CORRELATES OF REGULAR EXERCISE DURING PREGNANCY. THE NORWEGIAN MOTHER AND CHILD COHORT STUDY

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RUNNING HEAD: CORRELATES OF REGULAR EXERCISE DURING PREGNANCY

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ABSTRACT

The aims of this study were to describe the level of exercise during pregnancy and to assess factors associated with regular exercise. Using data from the Norwegian Mother and Child Cohort study (MoBa) conducted by the Norwegian Institute of Public Health, 34508 pregnancies were included in the present study. Data were collected by self-completed questionnaires in gestational week 17 and 30, and analyzed by logistic regression analysis. The results are presented as adjusted odds ratios (aOR) with 95% confidence interval (95% CI). The proportion of women exercising regularly was 46.4% before pregnancy and decreased to 28.0 and 20.4% in week 17 and 30, respectively. Walking and bicycling were the most frequently reported activities before and during pregnancy. The prevalence of swimming tended to increase from prepregnancy to week 30. Exercising regularly prepregnancy was highly related to regular exercise in week 17, aOR=18.4 (17.1-19.7) and 30, aOR 4.3 (4.1-4.6). Low gestational weight gain was positively associated with regular exercise in week 30, aOR=1.2 (1.1-1.4), whereas being overweight before pregnancy was inversely associated with regular exercise in week 17, aOR=0.8 (0.7-0.8) and 30, aOR=0.7 (0.6-0.7). Also, women experiencing a multiple pregnancy, pelvic girdle pain or nausea were less likely to exercise regularly.

INTRODUCTION

Physical activity (PA) during pregnancy has previously been discouraged primarily due to the fear of fetal hypoxia, fetal growth restriction, and hyperthermia which may lead to potential fetal teratogenic effects (Wolfe and Davies, 2003). However, recent reports have shown that exercise of moderate intensity during pregnancy may be beneficial in reducing the risk of complications and illnesses for both mother and fetus (Dempsey et al., 2004; Clapp, III et al., 2000), and is associated with overall health benefits for pregnant women (Brown, 2002).

Although the American College of Obstetricians and Gynecologists (ACOG) now recommend that virtually all pregnant women should exercise regularly, barring the presence of adverse complications (ACOG, 2002; Davies et al., 2003), pregnancy may be a time period when the level of physical activity declines (King, 1994; Mottola and Campbell, 2003). The prevalence of any physical activity during pregnancy varies widely and has been reported as high as 66% (Evenson et al., 2004; Ning et al., 2003). Understanding activity patterns during pregnancy and their correlates has significant public health implications. However, few longitudinal population-based studies have been conducted to investigate what kind of activities pregnant women do (Hatch et al., 1998), and how exercise levels change during pregnancy. Furthermore, information on pregnancy-related factors and other correlates of recreational exercise are currently sparse and equivocal with respect to pregnancy (Petersen et al., 2005).

Considering the insufficient data in this area, the aims of this study are a) to describe the level of exercise during pregnancy in relation to frequency and type of activities, and b) to assess factors associated with regular exercise during pregnancy.

MATERIAL AND METHODS

This study is based on the Norwegian Mother and Child Cohort Study (MoBa) conducted by the Norwegian Institute of Public Health (Magnus et al., 2006). MoBa is a pregnancy cohort that aims to include 100,000 pregnancies by 2008, and was designed to explore the associations between some of the lifestyle variables to which pregnant women and their fetuses are exposed in addition to diseases (MoBa, 2008).

Study population and inclusion criteria

The present study included pregnancies enrolled between 1 June 2001 and 31 May 2005. Of those invited in the MoBa study (116,224 pregnancies), 42% (n=48700) gave their informed consent. The overall participation rate was 45% (Magnus et al., 2006). The follow-up rate in gestational week 30 was 92% (n=43938).

