Physical activity during pregnancy through postpartum:  
A study of predictive and explanatory factors in a multi-ethnic population

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Papers


### Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AU-ROC</td>
<td>Area under the receiver operating characteristics curve</td>
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<td>BMI</td>
<td>Body mass index</td>
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<td>CI</td>
<td>Confidence interval</td>
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<tr>
<td>DAG</td>
<td>Direct acyclic graph</td>
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<td>EE</td>
<td>Energy expenditure</td>
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<tr>
<td>GDM</td>
<td>Gestational diabetes mellitus</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>GPS</td>
<td>Global position systems technology</td>
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<td>GW</td>
<td>Gestational week</td>
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<tr>
<td>ICC</td>
<td>Intra-class correlation coefficient</td>
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<tr>
<td>IQR</td>
<td>Interquartile range</td>
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<tr>
<td>ISCO-88</td>
<td>International Standard Classification of Occupations from 1988</td>
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<tr>
<td>Kcal</td>
<td>Kilocalories</td>
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<tr>
<td>MAR</td>
<td>Missing at random</td>
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<tr>
<td>MCAR</td>
<td>Missing completely at random</td>
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<tr>
<td>METs</td>
<td>Metabolic equivalents</td>
</tr>
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<td>MNAR</td>
<td>Missing not at random</td>
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<tr>
<td>MoBa</td>
<td>Norwegian Mother and Child Cohort Study</td>
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<tr>
<td>MVPA</td>
<td>Moderate-to-vigorous intensity physical activity</td>
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<td>OR</td>
<td>Odds ratio</td>
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<td>PAEE</td>
<td>Physical activity energy expenditure</td>
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<td>PAQ</td>
<td>Physical activity questionnaire</td>
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<tr>
<td>PCA</td>
<td>Principal components analysis</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<td>SE</td>
<td>Standard error</td>
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<td>STORK-G</td>
<td>Stork-Groddalen Cohort Study</td>
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<td>SWA</td>
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1. Introduction

Current Norwegian guidelines recommend that pregnant women should achieve 150 minutes/week of moderate-to-vigorous intensity physical activity (MVPA) [1]. An increasing number of studies demonstrate preventive effects of physical activity during pregnancy and in postpartum. For example, physical activity reduce the risk of gestational diabetes, excessive gestational weight gain and maternal depressive symptoms [2]. Despite the preventive effects of physical activity, descriptive studies show that the proportion who achieve 150 MVPA minutes/week is lower among pregnant than non-pregnant women, and PA levels decline as pregnancy progresses [3]. Studies also show that ethnic minority women are less physically active than the majority population [4, 5], but most of these studies have been conducted in the US. Little is known about physical activity levels among pregnant women with ethnic minority background in the European and Norwegian context.

Physical activity assessment and interventions are of particular importance in the case where there are differences in the distribution in both disease parameters and physical activity among sub-groups of the population [6]. Studies of pregnant women in Norway show that women with South Asian and Middle Eastern background have more than twofold risk of developing gestational diabetes [7] and depressive symptoms [8] compared with Western women. Ethnic minority women also retain more weight postpartum [9], which put women in these groups at increased risk for long-term weight imbalance [10]. In Norway, approximately 60,000 women enter pregnancy each year [11], and pregnancy is often referred to as a “teachable phase” during which inactive women are prepared for lifestyle change [12, 13]. Thus, pregnancy represents a window of opportunity during which healthcare workers can support women contemplating a lifestyle change, which may carry over into the period after pregnancy.

Descriptive data of physical activity levels among pregnant women in Norway, overall and for ethnic minority groups, are needed to inform public health initiatives. To plan public health strategies and identify high-risk groups, studies of factors that predict women at risk of sub-optimal levels of physical activity and factors that can positively affect physical activity behaviour are needed. It is important to bear in mind that the physical activity behaviour observed among women after they enter pregnancy and after birth cannot be
understood isolated from the wider societal context that influences also pre-pregnancy lifestyle. Societal changes has led to increasingly sedentary lifestyles and the proportion of women in Norway aged 18-24 years who were either obese or overweight increased from 1998 to 2008 [14].

Strategies to promote health must reflect that factors at many levels influence health and physical activity. According to socio-ecological theory, health and physical activity are influenced by intrapersonal factors, interpersonal factors and environmental factors [15]. For example, findings from the Born-in-Bradford Cohort showed that pregnant women who lived in neighbourhoods with a high degree of residential greenness had lower probability of depressive symptoms, and the authors speculated that physical activity partially mediated the association [16]. There is a growing number of studies of the association between the neighbourhood physical environment and physical activity in non-pregnant populations. Nevertheless, there is a dearth of similar studies in pregnant populations, while behavioural factors at the intrapersonal level have been more frequently studied [17].

Studies of factors that influence physical activity behaviour in pregnancy and postpartum have, predominantly, employed self-report measures of physical activity, which are hampered by measurement error [18]. Thus, the reported associations with physical activity behaviour may be biased [19]. Compared with self-reported measures, objective measures of physical activity yield more precise and valid estimates of physical activity, which may reduce the risk of bias in studies of explanatory factors of physical activity behaviour [19]. The present thesis is based on data from the multi-ethnic STORK-Groruddalen Cohort Study (STORK-G), which contains objectively recorded and longitudinal data on physical activity, and data on a range of demographic, anthropometric, health-related and psychosocial factors [20]. Analysis of data from STORK-G may therefore provide new insight into factors that predict and explain physical activity behaviour in pregnancy and postpartum.
2. Background

2.1. Definition of physical activity

In the present thesis physical activity is understood as habitual physical activity level at different stages of pregnancy and early postpartum. Physical activity encompasses all bodily actions produced by contractions of skeletal muscles that increase energy expenditure (EE) above resting level [21]. The use of EE as a proxy measure for physical activity is widespread [22]. However, while EE is a single parameter, physical activity is a unique construct in kinesiology incorporating behavioural, physiological and biomechanical principles [23]. Accordingly, physical activity can be described qualitatively (mode) and contextually (setting) in addition to the quantitative descriptions of intensity, duration and frequency [21, 24].

From a public health perspective, the quantitative data that express EE are highly relevant because EE is a better predictor of health-related outcomes than physical activity mode [25]. EE induced by physical activity is termed physical activity EE (PAEE) [21]. PAEE represents approximately 20% of total energy expenditure, while the other components are resting metabolic rate (70%) and thermic effect of food (10%) [24]. PAEE can be expressed as the daily expenditure of kilocalories (kcal) or metabolic equivalents (METs). One MET corresponds to the resting metabolic rate, and is typically expressed as an oxygen consumption of 3.5 ml \( \text{kg}^{-1} \cdot \text{min}^{-1} \) [26]. Empirical evidence suggests this formula overestimates the energy expenditure of resting EE in a heterogeneous sample by 35%, and more accurate estimates of METs can be produced by including correction factors or measures of resting metabolic rate [27].

Total daily PAEE can be accumulated by an infinite number of combinations of physical activity type, intensity, duration and frequency [21]. Intensity may be expressed by the metabolic equivalents ratio, which is the ratio of the rate of energy expended during an activity to the rate of energy expended at rest [28]. Typically, intensity levels are classified as sedentary (\( \leq 1.5 \) METs), light intensity (1.6-2.9 METs), moderate intensity (3.0-5.9 METs), and vigorous intensity (\( \geq 6 \) METs) [29]. In most population-based cohort studies of pregnant women moderate and vigorous intensity physical activity are collapsed into one category, moderate-to-vigorous intensity physical activity (MVPA), since a very
limited fraction of daily energy is expended during vigorous intensity physical activities in pregnancy. The *duration* of physical activity expresses the time interval of sustained periods of physical activity within certain intensity ranges (e.g. one bout of MVPA of 10 minutes). Physical activity *frequency* expresses the number of times physical activity is performed within a specified timeframe (e.g. three 10-minute bouts of MVPA per day). Examples of physical activity *modes* are vacuum cleaning, yoga exercises and recreational walking, while early pregnancy and neighbourhood are examples of physical activity *contexts*.

### 2.2. Public health rationale for the present thesis

The public health relevance of understanding physical activity behaviour is a consequence of the adverse health effects of insufficient physical activity and, vice versa, the health enhancing effects of physical activity. Meeting the recommended levels of physical activity during pregnancy is of particular importance, since both mother and offspring may benefit. The goals of performing physical activity during pregnancy include maintaining well-being, avoiding foetal harm and establishing a healthy lifestyle [30]. Despite the benefits of physical activity during pregnancy, there are precautions to take; e.g., the potentially adverse effect on foetal temperature, which can result from sustained high intensity exercise in pregnancy during which the metabolic rate is increased [30]. Recent systematic reviews and meta-analyses of experimental and observational studies indicate that physical activity is associated with lower likelihood for gestational diabetes, lower gestational weight-gain, lower likelihood for large-for-gestational-age babies, and lower risk for preterm delivery [31, 32]. Since gestational diabetes predisposes both mother and offspring for future type 2 diabetes and obesity [33-36], successful promotion of physical activity in pregnancy can positively influence health beyond pregnancy. From a strategic point of view, capitalizing on pregnancy as a window of opportunity to promote healthy living may prove effective, since health personnel during this phase reach women across social groups, and since pregnant women due to concerns about the well-being of the foetus may be more motivated for healthy lifestyle change [12].
2.2.1. Physical activity guidelines

The first national guidelines for physical activity during pregnancy were issued by the American College of Obstetricians and Gynaecologists (ACOG) in 1985, and these were updated in 1992, 1994, 2002 and 2015 [30, 37]. The ACOG update in 2002, together with the joint guideline issued by the Society of Obstetricians and Gynaecologists of Canada (SOGC) and the Canadian Society for Exercise Physiology (CSEP) represented a shift from a predominantly restrictive norm to a permissive and recommended attitude [30]. The Physical Activity Guidelines for Americans, published in 2008, were the first government-issued guidelines that contained recommendations for pregnant and postpartum women [30]. In 2010, the American College of Sports Medicine (ACSM) published separate guidelines for pregnant women in ACSM’s Guidelines for Exercise Testing and Prescription.

There are some discrepancies between the guidelines issued by the different institutions. The 2015-update of the ACOG guideline recommends that pregnant women perform 20-30 minutes of moderate exercise on most, if not all, days of the week [37]. The Canadian joint SOGC/CSEP guideline from 2003 recommends session of 25-30 minutes for up to 5 days per week [38]. The ACSM guideline recommends aerobic physical activity of 15-30 minutes duration and a total accumulation of 150 minutes/week, and in addition, resistance exercises that work all major muscle groups [39]. The 2008 Physical Activity Guidelines for Americans (UDHHS) recommends 150 minutes of moderate-intensity activity spread throughout the week, and women who habitually engaged in vigorous-intensity activity pre-pregnancy can maintain vigorous activities during pregnancy provided they remain healthy and discuss with their health-care provider [40]. The 2011 Canadian Physical Activity Guidelines encourages pregnant women to accumulate 150 minutes of aerobic MVPA every week in bouts of 10 minutes [41].

In a review article of physical activity guidelines for the postpartum period, Evenson and co-workers [42] noted that only the 2008 UDHHS [40] and the joint SOGC/CSEP guidelines were specific about the duration and intensity of physical activity. The UDHHS encourage 150 minutes/week of moderate-intensity physical activity, while the
SOGC/CSEP recommended aerobic exercise using conventional heart rate target for at least 15 minutes, 3-5 days per week [38].

Due to different interpretations of current guidelines and use of different guidelines, studies of compliance with the physical activity guidelines in pregnancy have yielded very different estimates of compliance, ranging from 3 to 78% [43].

2.3. Field-based assessments of habitual physical activity in pregnancy

Field-based assessments of physical activity encompass methods developed to capture habitual physical activity in the natural environment of the participants, and the main types are indirect calorimetry, self-reported physical activity (questionnaires and diaries), motion detection (pedometers/accelerometers/inclinometers) and physiological markers (e.g. heart rate, body temperature) [44]. More recently, multi-sensory devices using a combination of physiological markers with global positioning systems and/or motion detection have been used [45, 46].

In determining the appropriateness of any field-based method for assessing habitual physical activity, it is critical to consider instrument characteristics (e.g. validity, reliability, activity vs intensity), study characteristics (e.g. budget, population, sample size), population characteristics (e.g. cultural norms, socioeconomic position), and activity characteristics (e.g. walking, moderate activity, sports) [47].

It is important to define the purpose of the measurement as a first step to ensure the relevance of the measure of criterion validity [48]. If the purpose is to estimate MVPA minutes/day, criterion validity should be assessed with reference to the best available measure [49].

Sample characteristics (i.e. pregnant women from a multi-ethnic population) also have bearings on the appropriateness of the method. With respect to studying physical activity during pregnancy, measures of PAEE must reflect that both activity-induced and pregnancy-related metabolism will contribute to higher levels of total EE during pregnancy, irrespective of the actual physical activities. Using conventional approaches to estimate PAEE will therefore be misguided. All weight-bearing physical activities will
expend more energy during pregnancy contrasted with the non-pregnant state due to the increase in body mass [50]. Furthermore, the metabolic activity of the uterus and foetus, and the increasing load put on the lungs and the heart as pregnancy progress yield a resting metabolic rate that is 15-26% higher in pregnancy compared with postpartum [51].

Budgets have a defining role in the selection of method. While objective monitors are available at different costs [52], physical activity questionnaires (PAQs) are low-cost tools that are versatile and put minimal burden on the participant [53]. The feasibility of the objective monitor is another important criterion to consider in the study planning, and it is critical to take into account the participants’ perspective [54]. Participants’ assessments of the wearing comfort and the placement and appearance of the activity monitor are important, as these factors can influence the activity monitor compliance [54, 55].

2.3.1. Gold-standard methods

Indirect calorimetry is considered the gold-standard method for deriving criterion measures of the PAEE component of physical activity against which simpler field-based methods are compared [24]. Estimates of PAEE based on indirect calorimetry are obtained by measurement of oxygen uptake [26]. Although not exact, using a constant of 5 kilocalories per liter (kcal·L⁻¹), the oxygen uptake can be expressed in terms of kilocalories used per minute (kcal·min⁻¹)[26]. Doubly-labelled water is also considered a gold-standard method [24]. This method consists of oral administration of stable isotopes; the elimination rate of the isotopes is proportional to the carbon dioxide production, which can be converted to energy expenditure [24]. Since both methods are relatively expensive, these methods are not feasible in large epidemiological studies [24].

2.3.2. Methods based on self-report

The majority of observational studies of physical activity among pregnant women employ PAQs [3]. Some of the PAQs differentiate between time spent in physical activities at light, moderate and vigorous intensity levels, such as the International Physical Activity Questionnaire [56]. Other PAQs include items for reporting the frequency and duration of various pre-defined types of physical activity, such as the Norwegian Mother and Child
Study Physical Activity Questionnaire [57]. Data collected with PAQs that are specific with respect to physical activity type and duration can be converted to PAEE by using a compendium of activity-specific MET-values [58].

