelar. Tyvärr är det ofta så att kvinnor rör på sig mindre under graviditeten än vad de gjorde före. Det gäller både planerad träning och vardagsmotion. Huruvida viss typ av träning är bättre än annan, och vilken mängd träning som är bäst är dåligt undersökt.

Det vanliga är att man går upp i både vikt och fettmassa under en graviditet. Hur mycket man rekommenderas att gå upp beror på vilken vikt i förhållande till kroppslängd (BMI) man har sedan innan graviditeten. Kvinnor med normalt BMI innan graviditeten rekommenderas att gå upp mellan 11.5-16kg. Kvinnor som är underviktiga innan graviditeten rekommenderas att gå upp mer i vikt än kvinnor som har övervikt eller fetma. Att gå upp för mycket i vikt, och speciellt i fettmassa, under en graviditet kan påverka graviditeten, förlossningen och även barnet negativt. Går man upp för mycket i vikt är det dessutom högre risk för att man inte går ner den vikten igen och får en övervikt/fetma efter graviditeten. Övervikt och dess associerade sjukdomar (hjärt- och kärlproblem, diabetes med mera) är ett stort problem i dagens samhälle och upprepade graviditeter med för stor viktuppgång har föreslagits bidra till detta.

Vi har följt 124 kvinnor med tre besök under deras graviditet. Vid varje besök har de fått väga sig och mäta sin kroppssammansättning (fettmassa, fettfri massa, och fettprocent) samt svara på frågor om fysisk aktivitet.

Resultatet visar att kvinnor som anger att de tränar styrketräning går upp mindre i vikt och fettmassa under graviditeten. Att träna styrka och kondition mer än 150 min/vecka visade också vara kopplat till lägre viktuppgång. Kvinnor som anger någon form av aktiv transport

(cykel eller gång) till jobb/skola går också upp mindre i vikt och fettmassa än de som tar bilen eller åker kollektivt under sin graviditet. Detta tyder på att styrketräning, som tidigare varit något man avrått från, skulle kunna vara det föredragna sättet att träna på under graviditeten för att inte gå upp för mycket i vikt. Det visar också på att vardagsmotion som man får via att cykla eller promenera dagligen spelar roll för viktuppgång även under graviditet.

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Appendices

Interview about physical activity (in Swedish)

Är du fastande?

O Ja O Nej

Allergi/Intolerans?

Har du någon Födoämnesallergi eller intolerans O Ja
O Nej

- O Laktosintolerant
- O Glutenintolerant
- O Allergi

Mot:.....

Deltagare i kontrollgrupp:
Har du/har du haft dietist-kontakt under graviditeten? O Ja
O Nej

Fysisk aktivitet

Inplanerad träning/fysisk aktivitet?
Typ?

.....

.....

Hur ofta? (Gånger per vecka)

.....

Hur länge? (Min per gång)

.....

Hur tar du dig till och från jobbet?

Bil Cykel Promenerar
Spårvagn/Buss

Hur tar du dig fram under fritiden?

Bil Cykel Promenerar
Spårvagn/Buss

387. HUR MYCKET RÖR OCH ANSTRÄNGER DU DIG KROPPSLIGT I DITT ARBETE?

Vi vill veta hur kroppsligt ansträngande ditt arbete är, hur mycket Du går, springer, klättrar och lyfter. De yrken, som finns upptagna i nedanstående grupper är bara exempel. Frågan gäller det senaste året. Välj den grupp som bäst motsvarar ditt arbete vad gäller fysisk ansträngning.

Grupp 0 Ej yrkesarbetande ☐

Pensionärer eller långtidssjukskrivna fyller i grupp 0 eftersom frågan gäller fysisk ansträning i yrkeslivet.

Grupp 1 **Stillasittande arbete** ☐

Du har övervägande stillasittande arbete och går inte mycket under arbetstiden. Exempel på sådana arbeten är skrivbordsarbete, urmakeri och montering av lättare delar.

Grupp 2 **Lätt men något rörligt arbete** ☐

Du har ett arbete där Du går ganska mycket men ej bär eller lyfter tyngre saker. Exempel på sådana arbeten är rörligt expeditionsarbete, lätt industriarbete, förmanssysslor, sådan undervisning där man går mycket, arbete som affärsbiträde.

Grupp 3 **Måttligt tungt arbete** ☐

Du går mycket och lyfter dessutom ganska mycket eller går mycket uppför trappor eller backar. Exempel är brevbärning, arbete vid tyngre industri, byggnadssnickeri, rörläggningsarbete.

Grupp 4 **Tungt arbete** ☐

Du har ett tungt kroppsarbete, lyfter tunga föremål och ansträngер dig mycket kroppsligt. Exempel är skogsarbete, tungt lantbruksarbete, fiske med tunga redskap, byggnadsgrovarbete.

ett kryss

FRÅGOR OM FYSISK AKTIVITET

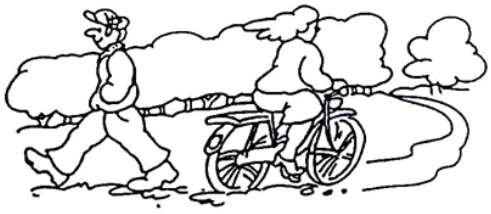
386. HUR MYCKET RÖR OCH ANSTRÄNGER DU DIG KROPPSLIGT UNDER DIN FRITID?

Om Din aktivitet varierar mycket mellan t.ex. sommar och vinter, så försök att ta ett genomsnitt. Frågan gäller det senaste året.

Välj den grupp som bäst motsvarar din egen fysiska aktivitet.

Grupp 1 Stillasittande fritid ☐

Du ägnar dig mestadels åt läsning, handarbete, TV, bio eller annan stillasittande sysselsättning på fritiden.



Grupp 2 Måttlig motion på fritiden ☐

Du promenerar, cyklar eller rör dig på annat sätt under minst 4 timmar i veckan. I detta inräknas också gång eller cykling till och från arbetet samt söndagspromenader, ordinärt trädgårdsarbete, fiske, bordtennis, bowling.

Grupp 3 Regelbunden motion och träning ☐

Du ägnar dig åt t.ex. löpning, simning, tennis, badminton, motionsgymnastik eller liknande, som motionssport. Tyngre trädgårdsarbete och liknande räknas till denna grupp. För att kryssa i grupp 3 skall Du ägna dig åt dessa aktiviteter minst 3 timmar i veckan.

Grupp 4 Hård träning eller tävlingsidrott ☐

Du ägnar dig åt hård träning och tävling i löpning, orientering, skidåkning, simning, fotboll, handboll etc regelbundet och minst 4 gånger i veckan.

ett kryss