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Pregnancy and advanced maternal age – the associations between regular exercise and maternal and newborn health variables

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ABSTRACT

Introduction:

Despite the associations between delayed childbearing and poorer maternal and perinatal outcomes, little is known about these issues in regular exercisers and in women with healthy lifestyles. The aims of the present study were: 1) compare lifestyle variables and exercise, pregnancy and birth outcomes in women ≥35 years and women <35 years, and 2) investigate the associations between regular exercise and maternal health and newborn variables in women of advanced maternal age.

Material and methods: Healthy pregnant women (≥35 years, n=104 and <35 years, n=362) were allocated to the study from Rikshospitalet, Oslo University Hospital, Norway. The participants completed a validated self-administered questionnaire, the Physical Activity Pregnancy Questionnaire (PAPQ) in gestation week 32-36. Pre-pregnancy body weight (kg) was self-reported, whereas maternal weight (kg) was measured at gestation weeks 14-16, 22-24, 30-32 and 36-38. Details of the delivery (gestation week at delivery, mode of delivery, Apgar score) and birthweight (g) were obtained from the hospital's medical records.

Results: More women <35 than ≥35 years of age reported to exercises pre-pregnancy (83.7% versus 74.0%, p=0.04) and in the 1st trimester (71.2% versus 61. 5%, p= 0.05). At gestation week 36, fewer than 50% were exercising regularly, with no group differences (p=0.74). Current alcohol (10.5% versus 3.3%, p=0.02) and tobacco use (5.8% versus 1.7%, p=0.02) were higher among women ≥35 than women <35 years, whereas for healthy diet the result was reversed (<35 years: 67.1% and ≥35 years: 80.8%, p= 0.02). There were higher rates of post-term birth (13.5% versus 6.4%, p=0.02) and induction of labor (40.5% versus 27.9%, p=0.02) in the ≥35 group, otherwise no other differences were observed in perinatal outcomes. In women with advanced maternal age, exercising ≥2 times weekly was associated with less pelvic girdle pain (40.0% versus 61.1%, p= 0.02), lower gestational weight gain (GWG) (12.7±4.0 kg versus 15.5±5.5 kg, p<0.01), fewer had GWG≥16 kg (22.0% versus 51.9%, p<0.01) and a newborn with macrosomia (10.0% versus 37.0%, p<0.01). The results were unchanged after adjusting for recognized confounders.

Conclusions: The results indicate that regular exercise is associated with improvement in some of the risks of advanced maternal age.

Key words: Birthweight, exercise, gestational weight gain, maternal age, pregnancy

Abbreviations:

BMI	Body Mass Index
CI	Confidence Interval
CS	Cesarean section
GWG	Gestational Weight Gain
IOM	Institute of Medicine
OR	Odds Ratios
PAPQ	Physical Activity Pregnancy Questionnaire
SD	Standard Deviation

Key Message (40 words):

In a highly educated population with a healthy-lifestyle, maternal age ≥35 years was not associated with adverse pregnancy outcomes. Throughout pregnancy, regular exercisers (≥2 weekly) were less likely to have large newborns, high gestational weight gain or pelvic girdle pain.

INTRODUCTION

Increased maternal age has become more common in Western countries, caused by socioeconomic changes including birth control, educational level and women's advancement in society, late marriage and re-marriage, as well as fertility expertise and technology.[1] Advanced maternal age has been defined as being ≥35 years at the time of delivery.[2] In Norway, the rate of advanced maternal age has increased the past decades; in 2017 it was 20.1 % nationally and 27.4% in Oslo (The Medical Birth Registry Norway, MBRN, 2018). These proportions are likely to further increase as trends of delayed childbearing continue. Advanced maternal age has been independently associated with adverse newborn and birth outcomes, including stillbirth, low birthweight, macrosomia, preterm birth and Cesarean section (CS).[3-6] CS is also associated with macrosomia, as well as high gestational weight gain (GWG) and pre-pregnancy Body Mass Index (BMI).[7-9] In 2016 in Norway, CS rates were 20% in women ≥35 years and 9% in women <35 years.[10]