The second version of the quality-assured data-file made available for research in April 2006 provided all data that was used for the statistical analysis in the present study. Both Questionnaire 1 and 3 had to be answered in order for the women to be included (n=40049). Additionally, pregnancies with missing data on all 13 items of the recreational exercise questions in week 17 (9.3%) and 30 (6.0%) were omitted from the analyses (n=5541). Thus, the study population includes 34508 pregnancies. The study has received approval by the Regional Committees for Medical Research Ethics and The Norwegian Social Science Data Services. Informed consent was obtained from each participant before inclusion.

The target population for MoBa consisted of all pregnant women in Norway who could read and write Norwegian. Pregnant women were recruited into the study through a postal invitation two weeks before their routine ultrasound examination, which usually takes place at their local hospital in gestational week 17. The invitation contained Questionnaire 1 and 2, a questionnaire for the father and an informed consent form. All participants received written and oral information about the MoBa study. If the questionnaires had not been returned within 2 weeks, one reminder was sent by mail. In gestational week 30 the women received Questionnaire 3.

The Questionnaires

Questionnaire 1 (Q1) provided data on various maternal behaviors and characteristics (e.g. body weight and height, marital status, education), diseases (e.g. depression, heart disease, pelvic girdle pain), and exposures before and during pregnancy. Questionnaire 3 (Q3) focused on health outcomes during pregnancy and included follow-up questions from Q1. Questionnaire 2 (Q2) was a food frequency questionnaire and was not relevant to this paper. Additional questionnaires were administered when the child was 6 months, 18 months, and 3 years of age. Data was obtained from 51 maternity units in Norway, all with more than 100 births annually. Linkage to the Medical Birth Registry of Norway (MBRN) was also provided.

Non-respondents

When comparing the MoBa participants and their births to the total number of births in Norway (approximately 55000 births annually) using MBRN, enrolled women were largely similar for characteristics such as parity, maternal age, preeclampsia, gestational diabetes and mean birth weight. However, enrolled women tended to have lower rates of preterm birth and low birth weight infants than women from the source population (Magnus et al., 2006).

When comparing demographic characteristic of women with (n=34508) and without (n=5541) information on recreational exercise, women whose information was missing were significantly more likely to smoke daily at enrollment (p=0.00), to have primary school only (p=0.00), to be sick-listed in pregnancy week 17 or 30, (p=0.00), and to have a BMI greater than 24.9 kg/m^2 prepregnancy (p=0.02). These differences with the study population are also true for non-exercisers.

Main outcome

The main outcome variable was regular exercise during pregnancy, defined as participating in any combination of recreational activities at least 3 times a week (Bouchard et al., 1994). The participants were asked to report how often they engaged in the following recreational activities during pregnancy week 17 and 30: strolling, brisk walking, running (jogging or orienteering), bicycling, fitness training in training centers, swimming, aerobic classes (low or high impact), prenatal aerobic classes, dancing, skiing, ball games, horse back riding and other. Frequency had five categories: "never", "1-3 times per month", "once a week", "twice a week", and "≥3 times a week". We merged aerobic classes (high and low impact aerobics) and prenatal aerobic classes into "aerobic dancing". Further, the level of exercise was defined in terms of frequency and categorized as non-exercisers, irregular or regular exercisers. Women who answered "never" or "1-3 times a month" were referred to as non-exercisers. A frequency of 1-2 times a week was defined as irregular exercisers and ≥3 times a week was defined as regular exercisers. Strolling was not defined as a recreational activity due to its very low intensity (Ainsworth et al., 2000), and therefore was excluded before estimating exercise levels before and during pregnancy.

In week 17, women were asked to recall the type and frequency of recreational exercise participated in during the last three months before the present pregnancy (Q1). The questions on recreational exercise before pregnancy, in pregnancy week 17 and 30 were identical (Q1 and Q3).