One of the main critiques of several PAQs concerns the lack of items reflecting physical activity types typical for women and a subsequent gender bias [59]. For example, many PAQs are insensitive to household work activities that women perform more frequently than men [60], many of which at intensity levels between three and six METs [61]. Parallel to the gender bias, concerns have been expressed about ethnic bias on the grounds that housework and caring tasks represent a higher proportion of PAEE among ethnic minority women than Western women [6, 62]. Ethnic bias can also result from ethnic differences in how questionnaire items are interpreted, response editing and social desirability of physical activity [6, 63].

Given that housework and caring activities are more prevalent among women than men, and women in certain ethnic groups in particular, there is a risk of biased estimates of physical activity [6, 60]. More recent PAQs, such as the Pregnancy Physical Activity Questionnaire and the Kaiser Physical Activity Questionnaire include household and child care activities [64, 65], and in theory, data collection aided by these questionnaires should reduce the risk of gender/ethnic bias. However, despite the inclusion of housework and caring activities, there is a risk of underestimation of duration of physical activity performed at specific intensities due to recall challenges resulting from the sporadic and intermittent nature of some of these activities [66]. While underestimation of certain modes of physical activity represents a threat, a considerable overestimation of total daily MVPA assessed by the Pregnancy Physical Activity Questionnaire has been reported when compared with accelerometry [67].

So far, one review of questionnaire validation studies in pregnant women has been published [68]. The poor agreement between estimates of physical activity during pregnancy (PAEE and MVPA duration) from PAQs and objective methods is well documented; Evenson and colleagues [68] reported that the correlation in studies reviewed were in the range 0.1-0.5. Troiano [55] argued that subjective and objective measures of physical activity correlate poorly because the methods are distinct and not
necessarily because subjective measures are “bad”. Arguably, while PAQs are not appropriate if the aim is to provide accurate estimates of total PAEE or the duration of MVPA, PAQs are feasible if the aim is to rank individuals in physical activity categories [64], and if the main interest concerns the physical activity setting or type.

2.3.3. Methods based on objective recording

Jacobs [69] argued that objective physical activity recording may be of particular value during pregnancy because physical activity habits change over the course of pregnancy. The use of activity monitors can overcome many of the challenges accompanying PAQs, such as misclassification of physical activity level and the challenges associated with cultural differences in responses to questionnaire items [63]. Objective physical activity monitors have progressed from simple recording of the total volume of physical activity (e.g. step counts) to assessment of physical activity intensity levels and time-stamped behaviours [70]. Pedometers, accelerometers and multi-sensory devices are the three main groups of activity monitors used to collect data on habitual physical activity in clinical populations [71]. Few activity monitors have been tested for validity in pregnant populations. To my knowledge, it has been published ten studies designed to validate objective measures of physical activity in pregnancy, of which seven assessed criterion validity [45, 72-77] and three assessed convergent validity [78-80].

The simplest activity monitor is the pedometer, which is normally attached to the hip, and collects data on the number of steps taken. Pedometers are lightweight and easy to administer, and relatively inexpensive, but range in price depending on the level of sophistication [81]. The pedometer responds to vertical hip accelerations and provides estimates of walking activity [24], which may be expressed in terms of steps/day, distance walked or EE [81]. Accordingly, pedometers are most relevant for use in populations were walking is the dominant type of physical activity [24], and may therefore be considered in pregnancy, during which there is an increase in the relative PAEE expended during walking [82]. An apparent weakness is the inability to monitor other types of physical activity, such as cycling, yoga, and sedentary activities.
Compared with pedometers, accelerometers represent a group of more advanced activity monitors. Accelerometers measure acceleration of displacement, and existing devices differ by how many movement planes in which displacement can be measured, i.e. uniaxial devices (usually vertical plan) biaxial devices (vertical and mediolateral or anterior-posterior), and triaxial devices (vertical, anterior-posterior and mediolateral) [83]. The displacement is converted into an electric voltage signal that is proportional to the acceleration [83]. Accelerometers are comparable in size to pedometers, and they are typically worn on the hip[53]. The accelerometer outputs “counts”, which are derived from the force and frequency of the displacements, and pre-set sampling frames, e.g. of 5-second epochs or 1-minute epochs, let the outcome be expressed as counts/minute [24]. Physical activity counts can be translated via regression equations into more meaningful data, and different cut-points (e.g. Troiano, Freedson and Swartz) have been defined to differentiate between physical activity performed at sedentary, light, moderate and vigorous intensity levels. Because several regression equations are used across studies, comparison between studies is challenging [84]. No cut points are equally precise across the entire range of physical activities, since each physical activity type would need specific cut-points [24]. To my knowledge, no published studies have established the validity of accelerometer cut points for different physical activity intensities during pregnancy. However, it has been suggested that the Swartz cut points allow a higher resolution of intensities than the Freedson cut points in populations with low levels of physical activity [85]. Accelerometers can also provide step counts, and analysis of the accuracy of the step count function of the Actigraph accelerometer demonstrated underestimation of steps and relatively poor accuracy compared with piezoelectric pedometers [72]. While accelerometers are minimally invasive and produce relatively precise estimates of physical activity, important drawbacks are the poor sensitivity to light and sedentary activities, and other non-ambulatory activities such as lifting and carrying objects [53].

More recently, the development of multi-sensory activity monitors has allowed combination of multiple physiological inputs with motion detection. Examples are ActiHeart [86], Intelligent Device for Energy Expenditure and Activity (IDEEA) [87] and Sensewear Armband [45]. Since multi-sensory activity monitors combine signals from
multiple sensors, these devices yield more precise measures of PAEE and physical activity intensity levels compared with accelerometry [53].

ActiHeart combines heart rate and accelerometry and has been validated for estimation of PAEE in pregnancy [88]. Studies of user-friendliness indicate that the sensor’s pads adhered poorly, presumably due to sweating [89]. Furthermore, due to heart rate variability, a 10-15 minute walking test must be performed to calibrate the device.

The IDEEA combines five accelerometers and estimates of PAEE during pregnancy are correlated with criterion measures [76]. The device consists of a microprocessor attached to the waist, and five wired sensors attached at the sternum, both anterior thighs and both soles. It uses a complex neural network and pattern recognition to determine activity type as well as specific algorithms to estimate PAEE [90]. The complexity of the IDEEA reduces the user-friendliness and may even interfere with normal activity behaviour.

Different versions of the Sensewear Armband (SWA) exist. The version used in the present thesis, SWA Pro3, combines inputs from a biaxial accelerometer and separate sensors for skin temperature, near-body temperature, heat flux and galvanic skin response [91]. The SWA provides data on total EE/PAEE, steps and duration of different levels of physical activity intensity [71], and it is one of the most accurate devices with respect to estimation of EE across a range of activities [92, 93]. The SWA uses proprietary software to estimate EE, and the prediction of EE is based on data from all sensors using pattern recognition, combined with information about gender, age, height and weight. The possibility to develop and refine algorithms based on pattern recognition represents a potential for more exact prediction of PAEE and MVPA duration for different types of physical activity, and the predictions seem to have improved over time [94]. Unfortunately, the SWA is not waterproof and is therefore not feasible for monitoring swimming and pool gymnastics physical activity.
2.4. Descriptive studies of physical activity in pregnancy/postpartum

2.4.1. Self-reported physical activity

Three review articles [3, 95, 96] summarise observational longitudinal studies of physical activity during pregnancy and postpartum. In the review article by Gaston and Cramp [3] all included studies employed self-reported physical activity. Only four of the 24 studies included in the review by Abbasi and van den Akker [95] and seven of the 30 studies reviewed by Poudevigne and O’Connor included objective measures of physical activity [96]. The existing reviews indicate that physical activity is lower in pregnancy compared to pre-pregnancy and/or after pregnancy, and that physical activity decreases during pregnancy [3, 95, 96]. Comparison of self-reported physical activity types pre-pregnancy and at different trimesters shows that the proportion of women who performed aerobic and muscle exercises was lower in the 1st trimester compared with pre-pregnancy (2.3% vs 5.1%) and fewer women participated in recreational sports (7.4% vs 8.7%) [97]. In contrast, the proportion who reported brisk walking increased from 25.1% before pregnancy to 29.9% in 1st trimester, and the proportion remained constant throughout pregnancy [97]. Results from the Avon Longitudinal study showed that walking was the most frequently reported leisure time physical activity in gestational week 18 (73.7 %), followed by swimming (46.4%) [82]. In contrast, only 2.2% reported jogging and less than 1% reported weight training [82]. There is evidence from the Danish Birth Cohort that physical activity infrastructure and national context impact on physical activity type during pregnancy; in Denmark bicycling is the most frequently reported physical activity during early pregnancy [98].

2.4.2. Objectively recorded physical activity

Few studies of physical activity in pregnancy and postpartum are based on objective data. A pragmatic search yielded five cross-sectional and 12 prospective studies of pregnant women, and, two cross-sectional and two prospective studies of postpartum women. One prospective study covered physical activity in pregnancy and postpartum.
As shown in Table 1, the cross-sectional studies in pregnancy show discrepancies in estimates of physical activity derived by different activity monitors and by different accelerometer cut-points for defining MVPA. Two of the studies reported physical activity outcomes for all trimesters (MVPA minutes/day and steps/day) and these studies indicated a slight increase from 1st to 2nd trimester, before a drop in physical activity in the 3rd trimester [4, 99].
# Table 1: Cross-sectional studies based on objectively recorded physical activity in pregnancy

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<tr>
<th>Study</th>
<th>Sample</th>
<th>N</th>
<th>Activity Monitor</th>
<th>Physical activity outcome as specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hjorth [100]</td>
<td>Women in Ethiopia</td>
<td>304</td>
<td>Actiheart</td>
<td>MVPA mins/day, median (IQR) 70 (50-99)</td>
</tr>
<tr>
<td>Lof [76]</td>
<td>Healthy women</td>
<td>18</td>
<td>IDEEA</td>
<td>MVPA mins/day, median (IQR) 60 (40-80)</td>
</tr>
<tr>
<td>Evenson [4]</td>
<td>Population-based</td>
<td>359</td>
<td>Actigraph</td>
<td>MVPA mins/day, mean (SE) Troiano: 15.5 (1.75) Swartz: 14.8 (1.65)</td>
</tr>
<tr>
<td>Renault [99]</td>
<td>Normal weight and obese women</td>
<td>285</td>
<td>Yamax Digiwalker SW 700/701</td>
<td>GW 13 Steps/day, median (IQR) Normal weight: 7,558 (6,416-9,367) Obese: 6,482 (4,640-8,645)</td>
</tr>
<tr>
<td>Downs [101]</td>
<td>Women in second trimester</td>
<td>50</td>
<td>Yamax Digiwalker SW 701</td>
<td>GW 20 Steps/day &lt;5000: 25% 5,000-7,499: 35% 7,500-9,999: 28% 10,000+: 14%</td>
</tr>
</tbody>
</table>

MVPA=moderate to vigorous physical activity; IQR=interquartile range, SE=standard error

1Troiano accelerometer cut-point; 2Swartz Accelerometer cut-point
Table 2 shows prospective studies based on physical activity data from multiple time points during pregnancy. Most of the studies indicate that physical activity drop from 1st trimester to the 3rd trimester. However, two studies show that physical activity increase initially, before a drop towards the end of pregnancy [102, 103]. The studies that report MVPA as outcome indicate approximately 35-40 MVPA minutes/day in 1st trimester, 34-65 minutes/day in 2nd trimester, and 23-66 minutes/day in the 3rd trimester [5, 43, 103]. Daily MVPA is considerably lower when restricted to MVPA bouts ≥10 minute; 20-32 minutes/day in the 2nd trimester, and 16-27 minutes/day in the 3rd trimester [43, 104]. Studies that report steps/day indicate that women on average walk 7,000-7,300 steps/day in gestational weeks 21-22, while these figures drop to 5,400-6,000 steps/day in gestational weeks 32-33 [101, 102]. In a study of Danish pregnant women, the authors reported that the drop in steps/day was pronounced after GW 29, and the authors speculated that the drop is associated with maternity leave, which commences in GW 29 in Denmark [102].

Compliance with different physical activity guidelines in pregnancy was reported in selected studies. Downs and co-workers [101] reported that 14% met the recommended target (>10,000 steps/day) in gestational week 20. All the prospective studies of guideline compliance demonstrated that the proportion who met the guideline dropped with progression of pregnancy, but the estimates of proportion were highly influenced by the operationalisation of physical activity guideline [43, 104]. For example, employing ≥150 MVPA minutes/week as the recommended target indicated that 95% and 91% met the guideline in gestational week 18 and 35, respectively [43] (Table 4). These figures dropped to 47% and 39%, respectively, after analysing only MVPA accumulated in bouts ≥10 minutes [43]. Including only MVPA in bouts ≥10 minutes makes estimates of MVPA and guideline compliance more comparable with studies based on self-report, which are less sensitive to sporadically shorter bursts of MVPA, e.g. negotiating a flight of stairs.