Although the natural musculoskeletal changes accompanying pregnancy vary from woman to woman, an increased rate of pelvic girdle pain has been reported in pregnant women with advanced maternal age.[11,12] Advanced maternal age is also recognized as a risk factor for the development of urinary incontinence, however, studies on the latter are not conclusive, and there is a need to further investigate this association.[13]

On the other hand, there may also be potential psychological and social advantages of delaying childbirth. For example, pregnant women aged ≥35 years are better educated, have higher socioeconomic status and lower parity. These factors may improve some of the adverse effects of advanced maternal age on perinatal outcomes reported in the past, such as preterm birth and low birthweight.[1]

Physical inactivity, overweight/obesity and GWG are modifiable factors. However, a search on PubMed revealed only one observational study of health behaviour in women of advanced maternal age. It was conducted in Korea, and had a small sample size (n=112).[14] Despite the suggested associations between delayed childbearing and poorer maternal (GWG, pelvic girdle pain and urinary incontinence) and perinatal outcomes (low birthweight, macrosomia, preterm birth and CS), little is known about these issues in regular exercisers and in women with healthy lifestyles. Hence, the aims of the present study were to: 1) compare lifestyle variables and exercise, pregnancy and birth outcomes in women ≥35 years and women <35 years, and 2) investigate the associations between regular exercise and maternal health and newborn variables in women of advanced maternal age.

MATERIAL AND METHODS

This is secondary analysis of cohort data collected as part of a prospective study of determinants of macrosomic newborns in Norway (STORK). Eligible women were recruited from the application form for birthing services at Rikshospitalet, Oslo University Hospital. Enrolment was limited to healthy Scandinavian speaking women aged 18 years or older, > 14 weeks gestation with a singleton pregnancy and no known risks for adverse pregnancy outcomes. Women with pre-gestational diabetes were excluded, as this may influence both lifestyle and birth outcomes.

Out of 678 women who agreed to participate, 125 were lost or withdrew before study enrolment. Hence, 553 women participated in the parent STORK study. Of these, 466 (84.3%) received our supplementary self-administered Physical Activity Pregnancy Questionnaire (PAPQ) and are included in the present study.

To assess the representativeness of the STORK cohort in terms of the general urban pregnant population, a comparison analysis was performed with data from150 non-participants who gave birth at the same hospital. No differences were found with respect to maternal age, parity, marital status, educational level, gestational age at delivery and the baby's birthweight. More details of the cohort have been published separately.[8,15]

Ethical approval

All the women signed an informed consent form, following the Helsinki declaration. The Regional Committee for Medical and Health Research Ethics, Southern Norway, Oslo, approved project and the complete data collection (2001/S-01191/REK).

Outcome measures

The trimester-specific PAPQ was used to obtain information on demographic, health and lifestyle characteristics, including pregnancy complaints and reports of being sick-listed, as well as daily life physical activity and sedentary behaviour (at work, transportation, household/childcare and recreational exercise/sport).[16] The questionnaire included 53 questions and required 10–15 minutes to answer. The midwife (NV) was available to help interpret the questions.

Participants' perceptions of daily diet were assessed using two similar questions, one asked about pre-pregnancy and the other about current eating habits: "*How would you describe your eating habits, including making healthy nutritional choices?*" The response options were ranked from 1-5, with the following description: excellent, good, average, bad and very bad. According to these five levels, we divided the women into two categories: healthy eating habits (excellent and good diet) and unhealthy eating habits (average, bad and very bad diet).

The nine questions concerning recreational exercise, included mode of activity, intensity, duration and frequency.[16] Exercise level (moderate intensity leisure-time physical activity≥20 minutes) was assessed by six response-alternatives: once per week or less, 2-3 times per week, 4–5 times per week, 6 times per week and every day or more than once every day. Participating in regular exercise was defined as performing moderate intensity (light breathing and modest sweating) leisure-time physical activity ≥ 2 times a week. The PAPQ was distributed at gestation week 32, and returned at the final visit (gestation week 36). Questions about physical activity and exercise level pre-pregnancy, and in the 1st and 2nd trimester were answered retrospectively. Third trimester data were obtained cross-sectionally.