Sociodemographic covariates

The following sociodemographic covariates were included: age, maternal education, marital status, parity, prepregnancy body mass index (BMI) and smoking status. Maternal age was treated as a continuous variable. Education was defined as the highest completed education at

baseline and was categorized as “primary school (9 yrs)”, “secondary school (12 yrs)”, “college/university (≥ 15 yrs) and “other”. Marital status included four categories: “married”, “cohabitant”, “single”, and “other”. Parity was collected from NMBR, and was defined in terms of earlier pregnancies lasting more than 20 weeks (Venes and Taber, 2005). Body mass index (BMI) was calculated from self-reported body weight (Q1) and height (Q1), and was divided into five categories: ‘<18.5’, ’18.5-24.9’, ‘25-29.9’, ‘30-34.9’, ‘35+’. A BMI between 18.5 and 24.9 kg/m^2 was defined as the reference category. To control for prepregnancy BMI, the participants were asked to report their body weight when they became pregnant. Hence, we used prepregnancy BMI as an independent covariate in the analysis. To calculate weight change throughout pregnancy, the differences between body weight when pregnancy started, in weeks 17 and 30 were used. Smoking status was categorized as “never smoke”, “occasional smoker”, and “daily smoker”. Being short of breath/sweating at work at least once a week was used to assess physical activity at work during pregnancy, and was also included as a covariate.

Pregnancy related variables

Pregnancy-related health problems in the current pregnancy which were included in the statistical analysis were: pelvic girdle pain, urinary incontinence, nausea (with or without vomiting), severe fatigue, musculoskeletal pain (i.e. lower back pain and neck/shoulder pain), and pregnancy induced high blood pressure. Information on uterine contractions (after week 13) was collected from Questionnaire 3, while information on whether or not it was a multiple pregnancy (i.e. more than one fetus) was collected from NMBR.

Statistical analysis

All analysis was performed using the statistical software program, SPSS, version 14.0 (SPSS, Chicago, IL). First, we described the women by level of exercise at baseline. Then we estimated the association between regular exercise (≥ 3 times a week) during pregnancy and sociodemographic characteristics of the women in pregnancy week 17 and 30, separately. The following maternal factors were included: age, prepregnancy BMI, parity, education, marital status, and smoking. The final model also included physical activity at work and regular exercise prepregnancy.

Furthermore, we examined the association between regular exercise in week 17 and 30 and the following pregnancy-related health problems: pelvic girdle pain, musculoskeletal pain, nausea, urinary leakage, uterine contractions, multiple pregnancy, severe fatigue, and sick-leave, adjusting for sociodemographic variables. The associations were estimated by logistic regression analysis, and the results are presented in terms of crude (cOR) and adjusted odds ratios (aOR) with 95% confidence intervals (95% CI). The choice of covariates was based on previous review of the literature and frequency tabulation. The final multivariable logistic regression analysis was performed including all covariates significantly associated with regular exercise in week 17 or 30.

Missing data on covariates were replaced by dummy variables and included in the analysis. Rates of missing data ranged from 0.2-0.7% up to 2.7% (for prepregnancy BMI only).

RESULTS

A total of 34508 pregnancies were included in the analyses. At enrollment in gestational week 17, the mean age was 29.4 years (SD 4.5), ranging from 14 to 47 years, and mean body mass index (BMI) was 25.2 (SD 4.2), ranging from 13.3 to 61.7 kg/m^2. Table 1 displays the

demographic characteristics of the study population by level of exercise when entering the study. Forty one percent of the women (n=14159) were non-exercisers, whereas 31.0% (n=10691) were irregular exercisers, and 28.0% (n=9658) were regular exercisers at enrollment. The latter group was more educated, cohabitant, smoked less, primiparous and was also more likely to exercise regularly before pregnancy (Table 1).

The proportion of regular exercisers before pregnancy was 46.4% and dropped to 28% and 20% by gestational weeks 17 and 30, respectively. The odds ratio of exercising regularly in gestational week 30 equals 6.9 (95% CI 6.48-7.26) if the woman also participated in regular exercise in week 17. Before pregnancy, 25% (n=8485) were non-exercisers compared to 41% (n=14159) and 53% (n=18221) in pregnancy weeks 17 and 30, respectively.