---

1 Estimates of MVPA mins/week is converted to mins/day; the weekly estimate is divided by seven.
### Table 2 Prospective studies based on objectively recorded physical activity in pregnancy

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>N</th>
<th>Activity monitor</th>
<th>Physical activity outcome as specified</th>
<th>1st trimester (or GW as specified)</th>
<th>2nd trimester (or GW as specified)</th>
<th>3rd trimester (or GW as specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huberty</td>
<td>Primarily healthy White</td>
<td>85</td>
<td>Fitbit Flex</td>
<td>GW 16-18, mean (sd): 39.0 (24.7-51.9)</td>
<td>GW 8-16 to GW 36-40, Moderate: 3.11 (2.0)</td>
<td>GW 27-28, Vigorous: 3.04 (2.4)</td>
<td>GW 35-36, Steps/day: 4,138 (1,713)</td>
</tr>
<tr>
<td>Hayes [5]</td>
<td>Ethnic diverse with BMI ≥30 kg/m²</td>
<td>183</td>
<td>Actigraph</td>
<td>GW 16-18: MVPA mins/day, median (IQR): 39.0 (24.7-51.9)</td>
<td>GW 16-18: MVPA mins/day, median (IQR): 34.5 (23.9-43.5)</td>
<td>GW 15-36: MVPA mins/day, median (IQR): 37.3 (18.0-38.0)</td>
<td></td>
</tr>
<tr>
<td>Di Fabio</td>
<td>Primarily healthy White</td>
<td>46</td>
<td>SenseWear Mini</td>
<td>GW 10-12: ≥150 Moderate PA mins/day: 68.3%</td>
<td>GW 10-12: Geometry: 7,200</td>
<td>GW 20-22: ≥150 Moderate PA mins/day: 57.3%</td>
<td></td>
</tr>
<tr>
<td>Renault</td>
<td>Normal-weight and obese women</td>
<td>140</td>
<td>Yamax Digiwalker SW700/1</td>
<td>GW 13: 7,200</td>
<td>GW 13: 7,200</td>
<td>GW 13: 6,000</td>
<td></td>
</tr>
<tr>
<td>Harrison</td>
<td>Ethnic women at risk of GDM</td>
<td>107</td>
<td>Yamax Digiwalker SW700</td>
<td>GW 13: Steps/day, mean (sd): 5,467 (2,951)</td>
<td>GW 13: Steps/day, mean (sd): 4,096 (2,438)</td>
<td>GW 13: Steps/day, mean (sd): 4,096 (2,438)</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Sample</td>
<td>N</td>
<td>Activity monitor</td>
<td>Physical activity outcome as specified</td>
<td>Physical activity outcome as specified</td>
<td>Physical activity outcome as specified</td>
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</tr>
<tr>
<td></td>
<td>Sample</td>
<td>N</td>
<td>Activity monitor</td>
<td>1st trimester (GW as specified)</td>
<td>2nd trimester (GW as specified)</td>
<td>3rd trimester (GW as specified)</td>
<td></td>
</tr>
<tr>
<td>Smith [43]</td>
<td>Primarily health White women</td>
<td>89</td>
<td>Sensewear Armband Mini</td>
<td>GW 18 Min/week, median (IQR)</td>
<td>GW 35 Min/week, median (IQR)</td>
<td>GW 35 Min/week, median (IQR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MVPA: 455 (351-585)</td>
<td>MVPA: 468 (240-644)</td>
<td>MVPA: 468 (240-644)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MVPA bouts*: 141 (79-199)</td>
<td>MVPA bouts*: 118 (31-257)</td>
<td>MVPA bouts*: 118 (31-257)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MVPA bouts**: 145 (86-221)</td>
<td>MVPA bouts**: 125 (32-268)</td>
<td>MVPA bouts**: 125 (32-268)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥150 MVPA: 95%</td>
<td>≥150 MVPA: 91%</td>
<td>≥150 MVPA: 91%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥150 MVPA bouts*: 47%</td>
<td>≥150 MVPA bouts*: 39%</td>
<td>≥150 MVPA bouts*: 39%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥150 MVPA bouts**: 49%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DiNallo [74]</td>
<td>Healthy middle class White women</td>
<td>36</td>
<td>RT3</td>
<td>GW 20 ≥150 kcal/day</td>
<td>GW 32 ≥150 kcal/day</td>
<td>GW 32 ≥150 kcal/day</td>
<td></td>
</tr>
<tr>
<td>Löf [108]</td>
<td>Healthy non-smoking women planning pregnancy</td>
<td>23</td>
<td>Doubly labelled water</td>
<td>Before conception PAL, mean (sd): 1.95 (0.24)</td>
<td>Before conception PAL, mean (sd): 1.89 (0.17)</td>
<td>Before conception PAL, mean (sd): 1.72 (0.17)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Indirect calorimetry -Polar HR monitor</td>
<td>PAL, mean (sd): 1.95 (0.24)</td>
<td>PAL, mean (sd): 1.89 (0.17)</td>
<td>PAL, mean (sd): 1.72 (0.17)</td>
<td></td>
</tr>
</tbody>
</table>

GW=gestational week; MVPA=moderate-to-vigorous intensity physical activity; PAL=physical activity level; IQR=interquartile range; sd=standard deviation

*aMVPA in bouts ≥10 minutes with 2-minute interruptions allowed; **MVPA in bouts ≥10 minutes with 2-minute interruptions allowed, and vigorous-intensity counted as two minutes
Both prospective [102] and cross-sectional studies of pregnant women indicated lower levels of objectively recorded physical activity or steps/day during weekends compared to week days [99].

Table 3 and Table 4 summarise cross-sectional and prospective studies of physical activity postpartum. Only one study followed women from pregnancy to postpartum, and the results showed that MVPA minutes/day increased from GW 38 to postpartum week 40 [109] (Table 4).

Table 3 Cross-sectional studies based on objectively recorded physical activity in postpartum

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>N</th>
<th>Activity monitor</th>
<th>Physical activity outcome as specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ainsworth</td>
<td>Latina overweight/obese women</td>
<td>139</td>
<td>-Actigraph</td>
<td>Postpartum week mean (sd): 13.6(7.7)</td>
</tr>
<tr>
<td>[85]</td>
<td></td>
<td></td>
<td>-Omron</td>
<td>mins/day, mean(sd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Moderate lifestyle¹: 78.3(39.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Moderate walking²: 16.7(14.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥10,000 steps/day: 2.9%</td>
</tr>
<tr>
<td>Behrens</td>
<td>Hispanic and White teenagers</td>
<td>21</td>
<td>-Accusplit AE</td>
<td>Postpartum week mean (sd): 28.6 (16.6)</td>
</tr>
<tr>
<td>[110]</td>
<td>(16-19 years)</td>
<td></td>
<td>120</td>
<td>Steps/day, mean(sd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Overall: 8,101</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hispanic: 8,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Caucasian: 8,040</td>
</tr>
</tbody>
</table>

sd=standard deviation

Furthermore, studies based on physical activity recorded within the first six months postpartum and again 12-18 months postpartum, suggest only a minimal increase in the duration of MVPA over this period [111, 112] (Table 4). Compliance with physical activity guidelines postpartum was reported in one study, which showed that 3% met the physical activity target (≥10,000 steps/day) at 14 weeks postpartum [85].
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>N</th>
<th>Activity monitor</th>
<th>Physical activity outcome as specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melzer [109]</td>
<td>Healthy women</td>
<td>71</td>
<td>Actiheart</td>
<td>Postpartum week 40 (mean) mins/day, mean (sd)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3≤METs&lt;6: 55.7 (34.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>METs≥6: 1.3 (3.5)</td>
</tr>
<tr>
<td>Evenson [111]</td>
<td>Overweight or obese women, Ethnic diverse</td>
<td>132</td>
<td>Actical B1 or BC</td>
<td>Postpartum month 2-7 MVPA mins/day, median (IQR): 6.9 (2.3-11.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Postpartum month 12-17 MVPA mins/day, median (IQR): 8.8 (4.1-17.9)</td>
</tr>
<tr>
<td>Evenson [112]</td>
<td>Predominantly White middle class</td>
<td>181</td>
<td>ActiGraph model 7164</td>
<td>Postpartum month 3 Moderate PA mins/day, median (IQR): Troiano: 13 (9-21) Swartz: 274 (233-309)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>204</td>
<td></td>
<td>Postpartum month 12 Moderate PA mins/day, median (IQR): Troiano: 17 (10-25) Swartz: 279 (239-328)</td>
</tr>
</tbody>
</table>

GW=gestational week; IQR=interquartile range; sd=standard deviation; PA=physical activity; MVPA=moderate to vigorous physical activity.

2.5. Physical activity behaviour in a socio-ecological framework

The present thesis is based on a socio-ecological understanding of physical activity as a health behaviour. The socio-ecological framework can incorporate multiple models, theories and constructs relevant in studies physical activity behaviour and thereby facilitate organization of multiple predictive or explanatory variables [15, 113]. This flexibility may therefore prove useful in studies of physical activity behaviour during pregnancy in multi-ethnic neighbourhoods. Figure 1 illustrates the socio-ecological assumption that factors at multiple levels impact on physical activity [114, 115]. According to Stokols [116], social ecology represents an overarching framework for understanding interrelations among diverse personal and environmental factors in human health. The integration of environmental factors makes an important distinction between socio-ecological models and behavioural models that exclusively address intrapersonal and social factors [15]. Figure 1 also illustrates that physical activity can be categorised into the four behavioural domains active recreation, active transport, household activities and occupational activities.
**Figure 1 Ecological model of physical activity behaviour**

Sallis and co-workers [15] proposed four principles for application of socio-ecological models:

a) Health behaviour is subject to multiple influences at different levels. These levels include intrapersonal (biological, psychological), interpersonal (social, cultural), organizational, community and public policy (e.g. neighbourhood factors) levels. Some concepts apply to multiple levels. For example, the physical environment of the neighbourhood cut across the community and public policy level.

b) Behavioural influences interact across levels. For example, the association between easy access to recreational areas in the neighbourhood and physical activity may be different for individuals with high and low socioeconomic position.

c) Models are developed for specific behaviours and include the most relevant influences at each level. For example, developing walking trails and green areas may stimulate walking, but is not likely to influence alcohol drinking behaviour.

d) Multilevel interventions are assumed to be most effective in changing health behaviour. For example, a single-level intervention to promote physical activity consisting of motivational interviews with pregnant women (intrapersonal) would be more effective if interventions at other levels were carried out simultaneously; e.g., if local walking groups were established (interpersonal) and if local walking trails were lit-up and maintained (community).

2.5.1. Ethnicity

According to Bhopal, ethnicity is a multifaceted quality that refers to groups that individuals themselves perceive, or are perceived by others, to belong to as a result of shared characteristics, including geographical/ancestral origin with emphasis on cultural traditions and languages [117]. Accordingly, defining ethnicity can be thought of as part of an individual’s process of self-identification, but, incongruent definitions, suggested by others, can result in stereotyping [118]. In either case, a key feature is the contrast made between the identified group and another group [119]. The concept ethnicity overlap with the concept culture, but, while culture conceptualises symbolic generalities about social groups, ethnicity concerns the matter of belonging [120].
Ethnic identification is a dynamic process, and at odds with the fluid nature of this process stands the more rigid conceptualisation of ethnic groups characteristic for research [117, 120]. Ethnic categories typically employed in research stem from censuses intended for administrative tasks, and these categories were never validated for research purposes [121]. Studies of ethnic differences in physical activity during pregnancy, predominately conducted in the US, have employed crude ethnic categories, such as Hispanics, Latino, non-Hispanic Black and non-Hispanic White. To make phenomena accessible for investigation, some form of reduction is avoidable, but the operationalisation (i.e. reduction) of the concept ethnicity must reflect facets that are relevant for the research aim [117].

The primary aim of descriptive research is to demonstrate distribution of health, disease and lifestyle factors in a population, and highlight differences between subgroups of the population. This is a balancing exercise, during which the researcher must combine the need to make visible systematic differences in lifestyle in order to reduce health inequalities in society, and, simultaneously the researches must not reinforce stereotypes and thereby increase the burden on marginalised groups in society.

The aim of predictive research is identification of high-risk groups and individuals, e.g. with respect to insufficient physical activity, to aid planning of targeted interventions. It is probably less clear how categories in predictive research should be formed, a priori, as the model building will unearth the type of information and categories that yield the best future predictions of physical activity [122]. However, it is likely that employing crude and heterogeneous categories will not yield accurate predictions at the individual level [123].

In etiologic research, the aim is to understand and explain behavioural mechanisms, e.g. why pregnant women of Pakistani origin spend little time performing MVPA. In order to fill this knowledge gap, information about ethnic origin, per se, will not suffice. Crude ethnic groups may be rather irrelevant, while more or less modifiable factors such as socioeconomic position, cultural aspects and the influence of the environmental setting of physical activity must be analysed (e.g. level of integration, gender roles, language skills, labour market participation, social networks, cultural norms, neighbourhoods). Etiologic research must reflect that differences in physical activity exist not only across ethnic
groups but also within them [6]. One analytic approach to gain knowledge about the heterogeneity within ethnic groups with respect to physical activity behaviour is exploring mediating factors. Different factors, such as socioeconomic position and acculturation have been proposed as fundamental explanatory factors or mediators of ethnic differences: The absence of ethnic differences in physical activity in cohorts characterised by small socioeconomic differences suggests that socioeconomic factors are important mediators of ethnic differences [124]. The importance of acculturation was demonstrated in a study of US Latino women, which showed that a larger proportion met the physical activity guideline among the women who preferred English language compared to those who preferred Spanish [125].

Another approach to gain more insight into ethnic differences is exploring factors that moderate the association between ethnic group and physical activity. For example, if socioeconomic position modifies the association between ethnicity and physical activity. In Western countries, socioeconomic position is positively associated with physical activity level, but this gradient is not necessarily universal. A study of Pakistani women in Punjab suggested that women with low socioeconomic position perceived physical strength as more important for a healthy life than women with high socioeconomic position, who perceived mental strength as more important for good health [126]. It cannot be inferred from this finding that South Asian women with low socioeconomic position are more active than those with high socioeconomic position, nor can it be inferred that this applies to Women of South Asian origin who reside in Western countries. Nevertheless, the finding indicates that socioeconomic position may be a potential moderator of the association between ethnicity and physical activity.

2.5.2. Neighbourhood recreational areas

Relevance for studies of physical activity

Proximal behavioural determinants, such as attitude, self-efficacy and intention, play key roles in explaining physical activity behaviour. However, a pregnant woman makes decisions concerning physical activity in a context; thus, a neighbourhood that makes it easier to incorporate physical activity in daily life may result in more physical activity. A
wide range of barriers to physical activity in pregnancy and postpartum are perceived to be outside women’s control (environment, work, family), and strategies to integrate physical activity in daily life are recommended [127]. Structural initiatives to secure good access to recreational areas in the neighbourhood may contribute towards this goal by reducing some of the environmental barriers to physical activity.

The physical neighbourhood environment is referred to as a behaviour setting in the socio-ecological framework [15], reflecting that it provides a context and a location in which physical activity can be performed. The rationale for studying the physical neighbourhood as a setting for physical activity is to describe and assess access to opportunities for physical activity, which is required to inform and guide public health strategies to increase physical activity and reduce disparities in opportunities to live physically active lives [128]. Empirical evidence suggests that physical activity is one of the important mediators of the effect of urban green space on health and obesity [129, 130]. Recent studies of pregnant women also suggest that physical activity is an important mediator of the association between access to recreational areas and maternal physical and mental health [131].

According to the Ottawa Charter, health promotion should include structural strategies (e.g. initiatives to improve access to recreational areas) as well as individual behaviour strategies [132]. Initiatives to secure good access to recreational areas are structural initiatives that can potentially increase physical activity level across all sub-groups of neighbourhood residents [133]. Since access to recreational areas influence walking behaviour, structural initiatives to improve access to recreational areas may be of particular importance in pregnancy, during which the frequency of many different types of physical activity decreases while walking levels are maintained [82]. It has been reported that 74% of all pregnant women spend some time on brisk walking every week [82]. Thus, compared with the non-pregnant state, a larger share of MVPA is accumulated by brisk walking during pregnancy [82].

Studies of non-pregnant women show that neighbourhood parks and natural green environments are associated with more total physical activity [134-140]. While access to these areas may be less important in initiating walking, their presence and proximity may
facilitate maintenance of recreational walking over time [141]. Compared with studies conducted in the US, studies of European neighbourhoods have been less conclusive in terms of the positive association between access to recreational areas and physical activity, and it has been suggested that the predominant use of perceived access to recreational areas, as opposed to objective measures, may explain this [137].

No identified studies of pregnant women included an analysis of the association between perceived neighbourhood environment and PA, but, a limited number of studies included descriptive reports of environmental barriers to physical activity [142, 143]. In one study, data on park access was collected by observational methods, but no significant association with self-reported physical activity was observed [144]. The authors suggested that the lack of association could result from analysing outdoor physical activity types that could not be performed in the neighbourhood, e.g. swimming and fast dancing, and that assessment of the association with walking would have been more appropriate [144].