Pre-pregnancy body weight (kg) was self-reported. Maternal weight (kg) was collected by the same midwife (NV) four times, at gestation week 14-16, 22-24, 30-32 and 36-38. Weighing was done in light clothing and without shoes using a digital beam scale to the nearest 0.1 kg. Height was measured with a fixed stadiometer to the nearest 0.5 cm at the first visit. Calculation of pre-pregnancy BMI (kg/m2) was based on self-reported weight and measured height. GWG was defined as the difference between self-reported pre-pregnancy body weight and body weight measured at the final visit prior to delivery (gestational week 37.0±1.1). Using pre-pregnancy BMI groupings recommended by the Institute of Medicine (IOM), we divided the participants into four GWG categories: 12.5-18.0 kg for underweight women (pre-pregnancy BMI<18.5), 11.5-16.0 kg for normal weight women (pre-pregnancy BMI 18.5-24.9), 7.0-11.5 kg for overweight women (pre-pregnancy BMI 25.0-29.9) and 5.0-9.0 kg weight gain for obese women (pre-pregnancy BMI≥30).[17] In addition, GWG was dichotomized as ≥16kg or <16 kg, irrespective of pre-pregnancy BMI group. [16]

Details of the delivery (gestation week at delivery, mode of delivery, Apgar score) and birthweight (g) were obtained from the medical records (Rikshospitalet University Hospital). Newborn birthweight was categorised as: low birthweight (<2,500 g), normal birthweight

(2,500–3,999 g) or macrosomia (≥4,000 g).[18,19] Macrosomina was also examined as birthweight ≥4200 g and >90th percentile. Nulliparous was defined as having no previous births and multiparous as having had at least one previous birth.

Statistical analysis

All statistical analyses were conducted with SPSS Software V. 24 for Windows. Data were presented as numbers with percentages or means with standard deviation (SD), as well as group differences with 95% Confidence Intervals (CIs) and p-values. Chi-squared analysis were used to compare categorical data and two-sided independent sample t-test for continuous data. To assess the difference between regular exercisers (≥ 2 times weekly, n=50) and non-exercisers (< 2 times weekly, n=54) on selected maternal and birth outcomes in advanced maternal age pregnancies (n=104), we included cross-sectional data obtained in the 3rd trimester, as this most likely represent the true regular exercisers, who continued regular exercise throughout pregnancy. If there was pre-existing evidence or a hypothesis that a variable could be a potential confounder of the association between regular exercise and the outcome, standard multiple regression was performed to explore the impact of a set of variables on the dependent variable. Likewise, a logistic regression model was used to explore the associations between regular exercise and dichotomous variables with adjustments for education, lifestyle and maternal health factors. As crude analyses (Table 4) revealed a significant difference between exercisers and no exercisers in GWG ≥16 kg (exercise: 22% and no exercise: 51.9%, p<0.01), but no differences between the groups in GWG above IOM guidelines, it was decided to use GWG ≥16 kg, and not GWG according to IOM in the logistic regression model. Due to a small number of women ≥35 years doing regular exercise throughout pregnancy, the final adjusted model (Table 5) contained five (GWG≥16 kg: exercise, healthy eating, parity, education, pelvic girdle pain) or six (macrosomia: exercise, healthy eating, parity, education, pelvic girdle pain and GWG) variables, all entered in step 1 in the above order.

RESULTS

On average, the participants answered the questionnaire in gestation week 36.4 (SD 1.7). In this sample, 78% and 22% were <35 years and ≥35 years, whereas 2% were ≥40 years. A comparison of the general characteristics of participants age ≥35 years and age <35 years is shown in Table 1. For both groups, about 80% reported university or college education. Nearly all (98%) were married or living together with their partner.