Brisk walking and bicycling were the two most frequently reported activities both prepregnancy (47.7% and 24.9%), and during pregnancy weeks 17 (39.0% and 14.6%) and 30 (27.4% and 8.5%) (Table 2). Before pregnancy, fitness training, aerobic dancing and running were among the five most common activities. The pattern of recreational exercise changed from prepregnancy to weeks 17 and 30, showing that fewer women were running and reporting fitness training compared to aerobic dancing (Table 2). Participation in all types of activities decreased during pregnancy except for swimming, in which participation increased from prepregnancy (7.3%) to week 30 (8.2%).

Regular exercise prepregnancy was strongly associated with regular exercise during pregnancy weeks 17 and 30 (Table 3). The corresponding relative risks (RR) equal 9.42 and 3.48, respectively. In week 17, PA at work (RR= 2.11) was strongly related to regular

exercise, whereas gaining 10 kg or less was positively associated with regular exercise in week 30 (Table 4).

A positive association was observed between maternal age and regular exercise during pregnancy, with a 2% increase per year in the odds of being regular exerciser (Table 3). Sociodemographic characteristics inversely associated with regular exercise in weeks 17 and 30 had a BMI equal to or greater than 25, parity (≥ 1), and secondary school education only. The crude OR showed that daily smoking also was inversely associated with regular exercise in both weeks 17 and 30, but after adjusting for age and regular exercise prepregnancy the association was only significant in week 30 (Table 2).

In exploring how pregnancy-related health problems influenced level of exercise, it was found that women experiencing a multiple pregnancy and women experiencing pelvic girdle pain, nausea (week 17), musculoskeletal pain (week 30), uterine contractions (week 30) and sick-leave were less likely to exercise regularly. Although pregnancy-related health problems in week 17 and 30 were included in the model, the association between regular exercise and sociodemographic characteristics remained unchanged (data not shown).

DISCUSSION

In this longitudinal cohort study, we observed a decline in regular exercise wherein the proportion of non-exercising women increased from three months before pregnancy and throughout pregnancy. Brisk walking was the most commonly reported activity both before and during pregnancy, whereas swimming was the only activity which increased during pregnancy. Established regular exercise routines prepregnancy was the strongest correlate of regular exercise during pregnancy. Regular exercisers were also older, primiparous and had

higher education. Prepregnancy overweight and gestational weight gain were independently associated with regular exercise during pregnancy. Pregnancy-related factors such as pelvic girdle pain, multiple pregnancy, nausea, uterine contractions, sick leave and musculoskeletal pain were all inversely associated with regular exercise during pregnancy.

Brisk walking was the most common type of physical activity at all time points, which is in line with findings in previous studies (Evenson et al., 2004; Mottola and Campbell, 2003; Ning et al., 2003). Increased focus has been put on the health benefits of walking in the adult population, and epidemiological studies suggest that they are substantial (Andersen, 2007). Compared with other recreational activities often performed by women, such as aerobic dancing and bicycling, the intensity of walking is often low. However, according to the Compendium of Physical Activity (Ainsworth et al., 2000), walking at a moderate pace (i.e. 5 km/hour) expends sufficient energy to meet the definition of moderate intensity physical activity and may improve fitness in sedentary women (Hardman et al., 1992). In an attempt to capture walking of moderate intensity only, we therefore excluded strolling prior to estimating exercise level. Hence, by definition one should be sweating and short of breath. On the other hand, intensity is the least valid component assessed by questionnaires (Sallis and Saelens, 2000), and we cannot eliminate a possible overestimation of regular exercisers due to a high prevalence of walking.