**Methodological considerations**

In line with the socio-ecological framework, analysis of the influence of neighbourhood factors on physical activity behaviour must reflect that multiple factors work together across levels [15]. Thus, analysis should explore interactions between neighbourhood level factors and individual level factors. For example, it is relevant to study if access to recreational areas modifies the association between self-efficacy and MVPA, and, if the association between access to recreational areas and MVPA is modified by socioeconomic position or ethnic group.

In most studies of the physical environment, three categories of environmental measures are used: (1) Perceptions of access to various elements of recreation and transportation environments (questionnaires); (2) quantification of environmental attributes based on systematic observations, or, (3) environmental data from Geographic Information Systems (GIS) [133, 145].

A major challenge in analysing the association between perceived environmental features and physical activity is that two individuals living in the same neighbourhood may perceive access to opportunities for physical activity very differently [145]. This underlines
that perceptions of the neighbourhood environment are only indirectly associated with objectively measured features of the environment [145].

GIS can be used to incorporate multiple environmental measures that are relevant for physical activity [128]. GIS organize data from specific digital maps in layers, with each layer containing information on specific features (e.g. green areas larger than 5,000 m², bike and walking paths, distance from residential addresses to access points) [128]. Currently, there is limited evidence for defining accessibility in terms of distance to a recreational destination for a pregnant population. Nevertheless, decisions about buffer size must be based on the abundance or paucity of destinations and the physical activity type of interest [146]. In a study that combined accelerometer and global position systems technology (GPS) data in a city in the US it was demonstrated that a larger proportion of MVPA was accumulated in locations that were 125-1,666 meters from home, compared with areas that were closer and further away [147]. In US studies of non-pregnant individuals, it has been assumed that 400 meters is the distance the average American is willing to walk rather than drive. To reflect that different sub-groups of the population have different walking capacities, a study of the association between physical activity and neighbourhood walkability in older adults employed a 200 meter street buffer as it was assumed that walking capacity decreased with age [148]. Against this background, a definition of easy access to recreational areas conditional upon an eligible route distance (network buffer) that is within 200 meters from the residence, may be reasonable also in studies of pregnant women, since many pregnant women seem to conserve PAEE to compensate for the increased resting metabolism during pregnancy [51].

2.5.3. Prognostic modelling of physical activity outcome

Prognostic models are tools that combine multiple predictors to obtain an estimate of the probability of a specified future outcome [149], and they are distinctively different from etiological models underpinned by causal theory [150]. In fact, prognostic models do not rest on causal assumptions [151]. Prognostic models are more commonly applied to predict disease outcomes, but may also predict lifestyle outcomes [149]. The primary goal of the prognostic modelling of a physical activity outcome is to identify the combination
of demographic, psychosocial and physiological variables that yield the most accurate prediction of future physical activity level.

Empirical evidence has shown that a simple one-item tool, employed in screening for physical inactivity among ethnic minority women (“Are you now doing physical activity, like walking, jogging, or dancing, more than 3 days a week for more than 30 minutes each time”) before inclusion into a physical activity intervention, falsely categorised many active women (85%) as inactive [152]. This demonstrates that accurate prognostic tools are required to make interventions cost-effective and for reaching the women who may benefit the most [152]. Valid prognostic models of pregnant women’s physical activity level can potentially aid identification of individuals and groups at increased risk of not meeting the recommended levels of physical activity. Information about high-risk groups can inform the decision-making concerning the need for interventions targeting certain groups. Targeting, which imply that subgroups are assigned to specific interventions based on key characteristics, may enhance intervention efficacy and save costs by matching intervention components and participant requirements [153]. There are very few examples of prognostic models developed to predict physical activity in non-pregnant populations [154], and to our knowledge, no previous studies have presented a prognostic model for insufficient physical activity in pregnancy.

To make prognostic models feasible for the clinical setting, it is recommended that predictors should be relevant (e.g. sufficient distribution of values) and that prognostic information can be easily obtained, both in monetary terms and with respect to the burden placed on the patient [122]. Furthermore, selection of predictors must be guided by previous studies of physical activity determinants. Determinants of physical activity are variables that are correlated with physical activity, and they may or may not be causally related [155]. While some determinants are modifiable (e.g. perceptions and social support), others cannot be modified (e.g. age and genetics). Expert knowledge is required to identify a large range of potential candidate predictors and to arrive at purposeful variable definitions, while the process of eliminating less predictive variables is partly data-driven [156]. While the data-driven steps of the model-building are described in the Methods chapter (paragraph 4.4.3), a review of empirical studies that informed the
identification of candidate predictors of non-compliance with the physical activity guideline in pregnancy (presented in paper II) are presented below.

2.5.4. Physical activity determinants and barriers in pregnancy

The first review article of determinants of physical activity in pregnancy included no studies based on objectively recorded physical activity [3], and only one of the observational studies reviewed by Thompson and co-workers [17] employed objective measures of physical activity. By a pragmatic search eight studies of physical activity determinants based on objectively recorded physical activity were identified: Three cross-sectional studies (Table 1) included determinants located in the intrapersonal domain, but none in interpersonal or environmental domain [4, 99, 100]. Four of the prospective studies (Table 2) included an analysis of physical activity determinants in the intrapersonal domain [5, 102, 103, 105], while interpersonal and environmental factors were not addressed. However, one study descriptively reported frequency of barriers categorised across all domains [106]. Past studies have shown inconsistent or no association between physical activity and several demographic and lifestyle factors (maternal age, marital status, employment level, occupational level, smoking), and these are not included in the summary below.

Demographic, lifestyle and behavioural factors at the intrapersonal level

The strong and consistent association between being white and being physically active during pregnancy reported by Gaston and Cramp [3], has been replicated in more recent studies based on self-reported physical activity [157] and objectively recorded physical activity [4, 5]. Most studies of physical activity among pregnant ethnic minority women in Western countries have been conducted in the US, thus, the ethnic White majority population has primarily been compared with ethnic groups referred to as Black or Hispanic women.

The positive association between higher education and physical activity reported by Gaston and Cramp [3] has also been observed in several recent studies based on self-reported physical activity [157-160]. However, an inverse association was observed in a
study based on self-reported physical activity [82] and in a study based on objectively recorded physical activity [5].

Gaston and Cramp reported that not having other children in the home was consistently associated with higher levels of self-reported physical activity [3]. More recent studies based on self-reported physical activity support this finding [82, 161]. These findings are in conflict with studies based on objectively recorded data. McParlin and co-workers [103] observed that parous women recorded significantly more light physical activity than nulliparous women [103]. In a study based on accelerometer data in early pregnancy, having at least one child was associated with spending more time being physically active (i.e. >100 accelerometer counts per minute) [5].

The consistent positive association between pre-pregnancy physical activity and physical activity during pregnancy reported by Gaston and Cramp [3] has been reported in more recent studies [159, 161, 162]. However, all studies were based on self-reported physical activity, and the finding is not supported by studies combining self-reported pre-pregnancy physical activity and objectively recorded physical activity during pregnancy [106].

Gaston and Cramp [3] reported that the association between body weight/BMI and self-reported physical activity was inconclusive. In contrast, studies based on objectively recorded physical activity demonstrate a consistent inverse association between body weight/BMI and physical activity [99, 100, 102, 105]. Studies of barriers to leisure time physical activity reported by pregnant women also support the importance of pregnancy-related limitations and symptoms (e.g. growing body, nausea, back/pelvic pain, tiredness) [163]. Other intrapersonal barriers were time constraints, lack of motivation and safety concerns [163].

The two review papers by Gaston and Cramp [3] and Thompson and co-workers [17] demonstrated that the majority of factors derived from behavioural theories were located at the intrapersonal level, and intention and self-efficacy were described as significantly associated with physical activity [3, 17].
Behavioural factors at the interpersonal level

Haakstad and co-workers [162] observed that social modelling (i.e. exercise habits of parents/siblings) in childhood was associated with self-reported physical activity in the 3rd trimester, while the exercise habits of friends in adulthood was not associated. In contrast, Leppanen and co-workers [159] reported that the physical activity level of the spouse was positively associated with self-reported physical activity. Frequently reported interpersonal barriers to leisure time physical activity are lack of advice and lack of social support [163].

Behavioural factors at the neighbourhood/environmental level

At present, there is scant evidence that factors at the neighbourhood level impact on physical activity during pregnancy. Studies of environmental factors are predominantly descriptive, and limited to perceptions of barriers [106, 142, 164]. Findings from qualitative studies indicate that perceived neighbourhood safety [127, 165, 166] and perceived availability of parks [166] influence pregnant women’s physical activity behaviour. One single study reported results of an analysis of the association between observational data on park access and physical activity, but no association was observed [144].
3. Aims and objectives

3.1. Project aims

The overall aim of this thesis was to contribute to the field of health promotion during pregnancy and postpartum. More precisely, the aims were to provide descriptive data on habitual physical activity across ethnic groups based on objective recording during pregnancy/postpartum, to analyse factors that can enhance our understanding of habitual physical activity behaviour, and to determine factors that can facilitate early identification of individuals with elevated risk for not meeting the recommended levels of physical activity.

3.2. Research objectives

- To explore the association between ethnic background and MVPA hours/day, number of walking steps, and related correlates in early pregnancy (paper I)
- To describe MVPA minutes/week in bouts ≥10 minutes in mid-pregnancy, and, to estimate the proportion who met the physical activity recommendation (i.e. ≥150 MVPA minutes/week performed in bouts ≥10 minutes (paper II)
- To assess the accuracy of variables collected in early pregnancy to predict non-compliance with the same physical activity recommendation in mid-pregnancy (paper II)
- To analyse changes in MVPA accumulated in bouts ≥10 minutes during pregnancy and early postpartum, and explore ethnic differences (paper III)
- To examine associations between objective and perceived access to recreational areas (paper III)
- To examine associations between MVPA and objective and perceived access to recreational areas, respectively, and potential effect modification by time point, ethnicity and socioeconomic position (paper III)
4. Material and methods

4.1. Source population and sample selection

The STORK-Groruddalen cohort

STORK-G cohort study is a longitudinal population-based study of pregnant women living in three multi-ethnic city districts of Oslo. At the initiation of the study, the three districts covered a population of approximately 82,500. According to routine data 75-85% of pregnant residents attended the public child health clinics in the city districts for antenatal care. Local general practitioners in the three city districts referred women in early pregnancy to the child health clinics. In addition, information material in Norwegian, Arabic, English, Sorani, Somali, Tamil, Turkish, Urdu and Vietnamese were distributed to promote the study at pharmacies, general practitioners’ centres and institutions for Norwegian classes, public service centres, shopping centres and mosques/temples. A convenience sampling technique was employed [167], consecutively asking all women who met the inclusion criteria to participate. Participants were included from 6th May 2008 to 15th May 2010.

Eligible women planned birth at either of two study hospitals, were able to communicate orally in Norwegian, Arabic, English, Sorani, Somali, Tamil, Turkish, Urdu, Vietnamese, and, were in gestational week ≤20. To secure sufficient number of Pakistani and Somali women it was decided, six months after study initiation, to extend the eligibility criterion on gestational age from gestational week from ≤20 to ≤24 for women in these two groups. Exclusion criteria were pre-gestational diabetes or other conditions necessitating intensive hospital follow-up during pregnancy. Before inclusion, women were given oral and written information at the Child health clinics, and all participants provided informed written consent.

The Interpreting and Translating Services (City Services Department, Oslo) translated all questionnaires. Two translators collaborated in the translation of questionnaires for each language. For each language, a bilingual health professional assessed and approved the translated questionnaires. Due to limited resources, the translated version could not be
validated by formal procedures. The questionnaires included items designed for the STORK-G as well as previously validated questions.

Cohort and study sample details

The source population consisted of 1,918 pregnant women attending the Child health clinics for antenatal care during the inclusion period. In total, 1,114 were eligible for inclusion, while 823 (74% of invited) consented to participation [20] (Figure 2). At inclusion, the cohort was representative for women attending the child health clinics with respect to ethnicity and age [20].

Study designs and samples for papers I-III

Paper I: A cross-sectional analysis of physical activity in early pregnancy (visit 1). The study sample consisted of 678 women (82.4% of visit 1 attenders) with ≥1 day of valid SWA data recorded at visit 1.

Paper II: A prospective analysis of physical activity in mid-pregnancy (visit 2). The study sample consisted of 555 women with ≥2 days of valid SWA recording at visit 2 (67.4% of visit 1 attenders).

Paper III: A longitudinal analysis of physical activity in pregnancy and postpartum (visits 1-3). The study sample consisted of 1,467 observations from 709 women with ≥2 days of valid SWA recording from at least one of the three visits.

4.2. Data collection

Specially trained midwives at the local child health clinics in the three study city districts (Stovner, Bjerke and Grorud) collected the data used in this thesis. Data was collected at three visits: visit 1 (mean gestational week 15), visit 2 (mean gestational week 28) and visit 3 (mean postpartum week 14). The data analysed in the present thesis encompasses objectively recorded physical activity, anthropometric measurements and questionnaire data collected during face-to-face interviews. During interviews, the midwives had access
Figure 2 Details on study samples and drop out
to questionnaires in all the nine languages listed, and professional interpreters assisted
during interviews if needed. The midwives were trained to perform the interviews
according to a detailed protocol to ensure standardisation.

4.3. Data material

Objectively recorded physical activity data was collected at all visits, as were data on
gestational week and season of physical activity recording. The remaining variables
analysed in the present thesis were collected at visit 1.

Objectively recorded moderate-to-vigorous intensity physical activity and step counts

MVPA (≥3 METs) and step counts were objectively recorded with the multi-sensor
device SenseWear™ Pro3 Armband (SWA) (BodyMedia Inc., Pittsburgh, Pennsylvania,
USA) [45]. Women were asked to wear the SWA across the right triceps brachii
continuously for 4-7 days following each visit, and remove it only for water activities. We
downloaded raw data integrated into 60-second epochs with the manufacturer’s software
(SenseWear™ Professional Research Software Version 6.1, BodyMedia Inc). A valid day
was defined as ≥19.2 hours SWA wear time.

There exist no studies documenting the validity of the MVPA estimates derived by the
SWA Pro3 (used in the present thesis) during pregnancy. However, the validity of physical
activity estimates derived by the SWA Pro2 and the SWA Mini during pregnancy has been
assessed: The SWA Pro2 version underestimated EE by 9% [45], and the error in the EE
estimates derived by the SWA Mini ranged between 8-45% across a range of activities
[77]. While the SWA Pro3 and Pro2 differ with respect to some properties, the software
and algorithms (SenseWear Professional Research Software version 6.1; BodyMedia Inc)
by which the raw data were analysed in the present thesis correspond with the software
employed in the validation study of the SWA Pro2 [45]. Comparison of SWA Pro3 and
SWA Mini have been performed in non-pregnant samples. In semi-structured activities,
assessment against indirect calorimetry (Oxycon Mobile 5.0) showed that the SWA Pro3
and SWA Mini overestimated EE by 3.9% and 0.9%, respectively, but differences were
non-significant [168]. The SWA Pro3 overestimated EE with increasing average values
relative to indirect calorimetry [168]. With respect to EE accumulated while performing
MVPA, the specificity of SWA Pro3 was 1.00 and the sensitivity 0.78 and in agreement with the SWA Mini [168]. In free-living activities total EE derived by SWA Pro3 was on average 4% lower (112 kcal·d⁻¹) compared with doubly labelled water, while the corresponding figure for SWA Mini was <0.1% (22 kcal·d⁻¹) [169]. SWA Pro3 did not differ from SWA Mini with respect to estimates of EE during walking [170].