Lifestyle variables and maternal health

Pre-pregnancy BMI was similar in both groups (p=0.79). In women aged ≥35 years, 1.9% were underweight (BMI<18.5), 71.2% were normal weight (BMI 18.5-24.9), 21.2% were overweight (BMI≥25-29.9), and 5.8% were categorized as obese (BMI≥30). Twelve responders (2.6%) reported being daily smokers and 33 drank alcohol once a month or more in the 3rd trimester, with a higher percentage for both variables among women of advanced maternal age than in women of younger maternal age (p=0.02). For healthy eating habits, the reverse results were found (<35 years: 67.1% and ≥35 years: 80.8%, p= 0.02) (Table 2).

Pre-pregnancy and during the 1st trimester, the proportions classified as regular exercisers were lower in the ≥35 group than in the <35 group. The proportions of regular exercisers decreased in the 2nd and 3rd trimesters, with no group differences. At late gestation (week 36), about half of the women ≥35 years (50/104) were exercising regularly (Table 2).

GWG was 14.2 kg (SD 5.0) and 13.7 kg (SD 5.2) in women ≥35 years and <35 years, respectively (p=0.44). Almost two thirds had weight gain above the IOMs recommendations [17], with no group differences. With respect to pregnancy complaints, about 55% and 25% experienced pelvic girdle pain and urinary incontinence, respectively, with no differences between advanced and young maternal age participants (Table 2).

Birth outcomes and newborn variables

More women in the older than in the younger age group delivered post-term (13.5% versus 6.4%, p= 0.02), but there were no differences in preterm births. The average weights of the newborns were similar (≥35 years: 3732 ±477 g and <35 years: 3672 ±509 g), as were the proportions with low birthweight and macrosomia (Table 3). There were between-group differences in the percentage of women who had labor induction (≥35 years: 40.5% versus <35 years: 27.9%, p= 0.02), as well a tendency towards higher rates of CS in the advanced maternal age group (≥35 years: 26.9% versus <35 years: 19.1%, p= 0.08), but fewer instrumental deliveries (≥35 years: 6.7% versus <35 years: 13.0%, p=0.08). Data from the Medical Birth Registry of Norway (Statistics Norway 2016), show CS rates of 20% in women ≥35 years and 9% in women <35 years, respectively.[10]

Regular exercise - maternal and birth outcomes

Comparison of maternal and birth outcomes in women with advanced maternal age according to 3rd trimester exercise level, are summarized in Table 4. Also after adjusting for healthy eating habits, parity, educational level and pelvic girdle pain, regular exercise was associated with a lower risk for GWG ≥16 kg (odds ratios (OR) 0.30 [95% CI 0.12 to 0.78], p<0.01), and the group difference in GWG was -2.6 kg (95% CI -4.5 to -0.6, p=0.01). The risk for having a high birthweight newborn ≥4000 g (OR 0.27 [95% CI 0.08 to 0.86], p=0.03) was significantly lower in regular exercisers. However, as shown in Table 5, GWG ≥16 kg was found to be the strongest factor associated with macrosomia (OR 4.0 [95% CI 1.38 to 11.59], p=0.01).

DISCUSSION

More women <35 year than ≥35 years reported regular exercise pre-pregnancy and in the 1st trimester. No group differences were observed in the 2nd and 3rd trimesters. Except for higher rates of post-term birth and induction of labor in the age group ≥35 years, no other differences were observed in maternal or birth outcomes. Among women ≥ 35 years, those who exercised ≥2 times weekly had lower mean GWG, fewer had GWG ≥16 kg and lower odds of newborn macrosomia, than women who exercised <2 times weekly (after adjusting for parity, educational level, pelvic girdle pain and report of healthy eating habits).