Based on our observations, pregnancy did not seem to influence the choice of recreational exercises when it came to walking and bicycling, as these activities were the most frequently reported activities both before and during pregnancy. Even though aerobic dancing decreased during pregnancy, it was ranked among the five most common activities at all times. However, women seemed to shift from high-impact aerobic classes to low-impact and

prenatal aerobic classes in late pregnancy. There also seems to be a shift from high intensity exercise (i.e. running, ballgames, fitness training) to low and moderate intensity exercises such as swimming and bicycling from prepregnancy to late pregnancy, which corresponds well with the guidelines for exercise during pregnancy and the postpartum period published by ACOG (2002). To our knowledge, this is the first study to report that swimming increased from prepregnancy to gestational week 30. Swimming is widely recognized as one of the safest forms of exercise for pregnant women due to maintained thermoregulation by preventing overheating, the buoyancy, and the redistribution of blood flow from the periphery to the internal viscera (Katz, 2003). Even light to moderate intensity swimming may improve fitness in sedentary pregnant women (Lynch et al., 2003; Lynch et al., 2007). Women who exercise in water also seem to continue their exercise regime throughout pregnancy rather than having to stop in the last 4 to 6 weeks (Katz, 2003). The type of exercise performed during pregnancy probably depends on the type of exercise the woman performed before she became pregnant, and is a personal choice. However, for previously sedentary women, swimming and other forms of aquatic exercise may be the safest and most beneficial exercise and should be a targeted activity.

Women who exercised regularly prepregnancy were almost 10 times more likely to continue to exercise regularly during pregnancy. Although other researchers have reported that pregnant women are less likely to engage in regular exercise compared to their non-pregnant counterparts (Petersen et al., 2005; Zhang and Savitz, 1996; Evenson et al., 2004), none of these studies have repeatedly assessed exercise level in the same population of women and this therefore makes it difficult to determine whether exercise level declines as a consequence of pregnancy or whether it was low also before pregnancy.

We observed a substantial increase in the proportion of non-exercisers from 25% prepregnancy to 53% in late pregnancy, which is in agreement with the study by Pereira et al. (2007). The prevalence of insufficient active lifestyle (i.e. fewer than 150 minutes per week of total leisure-time physical activity) in their study increased from 12.6% prepregnancy to 21.6% in the second trimester. Because pregnancy is a time period characterized by progressively physiological, psychological and metabolic changes, a decline in regular exercise may be expected as pregnancy progresses. However, the proportion of non-exercisers is high among pregnant women in our study considering that walking was included in the definition of regular exercise.

Pereira et al. (2007) reported that 34% of the women in their study were overweight or obese prepregnancy (BMI greater than 24 kg/m^2), compared to 32.8% in our study. Considering that self-reported weight tends to be underestimated, especially in overweight individuals (Gorber et al., 2007), this is an alarming observation. There is growing evidence that overweight and obesity before pregnancy is a significant risk factor for maternal and fetal complications including pregnancy-induced hypertension, preterm delivery, gestational diabetes, and macrosomia (Baeten et al., 2001; Cnattingius et al., 1998; Ehrenberg et al., 2004). Additional weight gain during pregnancy increases the risk for both mother and fetus (Kiel et al., 2007). We observed that women with a prepregnancy BMI greater than 24.9 kg/m^2 were less likely to participate in regular exercise in pregnancy weeks 17 and 30, and gaining more than 10kg was inversely associated with regular exercise in week 30. These results are of particular concern because both overweight, excessive gestational weight gain and inactivity are independently associated with adverse health outcomes in both woman and fetus.

Women who reported being short of breath/sweating from PA at work at least once a week, were more likely to participate in regular exercise during pregnancy. This could possible be explained by type of occupation, but we do not have this information. On the other hand, being short of breath or sweating during pregnancy is not a valid indicator of the intensity of physical activity, as the interaction of an increased body weight, core temperature and the respiratory changes could affect this matter.

Our results are consistent with previous studies which state that smokers and women with secondary school education only were significantly less likely to exercise regularly than non-smokers and women with a college/university degree (Petersen et al., 2005; Evenson et al., 2004; Hinton and Olson, 2001). In the present study, a positive association between age and regular exercise in pregnancy weeks 17 and 30 was observed. Other studies on pregnant women have reported both a positive (Hinton and Olson, 2001) and negative (Petersen et al., 2005) association between age and exercise frequency. According to the review article by Trost et al. (2002), a negative association between age and physical activity in non-pregnant populations has repeatedly been documented.