The validity of the step count estimates derived by the SWA version used in the present thesis has been assessed in patients with cystic fibrosis and chronic obstructive pulmonary disease, but not in pregnant women; The SWA underestimates step counts compared with manual counts (video observation) during fast and slow walking [171]. Dwyer and co-workers found a significant strong correlation between SWA step count estimates and estimates derived by manual counting (r=0.66), but the SWA underestimates step counts by seven steps/minute (95% CI 5-9) [172].

**Gestational and postpartum week of physical activity recording**

Gestational week of SWA monitoring following visit 1 and 2 was estimated using the self-reported first day in the last menstrual period. Postpartum week was estimated using the offspring’s date of birth at the start of physical activity recording following visit 3.

**Season of physical activity recording**

Season referred to the season the SWA was employed for physical activity recording. We extracted the month of the first day with valid SWA data at each visit, and categorised months as spring (March-May), summer (June-August), autumn (September-November) and winter (December-February).

**Maternal age**

Maternal age referred to the age at the day of study inclusion. Maternal date of birth was cross-checked with the Norwegian population register [173].
Ethnicity

Ethnicity was researcher determined, and defined by the participant’s country of birth or her mother’s country of birth if her mother was born outside Europe and North America [174].

Socioeconomic parameters

Educational level was defined as highest level of completed education. The educational categories were <7 years of schooling, primary school (7-9 years), 1-2 years’ upper secondary school (10-11 years), 3-year upper secondary school (12 years), maximum 4 years at district college/university (Bachelor’s degree), minimum 4 years at university/university college (Master’s degree, PhD) [Appendix 1].

Occupation was recorded and coded according to the International Standard Classification of Occupations from 1988 (ISCO-88) [175]. The hierarchical structure of ISCO-88 consists of 10 major groups by which occupations are organised according to skill level and skill specialization (armed forces/unspecified, elementary occupations, machine operators/assemblers, craft/trade workers, agricultural/forestry/fishery workers, service/sales workers, clerks, technicians and associate professionals, professionals, legislators/managers/senior officials) [Appendix 1]. In addition, a study-specific homemaker category was added. A project researcher double-checked all occupational codes [173].

Parity

Data on parity was reported as the number of previous births/stillbirths after gestational week 22.

Self-reported pre-pregnancy physical activity

The sub-scale for self-reported physical activity three months pre-pregnancy was a modified version of the original and validated physical activity scale from the Norwegian Mother and Child Cohort Study (MoBa) [57]. The duration of each activity was not available for the full MoBa cohort, and the median duration of activities based on a sub-
sample was employed to impute the duration of each activity [57]. The validation study of
the original MoBa scale showed that self-reported recreational activities were significantly
correlated with the accelerometer estimate of vigorous physical activity (≥6 METs), but
the correlation coefficient was modest (r=0.32) [57]. In the modified STORK-G scale
employed in the present thesis, both duration and frequency of activities were collected,
and the items used to measure physical activity referred to running/jogging, bicycling,
aerobic classes, dancing, ball sports, swimming and brisk walking/skiing [176] [Appendix
3]. The questionnaire response categories for frequency of physical activity types were
adapted before calculation [Appendix 3]: never=0, 1-3 sessions/month=0.5, 1
session/week=1, 2 sessions/week=2, 3-6 sessions/week=4.5, daily=7. For each physical
activity type, activity duration was multiplied by the number of sessions per week to
estimate minutes/week.

**Physically active friends**

Physically active friends was a measure of the theoretical construct descriptive norm,
which is defined as beliefs about whether most other people perform a particular
behaviour (e.g. physical activity) [177]. It was measured using a three-item scale that was a
modification of the friends and family scale developed by Okun and colleagues [178]. The
items measured perceptions of how many friends, same-aged friends and same-aged
female friends who were physically active ≥3x/week. Each item was scored on a 5-point
Likert Scale (0=none, 5=all) [Appendix 3].

**Perceived preventive effect of physical activity**

Perceived preventive effect of PA was assessed with reference to nine items
(cardiovascular, musculoskeletal, type 2 diabetes, cancer, hypertension, mental illness,
overweight/obesity, abdominal/intestinal disease, and, asthma/allergies) [179]. Response
categories were “don’t know”, “no effect”, “little effect” and “large effect”.

**Perceived access to recreational areas**

Perceived access to recreational areas was assessed by items included in neighbourhood
sub-scales 23 and 24 in the questionnaire [Appendix 3]. Four items deemed to be relevant
measures of access to recreational areas were modifications of items used in the Neighbourhood Environment Walkability Survey [180] and the Physical Activity Neighbourhood Environment Survey [181]. Item A assessed perceived time to walk from home to recreational areas on a 6-point Likert scale (1=1-5 min; 2=6-10 min; 3=11-20 min; 4=21-30 min; 5=>30 min; 6=don’t know) [180]. Items B-D used a 4-point Likert scale ranging from 1 (totally disagree) to 4 (totally agree). Item B assessed access to walking or cycling paths [180], item C assessed access to places/facilities appropriate for physical activity [181], and Item D assessed access to safe and adequately lit locations for walking [180, 181].

**Objective access to recreational areas in the neighbourhoods**

Objective access to recreational areas was measured at the neighbourhood level, expressed as the percentage of all neighbourhood residents with good access to recreational areas. The data was supplied by Statistics Norway and merged with the STORK-G data file.

Neighbourhoods were defined by postal codes recognized in 2008 by the national postal service (Posten Norge AS), which corresponded with the STORK-G data collection period. Mean (SD) population size per neighbourhood was 1,430 (721) residents. GIS-derived data was available for postal codes overlapping with the three study districts.

Analysts at Statistics Norway used ArcGis version 10.2.1 (ESRI, Redlands, CA, USA) to extract geographical coordinates for all postal code residential addresses, travel routes and recreational area access points to estimate the shortest distance between residential address and access point along an eligible route (i.e. no need to cross roads with speed limits >30 km/h or metro tracks). Good access was conditional upon residency <200 meters from a recreational area larger than 5,000 m² and access along an eligible walking route [182].

**Anthropometric measures**

Body fat percentage was measured with bio-impedance analysis using Tanita-Weight BC-418 MA (Tanita Corp., Tokyo, Japan) [20, 183]. Participants were told to meet fasting,
with an empty bladder and light clothes, and bio-impedance analysis were performed with empty pockets and belts and shoes removed.

### 4.4. Statistical analyses

#### 4.4.1. Descriptive statistics

Descriptive data are presented as means with standard deviation (SD), medians with interquartile range (IQR) and proportions. We analysed group differences between the participants eligible for analysis and the participants ineligible for analysis by Chi-square tests, independent t-tests and analysis of variance with Tukey’s post-hoc tests.

#### 4.4.2. Summary measures and categorisations

**Objectively recorded moderate-to-vigorous intensity physical activity (papers I-III)**

Step counts and/or MVPA were primary outcomes in all papers.

- In paper I MVPA hours/day in non-bouts and steps/day were expressed as the mean values based on all valid armband days (≥1 day).
- In papers II and III MVPA duration was limited to bouts ≥10 minutes. We used SQL Server Management Studio (Microsoft®) and SQL Server Express version 11.0.5058.0 (Microsoft®) to extract minutes in bouts of ≥10 minutes.
  - Paper III: Minutes/day of MVPA in bouts was expressed as the mean MVPA based on all valid armband days (≥2 days).
  - Paper II: Minutes/week of MVPA in bouts was calculated by multiplying MVPA minutes/day in bouts by seven. At least 150 MVPA minutes/week was selected as binary cut-off level based on the physical activity guideline [41].

**Ethnic groups (papers I-III)**

Women were categorised by four ethnic groups based on the researcher-determined ethnicity (described under paragraph 4.3) to secure sufficient group sizes in analyses.
South Asian, Middle Eastern, Western and other ethnicity were defined as ethnic groups in all papers (Table 5). The South Asian group corresponded with the World Bank region South Asia [184] and the Middle Eastern group corresponded with the World Bank regions Middle East and North Africa. Women were categorised as Western if a Western European or North American country defined researcher-determined ethnicity. The women referred to as other ethnicity represented 41 different researcher-determined ethnicities.

Table 5 Researcher-determined ethnicities organised by ethnic groups (full cohort at inclusion)

<table>
<thead>
<tr>
<th>Western</th>
<th>South Asian</th>
<th>Middle Eastern</th>
<th>Other ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norwegian (n=312)</td>
<td>Pakistani (n=126)</td>
<td>Iraqi (n=38)</td>
<td>Somali (n=40)</td>
</tr>
<tr>
<td>Swedish (n=11)</td>
<td>Sri Lankan (n=61)</td>
<td>Turkish (n=28)</td>
<td>Vietnamese (n=18)</td>
</tr>
<tr>
<td>Other (n=13)</td>
<td>Other (n=13)</td>
<td>Moroccan (n=27)</td>
<td>Filipino (n=13)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Afghan (n=13)</td>
<td>Other (n=90)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (n=20)</td>
<td></td>
</tr>
</tbody>
</table>

All participants (n=823) in the Stork-Groruddalen cohort organised by researcher determined ethnicities

Socioeconomic parameters (papers I-III)

In paper I, educational level was treated as a binary variable (≤ 12 years; >12 years), while three categories were employed in paper II (<10 years; 10-12 years; university/college).

The ISCO-88 groups that measured occupational class were collapsed into three groups: managers/degree occupations (ISCO-88 groups 1-3), clerical/care occupations (ISCO-88 groups 4-8) and elementary occupations and homemakers (ISCO-88 group 9 and homemakers) (papers I and II).

In paper III we extracted one component score reflecting socioeconomic position. The component demonstrated high reliability (Cronbach’s α >0.7) [185]. Higher score reflected higher socioeconomic position. The single parameters contributing most to the score were educational level, occupational class, employment status, renting tenure and rooms per person in the household. The score was normally distributed and treated as a continuous measure.

Parity (papers I -III)

Parity was treated as a binary variable (nullipara, uni-/multipara) in papers I and III, while three categories were employed in paper II (nullipara, unipara, multipara).
Self-reported pre-pregnancy physical activity (paper II)

We summarised minutes/week for the physical activity types defined as endurance activities (running, bicycling, aerobic classes, dancing, ball games, swimming, brisk walking) and generated a binary variable (≥ vs < 150 minutes/week).

Physically active friends (paper II)

We performed exploratory factor analysis to determine if a single factor score could express the three original items [Appendix 3]. The analysis revealed that loadings ranged from 0.88 to 0.83 and the Cronbach’s Alpha was 0.89, supporting one-factor structure. We calculated the sum score of the three items, and treated it as a binary variable (median dichotomised: few vs many physically active friends).

Perceived preventive effect of physical activity (paper II)

In analysis of perceived preventive effect of physical activity, we used the sum score of the nine items (paper II). The response categories were assigned the following numerical values before generating the sum score: 0 = don’t know/no effect, 1 = little effect, 2 = large effect.

Perceived access to recreational areas (paper III)

Deriving factor scores may identify useful groupings of neighbourhood variables [145]. Thus, we explored the commonality of the four questionnaire items in sub-scale 23 and 24 that were identified as measures of access to recreational areas [Appendix 3]. One component was extracted by principal components analysis (PCA) based on items B, C and D. Item A was removed due to weak loading on the extracted component. We observed a moderate reliability (Cronbach’s $\alpha = 0.55$), which was expected given the heterogeneous nature of the component [186] and the low number of items [187]. The component score was highly skewed (two thirds achieved the two highest scores), hence we treated the component score as a binary outcome. High scores, as defined by scores above the lower tertile, were categorised as perception of high access, while scores below the lower tertile were categorised as perception of low access.
**Objective access to recreational areas (paper III)**

There was no linear dose-response association between proportion of residents with access to recreational areas and MVPA. Hence, we explored the bivariate association with MVPA to determine the cut-off level. We observed that women who were residents in neighbourhoods where the proportion of residents with good access was below the 10th percentile recorded significantly less MVPA compared with women who were residents in neighbourhoods where the proportion of residents with good access was above the 10th percentile. Hence, neighbourhoods with objective access to recreational areas below the 10th percentile were categorised as providing limited access to recreational areas (0–41% of residents had good access), while neighbourhoods with objective access to above the 10th percentile were categorised as providing good access to recreational areas (46%–100% of residents had good access).

### 4.4.3. Main analyses

In all papers, regression coefficients were given with 95% CI. *P*-values ≤0.05 were considered statistically significant.

**Paper I**

Analysis of the association between ethnic groups and physical activity (MVPA and steps per day) was performed by multiple linear robust regression according to Huber’s method (C=1.345) [188]. Ethnic group was the exposure variable of primary interest. We considered covariates based on associations with physical activity demonstrated in previous studies, and we included variables in the main effects models if bivariate associations with the outcome (MVPA or walking steps) were sufficiently strong (*p*<0.2) [189]. The covariates were BMI, educational level, occupational class, maternal age, gestational week and parity. In addition, we adjusted for the number of hours and days of physical activity recording. The model building included testing for interactions [189], and we explored interaction terms that included ethnic group. Statistical analyses were performed with Number Cruncher Statistical System 2007 Version 07.1.12 (NCSS, LLC. Kaysville, Utah, USA).
**Paper II**

Logistic multiple regression analysis was performed to build a prognostic model of non-compliance with the physical activity guideline (<150 MVPA minutes/week) at visit 2. The candidate predictors were collected at visit 1. The development and validation of the model were performed in accordance with the TRIPOD-statement [149].

The first step of the model development was identification of potential predictors by a review of the existing literature. Corresponding candidate predictors available in the STORK-G data material were organized into eight domains [122], reflecting socio-ecological domains. A series of steps were performed to reduce the initial number of candidate predictors and identify the optimal predictors: We removed predictors with $p>0.2$ in univariate regression [189], and following removal, candidate predictors in seven domains remained. We included the strongest predictor from each domain in the full model [154], and performed multiple logistic regression analysis with backward elimination to determine the final prognostic model. As part of the model development, we assessed the calibration of the final model by the Hosmer-Lemeshow test, and we tested the ability of the model to discriminate between women who complied vs. did not comply with the physical activity guideline by the Area Under the Receiver Operating Characteristics curve (AU-ROC) [122].

Model validation was performed by a bootstrap resampling procedure using 1,000 iterations to correct for overfitting [190, 191]. The bootstrap procedure yielded a shrunk model consisting of corrected coefficients (i.e. the average of the coefficients from the 1,000 bootstrap samples). As internal validation of the discriminatory performance we calculated the bias-corrected AU-ROC (i.e. the average of 1,000 AU-ROCs) with bootstrap generated 95% CI.