Despite the suggested associations between advanced maternal age and poorer maternal (GWG, pelvic girdle pain and urinary incontinence) and perinatal outcomes (low birthweight, macrosomia, preterm birth and CS), we did not find such results. There may be three explanations for this. First, our participants who were ≥35 years were women who were able to conceive at this "advanced" age, which may be a positive marker of their physical health.[20] Secondly, the age gap between the two groups were about seven years; a larger age gap between the comparison groups might have given different results. Fitzpatrick et al.[21] described a J- shaped curve, with an increase in complications after 40 years. In the present cohort, only 10 women were ≥40 years. Thirdly, the study population included highly educated women, who generally have healthier lifestyles, including more participation in leisure-time physical activity. We found that nearly half the participants reported exercising regularly in the 3rd trimester.

Drinking alcohol more than once monthly during pregnancy was reported by as many as 11% in the age group ≥35 years, compared with 3% in the <35 years group. Also, prior to pregnancy, women in the ≥35 years group had higher alcohol consumption. Others have also reported that the proportion of women consuming low levels of alcohol during pregnancy significantly increased with increasing maternal age, and is a major concern.[23]

Significantly more women aged ≥35 (than younger women) perceived their overall diet quality to be healthy. In the present study, perception of daily diet was assessed by one question, which may not accurately capture their nutritional status. Hence, it might have been better to assess whether nutritional intake is sufficient. For future studies, we suggest using the Healthy mother, healthy baby – Nutritional questionnaire for pregnant women (https://www.figo.org) or the Alternate Healthy Eating Index modified for Pregnancy (AHEI-

P).[24] Nevertheless, the data were collected using a standardized format, and any inconsistency in reporting would have been equally distributed, regardless of maternal age. One previous study compared details of nutritional intake and serum iron values in young and advanced aged pregnant women, and found no between-group differences.[14]

With the exception of the higher rate of post-term birth in the older women, other newborn variables were comparable in the two groups. This is in contrast to other studies that have reported associations between advanced maternal age and several adverse outcomes including preterm birth, low birthweight and macrosomia.[3,5,6] However, the increased risks may be linked to the higher rate of overweight and obesity observed in older mothers.[21,25] Obesity is an independent risk factor for many health conditions, including pre-eclampsia and diabetes, and is associated with preterm delivery and macrosomia.[26-28] In the present study, fewer than 6% of participants were categorised as obese.

The higher rate of labour induction observed may be explained by the fact that advanced maternal age is a risk factor for stillbirth,[29] as such clinicians may have provided induction of labour at or around the due date, but we do not know if this was the case.

Age increases for every pregnancy a woman goes through, and women ≥35 years are more likely to be multiparous. Hence, it would have been interesting comparing only nulliparous women. In the present study, only 31 participants' ≥35 years were nulliparous, and the small sample size would have limited us from correctly estimating the target population.

Norwegian health authorities have adopted the IOM guidelines for GWG during pregnancy. As such, we have primarily used this when investigation number of participants gaining above, within or below these guidelines. Yet, on Norwegian webpages (eg Matportalen.no /Råd til spesielle grupper/Gravide/, authorized by the Norwegian Directorate of Health), it is frequently written that common weight gain during pregnancy is between 11-16 kg. The upper weight gain range according to IOM is 9 kg for obese and 11.5 kg for overweight women. In the present study, about 65% had gained weight above IOM guidelines. However, when dichotomizing GWG as ≥16kg, the corresponding number was 34%.

Most other studies of maternal age and maternal and birth outcomes have limited data on behavioral and health variables, including nutritional and smoking habits, alcohol consumption, physical activity and exercise.[2] These are all factors that may influence advanced maternal age outcomes.[21,30] Moreover, because of the trend to postpone pregnancy, it seems important to know who is at risk, as well as whether a healthy lifestyle, including regular exercise, may improve some of the adverse effects of advanced maternal age on maternal and perinatal outcomes.