We have not been able to find comparable studies that have investigated pregnancy-related (weight gain, pelvic girdle pain, nausea, uterine contractions), social (sick-leave, PA at work), and maternal health-related variables (smoking, musculoskeletal pain, chronic diseases) that may influence exercise levels during pregnancy. Hence, our study provides new information on correlates of an active lifestyle during pregnancy, as well as insight into potential risk factors for pregnant women that become inactive.

There are some limitations to be considered when interpreting the results from the present study. First, since the response rate was 42 % we cannot rule out the possibility of selection bias. Hence, we should interpret the prevalence of regular exercise in pregnancy with caution. However, the follow-up rate in gestational week 30 is high (92%) and the response rate in comparable studies varies between 41-74% (Hinton and Olson, 2001; Ning et al., 2003; Zhang and Savitz, 1996). When comparing demographic and reproductive variables between the MoBa participants and their births to the total number of births in Norway during the same period, there were only minor differences. However, it is likely that a socioeconomic gradient influenced the prevalence estimates, as women with lower socioeconomic status were underrepresented in the study population (Magnus et al., 2006). Demographic variables such as BMI, education, parity and smoking are distributed differently among low-income compared to high-income pregnant women. This may have introduced a bias, most likely towards a higher prevalence of regular exercise than in the target population. The observation that women without information on recreational exercise were more likely to smoke, have less education and be overweight prepregnancy adds to the same assumption.

Another limitation is that maternal exercise frequency was self-reported and thus prone to potential measurement errors (Sallis and Saelens, 2000). Assessing PA patterns in women in general and during pregnancy in particular is further complicated by the difficulty of assessing and quantifying physical activity in this population (Ainsworth, 2000a). Jakicic et al. (1998) found that overweight women who were enrolled in a behavioral weight loss program tended to over-report their exercise level when assessed by self-reporting compared to accelerometer. The questions chosen in our study have been evaluated as having higher validity since they aim to capture structured exercise activities of moderate to high intensity (Ainsworth et al., 1993), while pregnant women may differ from overweight women in many

ways. Even though questionnaires inadequately capture light to moderate physical activities and therefore tend to underestimate total physical activity in women (Ainsworth, 2000b;Schmidt et al., 2006), questionnaire-based studies are common and still the most feasible approach to measure general physical activity and exercise levels in large-scale epidemiological studies (LaPorte et al., 1985).

Strengths of the present study include the large sample size, population-based, comprehensive longitudinal data collection, and linkage to the NMBR which provided compulsory pregnancy and birth records filled in by midwives. These records are included in the MoBa database and provide information on pregnancy complications, pregnancy outcomes, and the neonatal period, as well as data on non-respondents (Magnus et al., 2006). In contradiction to other studies (Petersen et al., 2005; Evenson et al., 2004; Ning et al., 2003; Mottola and Campbell, 2003), we also collected longitudinal data from the same women from gestational weeks 17 and 30, measuring recreational exercise twice during pregnancy.

PERSPECTIVES

Given the adverse health effects of inactivity, overweight and excessive gestational weight gain, interventions for encouraging pregnant women to become physically active should be implemented. Considering that aerobic dancing is common among both non-pregnant and pregnant women, one strategy to increase participation in recreational exercise could be to develop exercise classes designed especially for pregnant women. Fitness trainers and instructors as well as health care providers should be educated on the benefits of regular exercise during pregnancy and on how pregnant women can safely exercise. Hence, the promotion of swimming and aquatic exercise should be emphasized. Multiparous women are less likely to exercise regularly compared to primiparous women. Given that child care

appears to be a major factor for women of childbearing age being able to perform physical activity (Booth et al., 1997) we suggest that fitness centers, sport clubs and public swimming pools provide child care in order to increase accessibility for more pregnant women. However, further research is needed on how different exercise regimes affect pregnancy and the offspring.

Key words**:** prospective, population-based, recreational exercise, pregnancy, correlates.

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