**Paper III**

Three-level linear mixed effects regression models were employed to account for clustering of participants within neighbourhoods and for the repeated observations clustered within individuals [192-194]. Level 1 of the data structure consisted of repeated
measurements (n=1467) from visits 1-3. The repeated measurements were nested within women (n=709) at level 2, and women were nested within neighbourhoods (n=56 postal code areas) at level 3. Levels 2 and 3 were treated as random effects in the analyses.

The association between objective and perceived access to recreational areas was analysed by Kappa statistics.

The longitudinal changes in MVPA used data from three time points. Because maximum three measurements per woman were analysed and due to challenges in aligning week number on a single time axis due to natural variation in the gestational week of birth, we modelled time by using a categorical variable (visit 1-3). To adjust for within-visit differences with respect to gestational week of physical activity recording, we adjusted for the week number that was mean-centred for each visit. Finally, we adjusted for season of physical activity recording, which was a time-varying co-variate. The equivalent modelling of time was used in the analyses of MVPA that included the explanatory factors (ethnicity and objective/perceived access to recreational areas).

In the analysis of the association between ethnicity and MVPA we adjusted also for maternal age and we explored interactions between ethnicity and visit. In the analysis of the association between objective access to recreational areas and MVPA, we adjusted for ethnicity, SEP, parity and age, and explored interaction terms between access to recreational areas and ethnicity, socioeconomic position and visit, respectively. We analysed the association between perceived access to recreational areas and MVPA changes using the same approach. Finally, we explored the possible interaction between objective and perceived access to recreational areas.

Estimates of intra-class correlation coefficients (ICC) obtained from a variance components model were employed to describe the variation in MVPA that can be attributed to neighbourhoods and individuals. Adjusted ICC values were obtained from the final regression models 1-3.
4.4.4. Missing analysis and imputation procedures

Paper I

The sample presented in paper I encompassed 678 participants with at least one day of valid SWA data (i.e. 17% of the cohort had missing data). Multiple logistic regression analysis to predict missing data included the co-variates employment status, parity, occupational class, educational level, age, BMI and the explanatory variable ethnic group. The analysis revealed that missing SWA was predicted by ethnic group, exclusively. Since ethnic group was included in the model as an independent variable the plausibility of the missing at random assumption was supported [195]. We performed no imputation procedure to assess the sensitivity to missing data.

Paper II

Missing data for the predictors were assumed missing at random. As a sensitivity analysis, missing values for predictors included in the full model were imputed by chained equations to assess potential bias in complete case analyses. We analysed 20 replications [196]. We did not address missing outcome data (i.e. objectively recorded MVPA).

Paper III

A considerable number of participants had missing outcome data (i.e. objectively recorded MVPA) at visit 3. We performed a multiple logistic regression analysis to identify predictors of missing MVPA data and multiple linear regression analysis to identify factors that predicted MVPA level to identify which variables to include in the imputation model [195]. In addition to the variables included in the original models we included BMI in the imputation model based on the variables prediction of MVPA. We generated 50 imputed datasets by multiple imputation, which we performed in REALCOM-IMPUTE to account for cluster effects [197]. Full details are presented in the electronic supplement to paper III, additional file 2 [Appendix 7].

We performed worst-case sensitivity analyses to test the robustness of the estimates from the original model and the multiple imputation models to possible missing not at random.
We imputed missing values on MVPA by replacing the missing value with 0 MVPA minutes/day since we hypothesised that participants with missing MVPA data “would have” recorded 0 MVPA minutes/day. Full details are presented in the electronic supplement to paper III, additional file 2 [Appendix 7].

4.4.5. Sensitivity analysis

Paper II: We assessed sensitivity to inclusion of data from participants with <4 valid SWA days in the original model by repeating the procedure using observations with ≥4 valid SWA day.

Paper III: We analysed sensitivity to including data from participant observations at visit 1-3 with <3 valid SWA days by repeating the analysis using observations with ≥3 valid SWA days.

4.5. Ethics

The STORK-G Cohort study was conducted in agreement with the Helsinki Declaration. All pregnant women who contacted the child health clinic to book their first appointment for antenatal care were asked if they needed an interpreter. Written and oral information about the STORK-G cohort study were given to all participants when attending the child health clinic. Information material was available in nine different languages, corresponding with the eligibility criteria for language. Women gave informed written consent before study enrolment [Appendix 4]. The Regional Committee for Medical and Health Research Ethics for South Eastern Norway (ref: 2007/894) [Appendix 5] and the Norwegian Data Protection Authority [Appendix 6] approved the study protocol. Data are stored in accordance with the standards by the Norwegian Data Inspectorate. All data were anonymised prior to analysis.
5. Results

Paper I

Crude mean values showed that in early pregnancy Western women walked significantly more steps/day than South Asian women on weekdays and weekend days; Western women walked on average 9,603 steps/weekday, while the corresponding figure for South Asian women was 7,718. The adjusted models showed that South Asian women walked on average 1,700 fewer steps/weekday and 1,370 fewer steps on weekend days compared with Western women. The other ethnic groups did not differ significantly from Western women.

All ethnic groups recorded significantly less MVPA during weekend days compared with weekdays. There was no significant difference between any ethnic groups in MVPA hours/day (crude values). However, after adjustments, South Asian women accumulated significantly fewer MVPA hours/day compared with Western women on weekdays and weekend days.

Significant interactions were observed with respect to MVPA hours/weekend days and steps/weekend day; among South Asian women, the paras walked more than the nulliparas, while the opposite association was observed among Western women. Further, South Asian women with <12 years education walked more than those with >12 years, while among Western women the opposite association was observed. The same interaction between ethnicity and education was observed with respect to MVPA hours/day.

Paper II

Overall, 25% complied with the physical activity guideline in gestational week 28. However, compliance estimates for the ethnic minority groups were lower than for Western women (Figure 3). 25% of the sample recorded no MVPA minutes/week in bouts ≥10 minutes. The proportion was 18% for Westerners, 35% for South Asians and 18% for Middle Easterners.
Differences in MVPA minutes/week were observed across educational levels, parity groups, by pre-pregnancy compliance with the physical activity guideline (based on self-report) and by ethnic groups. Figure 4 below shows a higher median value for MVPA minutes/week among Western women than the other ethnic groups. The dashed line represents the physical activity guideline (150 MVPA minutes/week).

The prognostic model showed that ethnic minority background, multiparity, high body fat percentage and few physically active friends predicted non-compliance with the physical activity guideline. Compared with Western women, the odds ratios (CI) for not achieving 150 minutes/week were 2.7 (1.5, 4.8) among South Asians, 2.2 (1.1, 4.5) for Middle Easterners and 1.8 (1.0, 3.3) for other ethnicity. Compared with nulliparas, the odds ratio for multiparas was 5.3 (2.1, 12.9). The prediction model showed fair discrimination between women who complied vs did not comply with the physical activity guideline, but the predicted outcome was false for one out of four women (AU-ROC = 0.757). The Hosmer-Lemeshow test (p=0.85) demonstrated good match between the predicted and observed outcomes across deciles of the data. The validation procedure (bootstrapping) supported the odds ratios in the original model, and the bias-corrected AU-ROC (CI 95%) was 0.757 (0.0638, 0.784), which indicates bias was marginal.
In early pregnancy Western women recorded nine more MVPA minutes/day compared with South Asian women (p<0.01). In mid-pregnancy, both South Asian and Middle-Eastern women recorded 8 minutes/day less than Western women (p<0.05). At postpartum, compared with Western women South Asian women recorded 26 minutes/day less (p<0.01), Middle Eastern women recorded 22 minutes/day less (p<0.01). There was a significant interaction between ethnicity and time-point (p<0.01) manifested as a steeper increase in MVPA minutes/day in bouts between mid-pregnancy and postpartum among Western women relative to the other ethnic groups. In the marginsplots presented in Figure 5 and Figure 6, overlapping confidence intervals for participants in different ethnic groups and participants living in neighbourhood with good vs limited access are evident. The confidence interval refers to the adjusted mean (i.e. after adjustment for covariates), and it cannot be used to assess differences between participants with good and limited access [198, pg.202-5 and 244-6].
Figure 5 MVPA minutes/day in pregnancy and postpartum by ethnic groups

MVPA minutes/day (estimated marginal means with 95 % CI) according to ethnic group. Adjusted for season and week of PA monitoring, age and dependence between observations within individuals and within neighbourhoods. A significant interaction between ethnicity and time point manifests as a steeper increase in MVPA between mid-pregnancy and postpartum for Western women compared with the other ethnic groups. Originally published in: Richardsen et al. (2016). Objectively recorded physical activity in pregnancy and postpartum in a multi-ethnic cohort: association with access to recreational areas in the neighbourhood. Int J Behav Nutr Phys Act. 13:78, DOI: 10.1186/s12966-016-0401-y. (Publisher: BioMed Central)

Participants who resided in neighbourhoods with limited objective access to recreational areas recorded on average nine MVPA minutes/day less compared with participants in neighbourhoods with good objective access (p<0.01) (Figure 6). The association was not modified by visit, ethnicity or socioeconomic position. Participants with perception of low access to recreational areas recorded on average five MVPA minutes/day less compared with participants with perceptions of high access (p=0.02). The association was not modified by visit, ethnicity or socioeconomic position. After mutual adjustments for objective and perceived access to recreational areas, the associations between MVPA and objective access (p<0.01) and perceived access (p=0.03) remained significant. The beta coefficient for objective access did not change after mutual adjustment, while the beta coefficient for perceived access dropped by approximately 10%. We observed no interaction between objective and perceived access to recreational areas.
Figure 6 MVPA minutes/day in pregnancy and postpartum by access to recreational areas

Estimated marginal effects with 95% CI for limited and good objective access to recreational areas by time point. Adjusted for ethnicity, socioeconomic position, season, parity, age, week of PA monitoring and dependence between observations within individuals and within neighbourhoods. Originally published in: Richardsen et al. (2016). Objectively recorded physical activity in pregnancy and postpartum in a multi-ethnic cohort: association with access to recreational areas in the neighbourhood. Int J Behav Nutr Phys Act. 13:78, DOI: 10.1186/s12966-016-0401-y. (Publisher: BioMed Central)

The sensitivity analyses based on ≥1 and ≥3 valid SWA days yielded similar results as the original models. The ICC for the variance component showed that 39% of the variation in MVPA was attributed to differences between individuals and 2.2% was attributed to differences between neighbourhoods. The ICC values were slightly lower in the adjusted models (including the explanatory variables and confounders). The association between objective and perceived access to recreational areas was tested by the Kappa value, which indicated poor agreement. The Kappa value (95% CI) was 0.05 (-0.02, 0.11).
6. Discussion

6.1. Methodological issues

The aim of any epidemiological study of the association between a given exposure and outcome is to obtain an accurate estimate of the association, which can be generalized to the target population [199]. Precision and validity are components of the accuracy of the estimate, and while the precision can be reduced by random error, the validity can be compromised by random and systematic error [199]. Systematic error is consistently wrong in a particular direction, while random error has no apparent connection to another variable [200]. Internal validity refers to the inferences to the study sample, and it is a prerequisite for external validity, which is the inferences to the target population [200]. Bias analysis is recommended to incorporate uncertainties regarding systematic errors resulting from selection bias, uncontrolled confounders and misclassification, and a STATA command has been developed to perform such analysis [201]. We did not perform such bias analysis, but in hindsight, it can be acknowledged that this would have provided valuable information about potential bias.

6.1.1. Selection bias

Selection bias occurs when a systematic error in the recruitment or retention of exposed or unexposed subjects in a cohort study distorts the measure of association between exposure and outcome relative to the association that, hypothetically, would have been observed in the target population [199, 202]. Phrased differently, if either study participation or complete data are common effects of the exposure (e.g. ethnic group) and the outcome (e.g. physical activity), a collider bias will result because the observed association between exposure and outcome is not entirely a result of the causal effect [203]. Empirical evidence suggests that self-selection may bias prevalence estimates in prospective cohort studies like STORK-G, but to a much lesser extent result in biased measures of association, presumably because exposures are collected before the outcome in prospective studies [204]. Selection bias may still manifest if exposure and outcome are associated with another factor also associated with participation [203]. While several types
of selection bias are described in the literature, volunteer bias and missing data bias are of particular relevance for the three papers submitted as part of the present thesis.

**Volunteer bias**

The STORK-G cohort at visit 1 was representative for women attending child health clinics with respect to ethnicity and age, while dropout was relatively small (19.5% of visit 1 attenders did not attend visit 3) [20]. This suggests that volunteer bias is minimal. There were no available background data to assess if the cohort comprised a true probability sample of the source population, since no routine data were available for assessment of other demographic and socioeconomic factors. To what extent more health conscious individuals opted for participation is unknown.

**Missing data bias**

In all analyses presented in papers I-III, independent variables were collected at visit 1, which reduce the risk of bias with respect to associations with the physical activity outcome collected prospectively [204]. Missing data on independent variables was minimal (<5% for 10 of 11 independent variables). For perceived access to recreational areas (paper III) 6.6% of the sample had missing values. Thus, missing values were imputed for this variable (Appendix 7: Electronic supplement to paper III, additional file 2). The major challenge in the present thesis was missing SWA data, which was extensive at visit 3. Valid SWA data (i.e. ≥2 valid days) from the three visits was available for 647 (visit 1), 555 (visit 2) and 346 (visit 3) women. Figure 7 illustrates dropout and details on missing postal code and SWA data. Regardless of the reason for missing SWA (loss to follow up, unwillingness, etc), results will be biased if analyses are restricted to individuals with complete follow-up data [205], unless data are completely missing at random (MCAR) [195]. The MCAR assumption is rarely plausible. More commonly, the missing mechanism is a mixture of missing at random (MAR) and missing not at random (MNAR) [206]. To reduce the risk of biased estimates, actions to support the plausibility of MAR are recommended: These actions encompass inclusion of variables in the analytic model that are predictive of missingness [195], since the model will yield valid measures of association if participants are randomly sampled within levels of these variables [207].
Figure 7 Flowchart of dropout and missing data - paper III

The recommended methods for dealing with missing data are inverse probability weighting and imputation methods. In the electronic supplementary file 2 to paper III [Appendix 7] details on the analysis of missing data and the multiple imputation techniques employed are described. In brief, we identified predictors of missing values. If individuals with low socioeconomic position were less likely to use the SWA to monitor physical activity, and more likely to record lower levels of physical activity, not including socioeconomic position as a predictor in the imputation model would underestimate physical activity and give a wrong picture of the association with the explanatory factor [195]. Table 6 presents predictors of missing SWA data for the sample of women (n=709) analysed in paper III; the odds ratios show that South Asian women had a significantly increased risk (OR 1.6) for missing SWA data at visit 3 and incomplete SWA data. Also, higher socioeconomic position indicated a reduced probability of missing SWA data at visit 3 (OR 0.7) and incomplete SWA data (OR=0.8).