To date, healthy pregnant women are encouraged to be physically active for at least 20-30 minutes daily, equal to a minimum of 150 minutes per week of moderate-intensity aerobic activity. [31] However, despite many benefits of meeting todays recommendations, studies have shown that the prevalence of recommended activity is lower among pregnant than non-pregnant women, and further that the levels tend to decline throughout the course of pregnancy. [22] We found that only 50 participants (10.7%) were defined as regular exercisers according to ACOG recommendations in the 3rd trimester, hence using this, our sample size would have been very small, particularly when doing subgroup analyses with women of advanced maternal age. In another study from the same population, we also found that most women were regularly active only once per week. [16] As such, we decided to use a cut-off of at least 20 minutes ≥2 times weekly throughout pregnancy.

In research, every study population will have slight imbalances that do not mirror the target population. Hence, if a study involve several comparisons, scientist are almost certain to find some quirks and conclude (falsely) that they are true for the entire population. This is a problem of multiple testing, especially in very large dataset with lengthy questionnaires. However, in the present dataset, all our analyses concerning GWG and macrosomia are consistent and complementary. The multiple testing each ask the same question in a different way, and all the comparisons point to the same conclusion, exercising ≥2 times weekly was inversely associated with GWG and newborn macrosomia.

In contrast with maternal age, physical inactivity and GWG are modifiable factors and may be subject to habitual changes in lifestyle. Pregnancy is a unique period where women are likely to consider and implement lifestyle changes.[31]

Pelvic girdle pain and urinary incontinence were less frequently reported among the exercising women. However, the design of the present study limits the interpretation of these findings. Observational cross sectional studies can show associations between variables, however cannot show the direction of these associations. Women may be able to exercise because they have no pain or are continent, or exercise may prevent urinary leakage or pelvic girdle pain. The hypothesis that a physically strong and fit body may be less vulnerable to pregnancy complaints such as pelvic girdle pain is not unlikely.

The PAPQ was specially designed for use in a pregnant population, and has been validated with data from a motion monitor, with acceptable results (ActiReg®, PreMed AS, Oslo, Norway).[32] Nonetheless, a limitation of self-report is that the results rely on what participants say they do (exercise and healthy eating), without direct measures of the behaviours. Pre-pregnancy, 1st and 2nd trimester physical activity level were answered retrospectively, as the PAPQ was distributed at late gestation. Hence, questions about exercise frequency, duration and intensity were recalled many months back in time. When planning the study, it was important that the PAPQ should not be too time consuming, because physical activity/exercise was only one of several exposure variables assessed in the STORK project. Hence, distributing the questionnaire in all three trimesters was not considered feasible and would have placed more burden on the participants.

Strengths and limitations

The strength of the present study is the high response rate and the inclusion of data concerning personal behaviours and several health variables (such as BMI, GWG, pelvic girdle pain, smoking, diet, exercise). Hence, we were able to adjust for these factors in the analyses. As far as we have ascertained, the study is also the first to report on associations between regular exercise and gestational weight gain and birthweight in women of advanced maternal age. In addition, the study population was similar in marital status, educational level, mean maternal age, parity, gestational age at delivery and the baby’s birthweight to non-participants giving birth at the same hospital,[8] this improved the generalizability of our findings.

As this study reported on secondary outcomes and was not primarily geared towards researching advanced/younger age and adverse pregnancy outcomes, the findings should be interpreted with care. An additional limitation was the sample size, as it was not large enough to assess associations with severe and less frequent adverse pregnancy and birth complications, especially for the sub-group analysis of data from women ≥35 years participating in regular exercise (n=50) or not (n=54). The study population was from a single hospital in Oslo and the investigation was carried out in Norwegian only, hence excluding women from other ethnic groups. The participants also had a higher educational level than the average Norwegian level. Therefore, our results cannot be generalized to less educated populations or other ethnic groups.

CONCLUSION

Regular exercise may improve some of the adverse effects of advanced maternal age on maternal and perinatal outcomes which have been previously reported. Hence, women should be encouraged to optimize their physical health both prior to and during pregnancy, including regular participation in exercise. The net effect of regular exercise on maternal and newborn variables should be further investigated in a well-designed RCT.

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Tweetable Abstract:

"In moms over 35 years, regular exercise and a healthy lifestyle may improve some of the adverse effects reported in the past"

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