Table 6 Multiple logistic regression analysis of missing Sensewear Armband data (n=709)

<table>
<thead>
<tr>
<th></th>
<th>Visit 1</th>
<th>Visit 2</th>
<th>Visit 3</th>
<th>Incomplete MVPA¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parity (ref: nullipara)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-/unipara</td>
<td>0.67 (0.46 , 0.98)**</td>
<td>0.61 (0.44 , 0.86)**</td>
<td>0.68 (0.48 , 0.97)*</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic position score (min: -2.9, max: 2.5)</td>
<td>0.73 (0.60 , 0.87)**</td>
<td>0.80 (0.66 , 0.97)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity (ref: Western)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Asian</td>
<td>1.6 (1.06 , 2.47)*</td>
<td>1.6 (1.04 , 2.49)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Eastern</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective access to recreational areas (good vs limited)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*<0.05; **<0.01; ¹Missing data at one or two visits

The analysis of the association between access to recreational areas in the neighbourhood and physical activity was a secondary analysis that was not originally planned for at the outset of the STORK-G cohort study. As the neighbourhoods were located within the city districts that participated in the STORK-G cohort study, the neighbourhoods were not randomly sampled, and this may have prevented maximum variation in environmental
characteristics. Hence, it is probable that a larger variability between neighbourhoods could lead to detection of even stronger environmental impact.

6.1.2. Information bias

Information bias can result from error in the measurement of collected information/data, whether it involves the exposure, outcome or covariates [202, 208]. Error in categorical variables (including categorisation of continuous variables) are referred to as misclassification [208]. The misclassification can be differential or non-differential. Differential misclassification depends on the values of other variables, while non-differential misclassification does not depend on values of other variables and is of equal magnitude across comparison groups [199]. Both random and systematic error in measurement of a continuous variable can lead to differential misclassification when categories are formed on the basis of the continuous outcome [209].

The direction of the bias depends on the error distribution and a) the actual value of the variable; b) the actual value of other variables, c) or measurement error in other variables [208]. Random error (and non-differential misclassification) and differential misclassification of binary outcomes lead to bias toward the null. It is more challenging to predict the direction of the bias for other types of systematic error. In the following, I discuss potential information bias in papers I-III resulting from misclassification of exposure and outcome variables, while misclassification of covariates are not addressed.

Exposure misclassification

Self-reported pre-pregnancy physical activity

In paper II, self-reported pre-pregnancy physical activity was included among the candidate predictors, but this candidate predictor did not qualify for the final model. Levels of self-reported physical activity are highly sensitive to the wording of the questionnaire item, as small differences in the wording can result in large differences in estimates of physical activity and prevalence of physical activity guideline compliance [19, 210]. The scale used to measure self-reported physical activity in the current study was a modification of a previously validated scale (for vigorous physical activity the correlation
Since the psychometric properties of the modified scale used in the current study have not been examined, there is a risk of non-differential misclassification [59].

Misclassification of the exposure variable in prospective studies is normally non-differential, since the exposure is measured before the outcome of interest [202]. Because the outcome measures employed in in papers I-III are different measures of physical activity, differential misclassification of the exposure can still pose a threat. In contrast to studies of disease outcomes, which are unknown before time of measurement (e.g. cancer), the objectively recorded physical activity outcome reflects a long-term behaviour [211]. Because physical activity is a long-term behaviour, this behaviour (and indirectly the objectively recorded physical activity outcome) may have influenced the exposure variable. In the present thesis, the risk of differential exposure misclassification is a highly relevant issue with respect to self-reported exposure levels, such as self-reported levels of pre-pregnancy physical activity. Given that the outcome variable (compliance vs non-compliance with the physical activity guideline based on objectively recorded MVPA visit 2) reflects a long term physical activity behaviour, there is a possibility that participants who complied with the guideline differ systematically in fitness level from participants who did not, and subsequently, with respect to how they assessed slow vs brisk walking in early pre-pregnancy. Women who did not comply with the guideline may have lower cardiorespiratory fitness than those who did. If women with low and high cardiorespiratory fitness walk at the same speed, the women with low fitness level will more likely perceive the walk as brisk rather than slow [19]. This is an example of differential exposure misclassification, that may bias the association between self-reported physical activity pre-pregnancy and physical activity guideline compliance at visit 2 towards the null [59].

**Perceived access to recreational areas**

One of the explanatory variables employed in paper III was perceived access to recreational areas. For the purpose of reducing the total volume of the questionnaire items in STORK-G, only selected items perceived as relevant were included in the STORK-G questionnaire (Appendix 3) and with respect to perceived neighbourhood the
questionnaire items used were modifications of items in validated scales [180, 181]. Since we did not use a validated scale, no formal validation of the sub-scale exists.

Evaluating error in the measurement of perceived access to recreational areas is challenging, and it can be argued that comparison with an objective criterion is irrelevant as the perceptions represent a perceived reality [145]. The three items included in the PCA score reflected different dimensions of access and qualities of a recreational area, such as perceived effort to access the area, perceived safety while using the recreational area, presence of lights and time to walk. A low Cronbach alpha score was observed for the three items, but the low reliability was expected given the heterogeneity of the items. However, a low Cronbach alpha is not necessarily a measurement limitation, since there is little reason to expect conceptually similar environmental variables to co-occur [145].

Differential misclassification cannot be excluded given the long-term behaviour reflected by the outcome measure, objectively recorded MVPA [211]. Participants with a long-term habit of walking in the neighbourhood may perceive opportunities in the neighbourhood differently than women who never go for walks in the neighbourhood. Given that the long-term walkers possess more knowledge about different recreational areas, they may perceive access more positively than women with limited experience with walking in the neighbourhood. As a result, the observed association between perceived access to recreational areas and physical activity may be overestimated, (i.e. bias away from the null).

**Ethnicity**

Possible misclassification of ethnicity must be assessed with reference to the underlying construct that ethnicity is intended to measure. Categorisation results from an interplay between the researcher’s understanding of the substantive matter, and, restrictions imposed by the available data sources [212]. We defined ethnicity as the country of birth of the participant, or her mother’s country of birth if her mother was born outside Europe/North America. By using country of birth, we intended to let ethnicity be a proxy measure for shared cultural values, knowledge and attitudes relevant for the study of physical activity behaviour. An alternative procedure for defining ethnicity would be using the participants’ own perceptions of ethnicity. If we accept that an individual’s assessment
of her own ethnicity is correct, our criteria for defining ethnicity may have resulted in misclassification [213]. The need for securing sufficiently large group sizes (achieved by grouping individuals with different nationalities (ethnicities) by four regional ethnic groups) may have increased the within-group variance and reduced the variance between groups.

**Objective access to recreational areas**

Objective access to recreational areas in the neighbourhood was measured at the post code level. This would preclude the possibility of systematic error in the measurement. However, analysing neighbourhood factors requires consideration of how best to define a neighbourhood. It could be argued that the area size of the postal code is larger than what residents would perceive as their actual neighbourhood. The exposure was expressed as the proportion of neighbourhood residents with good access to recreational areas. If the neighbourhood defined by the postal code area contain multiple “micro neighbourhoods” which are characterised by different levels of access to recreational areas, the clustering of these “micro neighbourhoods” within “postcode level neighbourhoods” may mask variation in access levels. This represents a potential source of non-differential misclassification of access to recreational areas at the neighbourhood level.

**Outcome misclassification**

The outcome measures analysed in all three papers were operationalisations of objectively recorded physical activity, expressed in terms of MVPA duration or steps/day. The measures of MVPA duration (hrs/day, mins/day, mins/week) were intended to reflect the habitual physical activity at the respective time points in pregnancy and postpartum. Thus, in order to assess risk of misclassification, consideration of the criterion validity of estimates of specific activity intensities and durations derived by the SWA are required. Since the estimates of MVPA duration are defined by the average duration over the monitoring period, issues concerning the criteria for hours and days of monitoring must also be addressed.
Criterion validity

Sources of random error that influence the reliability of objective methods of physical activity measurement include inconsistencies in capturing signals and accidental altering of the position of the device [214]. With respect to the SWA version used in the current study (SWA Pro3), there are no published studies reporting assessment of measurement error with respect to estimates of EE and MVPA in pregnancy. A thorough assessment of measurement error is therefore compromised by the need to rely on validations studies performed in non-pregnant samples, and validation of estimates of EE and MVPA in pregnancy derived by other versions of the SWA (SWA Pro2 and SWA Mini).

In non-pregnant adults, the SWA significantly overestimated EE at higher intensity levels [168], but despite this overestimation the misclassification of MVPA was minimal (specificity: 1.00 and the sensitivity 0.78) [168]. The similarity between estimates of EE and MVPA derived by the SWA and the SWA Mini in non-pregnant samples indicates the estimates derived by the SWA Mini during pregnancy approximate the estimates that would be expected given that the SWA was employed [168, 170].

One study of non-pregnant women indicates that ethnic differences in SWA measurement error can be a source of differential misclassification of EE estimates; estimates were overestimated by 25% in White women, while among black women the SWA overestimated EE by 50% [215]. Thus, the multi-ethnic composition of the STORK-G cohort commands awareness of systematic ethnic differences in SWA measurement error is highly relevant, but there is currently no empirical evidence that confirm differential misclassification of MVPA based on systematic differences in measurement error across Western, South Asian and Middle Eastern women.

In pregnant samples, validation studies of the other SWA versions (Pro2 and Mini) indicate misclassification of EE estimates deviates, at best, 8% from the criterion measure [45, 77]. Assessment of the measurement error in EE derived by the Mini demonstrated that mean absolute error percent was 8% during walking (3 miles per hour at 3% incline), and 45% during folding laundry activities [77]. Accordingly, misclassification will be differential, as the measurement will differ by physical activity type. Hence, for women
who expend energy primarily during housework, misclassification will be more pronounced than women who expend more energy during walking activities.

Criteria for days and hours of physical activity recording

Reliability defines the upper limit for validity [216]. In studies based on objectively recorded MVPA, the criteria defined to determine the required number of monitoring days and hours influence the reliability of estimates of habitual MVPA, since the estimates reflect an average duration over several days.

In general, an estimate of habitual physical activity based on data from one visit does not truly reflect the habitual physical activity level [217]. This claim is even more plausible with respect to the nine to 12 months women were followed in the STORK-G study, during which habitual physical activity was probably less stable compared with 12 months when not pregnant. Thus, longitudinal analysis of physical activity data from multiple visits and the need to account for seasonal variations in physical activity are of particular importance [70]. Still, the estimation of physical activity at each study visit must take into account day-to-day variation [24, 70]. According to recommendations for estimation of habitual physical activity in adults, analysis should be based on data from three to five days of monitoring [218]. Using several days reflect a “regression-to-the-mean” approach that will smooth the day-to-day variation in physical activity and yield an estimate less prone to error caused by relying on very active or very inactive days. Recommendations are less clear on the required hours/day. In all submitted papers, a valid day was defined as SWA wear ≥19.2 hours/day.

In conflict with the recommended three to five days, all analyses included data from women with fewer valid days [218]. In paper I, the analyses included participants with one valid day, while in paper II and III, women with two valid days were included. Due to the day-to-day variation, inclusion of women with less than three valid days may have introduced random error. The rationale for including data from participants with at least two valid days was to maintain a large sample size and sample heterogeneity, as participants with maximum two monitoring days recorded on average lower levels of MVPA at all time points compared with participants with three days or more (Table 7).
Table 7 MVPA minutes/day accumulated in bouts by criteria for valid monitoring days

<table>
<thead>
<tr>
<th></th>
<th>Valid days with Sensewear Armband</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 day</td>
</tr>
<tr>
<td></td>
<td>Women MVPA (mins/day)</td>
</tr>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Visit 1</td>
<td>31</td>
</tr>
<tr>
<td>Visit 2</td>
<td>87</td>
</tr>
<tr>
<td>Visit 3</td>
<td>81</td>
</tr>
</tbody>
</table>

The table shows lower estimates of MVPA minutes/day for sub-samples consisting of women with 1 or 2 valid days with Sensewear armband compared with sub-samples of women with ≥3 valid days.

While internal validity is a prerequisite for the external validity [200], the dilemma between maintaining sample size and analysing data collected on a sufficient number of days reflects the dilemma between internal and external validity [219, 220]. It is impossible to determine if the estimates of MVPA for women with less than three valid days introduce error. However, by excluding data from participants with less than three days, data from the least physically active women would be excluded, and subsequently, the target population to which data can be inferred would be narrowed down to a more active population not reflecting the intended source population (Table 7).

6.1.3. Confounding

A confounding effect is a biased estimate of an association between an exposure variable and an outcome variable occurring as a result of a common cause [203]. It is imperative to address and control for confounding effects in etiological studies. In studies of predictors, causal mechanisms are irrelevant and control for confounders is not required [150, 221].

Confounding impacts on the association measure in different ways; it may bias towards the null and away from the null and alter the sign of the estimate [199]. The strategies by which confounding can be controlled are by adjustment or stratification by levels of the confounder [203]. If the confounder is unmeasured, an alternative approach is to adjust for a proxy measure of the confounder. If the confounder is imperfectly measured, or if the functional form of the regression analysis is sub-optimal, it is not possible to eliminate the confounding effect, and what remains is referred to as residual confounding [222].
Potential confounders in paper III

In analysis of the association between neighbourhood level access to recreational areas and MVPA (paper III) individual characteristics may confound the association. Direct acyclic graphs in the context of neighbourhood studies have been discussed by several authors [223, 224], and the model shown in Figure 8 is inspired by the schematic models developed by Subramanian and co-workers [224]. Variables with arrows pointing into both exposure and outcome variables are referred to as confounders. Since repeated measures of physical activity were recorded during approximately one year, season was a time-variant confounder that had to be controlled in the analysis.

**Figure 8 Direct acyclic graph**

The direct acyclic graph visualises assumptions about causal relations between access to recreational area, physical activity and confounders. Variables with arrows pointing into neighbourhood residence (and indirectly access to recreational area) and physical activity are confounders.

Furthermore, Figure 8 illustrates that ethnicity, socioeconomic position, parity and age are individual characteristics that potentially confound the association between access to recreational areas and physical activity (MVPA). The underlying assumption is, that these individual characteristics both influence the decisions concerning neighbourhood residence (and indirectly access to recreational areas) and MVPA. For example, individuals with a high socioeconomic position may prefer to settle in neighbourhoods with more activity friendly environments. Given that the same individuals are more
physically active than individuals with low socioeconomic position, not controlling for socioeconomic position would result in a spurious association between access to recreational areas and MVPA. In conflict with this stance, others warn against adjustment for individual level factors in analysis of environmental effects [225]; individual characteristics may be in the causal pathway between contextual influences (such as objective access to recreational areas) and physical activity. According to this stance, adjustment for individual characteristics in the models presented in paper III may have understated the influence of the neighbourhood context [225].

**Potential unmeasured confounders in paper III**

Neighbourhood selection, i.e. neighbourhood choice based on a specific neighbourhood preference, has been referred to as one of the most challenging obstacles in puzzling out how neighbourhood factors influence health and lifestyle [226]. Neighbourhood preferences are not only associated with choice of residence, but also with the outcome variable (physical activity). Individuals who enjoy physical activity are more likely to move into activity-friendly neighbourhoods [226-229]. Establishing a causal association between neighbourhood access to recreational areas and MVPA thus requires separate data on neighbourhood preference [228]. The STORK-G questionnaire included no items to measure neighbourhood preference, and neighbourhood selection therefore represents a potential unmeasured confounder of the association presented in paper III. In the worst case, the unmeasured confounding effect may leave the association between access to recreational areas and physical activity completely spurious [226]. While addressing neighbourhood selection in the analysis is important, neighbourhood selection is, arguably, not a choice influenced by preference alone. Since neighbourhood attractiveness impact on property values, it is likely that socioeconomic factors influence neighbourhood selection. Correspondingly, it is plausible that adjustment for socioeconomic position will attenuate the possible confounding effect of unmeasured neighbourhood selection.
6.1.4. Discussion of statistical methods

Cross-sectional analysis of the association between ethnic group and MVPA/steps (paper I)

There was no evidence of multicollinearity, and the independent continuous variables showed a linear association with the dependent variables, MVPA and walking steps. The distribution of values on MVPA hours/day was positively skewed, and the residual variance in ordinary least square regression violated the assumption of homoscedasticity. Thus, robust regression based on Huber’s method was performed to make the model less sensitive to outliers [230].

Several covariates were adjusted for in the full model, such as educational level, occupational class, BMI and parity. These covariates are, arguably, not confounders, since we cannot exclude that these variables are on the causal pathway between ethnicity and MVPA/walking steps [203]. Given that the impact of ethnic group on physical activity works indirectly through socioeconomic factors and BMI, adjustment for these factors means that the coefficient for the association between ethnic groups and physical activity does not show the total “effect” of ethnic group on physical activity. Preliminary analyses (not published) indicated that adjustment for socioeconomic factors attenuated the difference between South Asian and Western women with respect to MVPA. In contrast, adjustment for BMI accentuated the difference.

In line with the explorative strategy of the analysis, interactions were tested to assess if the covariates modified the association between ethnicity and MVPA/walking steps [231]. Interactions were explored in the full models, but significant interactions were only presented as visualisations of crude models that included the interaction term and the outcome. Leaving out the interaction term from the final models may have resulted in misspecification of the models.

In total, 145 women had missing SWA data, but the statistical models included independent variables that were predictors of missing SWA data, hence the models supported the plausibility of MAR assumption [195].
Prognostic modelling by logistic regression (paper II)

The ultimate goal of building a prognostic model is to arrive at the model that provides the best prediction of the outcome [232]. Our objective was to build a prognostic model of non-compliance with the physical activity guideline (<150 MVPA minutes/week). A wide range of candidate predictors were considered, which increases the likelihood of including important predictors [122]. Continuous predictors were linearly related to the log odds.

The sample size and the number of participants in the less frequent outcome category, however, put restrictions on the number of predictors that could be analysed simultaneously [233]. Thus, we reduced the number of candidate predictors by including only one predictor from each of the specified socio-ecological domains. This could potentially prevent inclusion of the best predictors in the final model, as a predictor rated second best in one domain would not be included in the full model. We assessed the relevance of the predictors by assessment of validity (by bootstrapping) and discriminatory performance.

There is always a risk of overfitting a statistical model, i.e. making it excessively dependent on the observed data. Arguably, the small number of predictors included in the final model reduced the risk of overfitting [189]. A cardinal feature of developing prognostic models is the quantification of the model’s prediction accuracy in future, yet-to-be-seen data [156], i.e. validation of the predictors in an external sample. Since assessment in an external sample was not feasible, we performed validation by bootstrapping, which is the recommended internal validation procedure [191]. The procedure indicated that the model was not over-fitted, i.e. the model fit represented general patterns rather than unique features of the data [122].

As a test of discriminatory performance, the AU-ROC provides information about the robustness of the prognostic model [123]. The finding that the outcome was false for one in four women indicates that the prognostic model is not optimal and that some relevant predictors were not included in the final model. The predictors included in the final prognostic model may have been influenced by the variable selection method. We employed multiple logistic regression analysis with backward elimination, which is a data-
driven procedure by which a specified criterion determines variable selection. In the present analysis the criterion for selecting variables was p-value ≤0.05. A major criticism of this approach is the “one-at-a-time” nature of dropping variables, which means that only a fraction of all possible models are tested and the optimal model might be missed [234]. An alternative variable selection method is best subsets variable selection [235], which generates a series of regression models at each level of complexity (where complexity is defined by number of predictors included in the model), and outputs the models with the highest log likelihood at each level [235, 236]. These models can be compared by using the Bayesian Information Criterion, and the model with the lowest criterion value indicates the optimal model. As a sensitivity test (not published), all subsets variable selection was performed using the “gvselect” program in STATA 13 [235, 236]. This test replicated the results of the backward elimination procedure presented in paper II, hence providing support for the prognostic model.

MVPA and relation with ethnic group and access to recreational areas (paper III)

Three-level linear mixed effects regression models were employed to account for clustering of participants within neighbourhoods and for the repeated observations for individuals. The assumption of normally distributed level 1 residuals was considered satisfied for all models, but the histograms of the residuals showed signs of kurtosis. The plots of residual variance showed considerable heteroscedasticity in all models, but the mixed effects models were considered sufficiently robust.

In order to integrate several dimensions of socioeconomic position, we used a component score to express the multiple facets of socioeconomic position rather than including several separate measures of socioeconomic position to reduce the risk of multicollinearity [237]. A main critique of using a single component score is the possible masking of unique independent and interactive effects of the individual measures [237]. To assess the possibility of different interaction effects, separate analyses were performed (not published) including single measures of socioeconomic position (i.e. educational level, occupational class, employment status, renting tenure and rooms per person in the household), but the findings corresponded with the models that included the socioeconomic position component score.
6.1.5. External validity

In assessment of the generalisability of the findings to the target population, a clear definition of the target population is required; the target population is defined by the eligibility criteria and the characteristics of the source population [238]. The source population encompassed pregnant women who received antenatal care at child health clinics in city districts with a multi-ethnic population, and they spoke either of the nine languages described as eligibility criteria. Also, women in the source population were generally healthy at inclusion.

In cohort studies, the external validity is highest if the included participants from the exposed groups are representative for all exposed individuals in the source population [238]. The mapping of public health challenges in a multi-ethnic population was an important objective in the STORK-G cohort study, and this objective commanded thoughtful consideration and implementation of the inclusion strategy. Individuals who do not speak the language of the host country are often not included as participants in health research. This restricts the generalisability of the results, since the participating ethnic minority women represent only those with the highest level of integration. To promote inclusion of women from the entire multi-ethnic source population, considerable efforts were made to ensure that individuals with poor Norwegian language skills were included. Representative inclusion was facilitated by collaboration with general practitioners who referred women to the child health clinics, and collaboration with staff at the Interpreting and Translating Services in Oslo, who contributed in translation of information material/questionnaires and provided interpreters during interviews. Furthermore, the cultural expertise possessed by the midwives at the child health clinics and the trustworthiness of the child health clinics and the midwives were key success factors.

Women defined as immigrants made up 58% of the sample, and of these women approximately 21% self-reported poor and 18% self-reported mediocre Norwegian language skills. At visit 1, the cohort was representative for women attending the child health clinics with respect to ethnicity and age [20]. Routine data on use of interpreters at the child health clinics was not available for comparison. However, the number of
participants who required an interpreter at visit 1 suggests that the inclusion of women who did not speak Norwegian was successful; 20% of South Asian women and women with other ethnicity, and, 29% of Middle Eastern women required an interpreter at visit 1.

To what extent the research setting can be generalised to the real-life setting is another issue concerning the external validity. With respect to physical activity, wearing the SWA may have influenced the participants’ physical activity behaviour in a positive direction. Furthermore, since the physical activity interview was scheduled immediately prior to the physical activity recording, participants may have become more aware and conscious about their physical activity behaviour (the mere-measurement effect) [239], and the monitored physical activity level may have been higher than if the interview was performed immediately after the monitoring period.

6.2. Discussion of main findings

6.2.1. Ethnic differences in physical activity and trajectories

Analysis of diverse objective physical activity outcomes (steps/day, MVPA in non-bouts, MVPA in bouts and non-compliance with the physical activity guideline) demonstrated ethnic differences in physical activity. While MVPA in non-bouts and steps/day capture both sporadic and continuous physical activity (paper I), MVPA in bouts more specifically captures extended periods of physical activity (papers II and III). While physical activity type cannot be determined by the SWA, it is plausible to assume that bouts of MVPA is more specific with respect to recreational and transport physical activity, since sporadic bursts, which are probably more typical for household activities, are not included.

The various estimates of physical activity indicated that South Asian women were less physically active than Western women irrespective of the physical activity outcome analysed. There were no statistically significant differences in estimates for steps/day, MVPA in non-bouts and MVPA in bouts for Middle Eastern and Western women at visit 1 (paper I and III). However, lower levels of MVPA in bouts among Middle Eastern compared to Western women at visit 2 and visit 3 were statistically significant. We did not analyse MVPA in non-bouts or steps/day at visit 2 or 3.
The general finding that women with ethnic minority background are less physically active is supported by previous studies of pregnant women, but lower physical activity levels have not been consistently reported for all ethnic minority groups. For example, studies of physical activity in White and Black pregnant women in the US show conflicting results [240-243]. However, physical activity level among pregnant Asian and Hispanic women are consistently lower than among White women [240-243]. The conflicting results suggest that other factors than simply being an ethnic minority is important.

Estimates of physical activity from studies of non-pregnant ethnic minority women are potentially biased due to the predominant use of self-report, in particular with reference to South Asian women [244]. A mixed-methods review showed that only two of 25 studies of physical activity among South Asian women were based on objective measures of physical activity [244]. According to the review, studies that compared ethnic minority South Asian women with the White majority population consistently reported lower prevalence of physical activity among South Asian women [244]. Studies based on objective measures of physical activity in non-pregnant South Asians are not straightforward comparative with results from papers I-III, as physical activity level and type during pregnancy/postpartum differ from the non-pregnant state. Furthermore, because most studies of non-pregnant South-Asian women are collected in cohorts with a wide age range that includes postmenopausal and elderly women, comparison with a pregnant population with a narrower age range is compromised.

**Steps/day and MVPA in non-bouts in early pregnancy**

The only comparable study based on step counts among South Asian women included Asian Indian women in New Zealand; steps/day was not reported for the majority population, but Asian Indian women walked on average 5,159 steps/day [245]. Comparatively, we observed that South Asian women walked approximately 7,500 steps/day in early pregnancy (paper I). The lower estimate reported by Kolt and co-workers [245] is probably explained by the higher mean age of their sample (65.8 years). We observed significant differences between South Asian and Western women (who walked 9,600 steps/weekday), but no identified studies have compared step counts across ethnic groups in pregnancy.
With respect to MVPA in non-bouts presented in paper I, crude estimates indicate South Asian women accumulated fewer minutes/weekday compared with Western women (approx. 57 vs 72 minutes/weekday), but the difference only reached statistical significance after adjustment for covariates (South Asian women recorded approx. 18 minutes/weekday less than Western women). The study by Evenson and co-workers [4] is the only comparable population based cohort of pregnant women where estimates of MVPA in non-bouts are reported; they found that Hispanic and Black women accumulated less MVPA than white women, which supports our findings [4]. The total sample estimates for MVPA in the 1st trimester depended on accelerometer cut-point: 11.5 minutes/day (Troiano cut-point) and 106 minutes/day (Swartz cut point). Because the SWA used to monitor physical activity in the present thesis derives estimates of MVPA by different methods (propriety algorithms), our estimates of MVPA are not comparable with the estimates from Evenson and co-workers [4].

Accelerometer derived estimates of physical activity from the UPBEAT study of obese pregnant women in the United Kingdom showed that the probability of spending more than half the time in physical activities in gestational weeks 27-28 was four times higher in non-White (i.e. Black, Asian or other) compared with White women [5]. No differences between ethnic groups were observed in the 1st and the late 3rd trimesters. While the findings may appear to be at odds with the results reported in paper I, the physical activity outcome measure is not directly comparable, as physical activity level in the UPBEAT study was defined by proportion of accelerometer wear time ≥100 accelerometer counts per minute, which includes light physical activity. However, the findings from the UPBEAT study highlight that light and moderate intensity levels can hold different importance for non-White and White women [5].

A study of non-pregnant South-Asian women (18-72 years) residing in Cardiff, Wales, showed these women on average spent 36 minutes/weekday engaging in MVPA in non-bouts [246]. The lower estimate of MVPA observed in a non-pregnant sample compared with our findings is surprising, but it may be explained by the comparatively wider age range in the other study.
Physical activity guideline compliance

In paper II and III, physical activity was expressed in terms of MVPA in bouts and the operationalisation of compliance with the physical activity guideline at visit 2 did also reflect this definition of physical activity. A significantly higher proportion of Western women (35%) met the guideline (i.e. ≥150 MVPA minutes/week in bouts ≥10 minutes) compared with South Asian (14%) and Middle Eastern (16%) women (paper II). Comparison with physical activity guideline compliance in other studies is challenging due to the application of different guidelines and different interpretations of the guidelines. Our findings concur with the findings based on data from the Danish Birth Cohort; Broberg and co-workers [98] found slightly higher estimates of physical activity guideline compliance (self-reported physical activity), but, in line with our findings, they observed differences between women who did not speak Danish (21%) and women who could speak Danish (39%). The use of language skills rather than country of origin reflects the possible role of the acculturation process in predicting physical activity behaviour. A study by Curry and co-workers of non-pregnant South Asian women in Cardiff (age range 18-72 years) showed that 53% achieved the recommended 30 minutes per day, but this figure dropped to 35% when limited to those accruing 30 minutes per day in 10-minute bouts [246]. There exist no longitudinal studies of multi-ethnic samples based on objectively recorded physical activity monitored in pre-pregnancy, pregnancy and postpartum. Thus, current knowledge is limited with respect to changes in South Asian women’s guideline compliance from pre-pregnancy to pregnancy. The operationalisation of guideline compliance applied in paper II is not directly comparable with that of Curry and co-workers [246]. Still, the finding that 35% of South Asian women in Wales comply with the guideline suggests that a larger proportion of South Asian women meet the recommended physical activity in the non-pregnant state contrasted with the 14% we observed in mid-pregnancy (paper II).

Changes in MVPA in bouts during pregnancy and postpartum

There is a dearth of longitudinal studies of physical activity during pregnancy and postpartum based on objective measures, and only one based on measures of physical activity from pregnancy and postpartum [109].
Studies based on self-reported physical activity [95] and prospective studies based on objectively recorded physical activity [5, 43, 103, 104] show that MVPA drop with progression of pregnancy. These findings are in agreement with the finding in the present thesis (paper III). The estimates of MVPA in studies of MVPA in bouts ≥10 minute were 20-32 minutes/day in the 2nd trimester, and 16-27 minutes/day in the 3rd trimester [43, 104]. These estimates originate from small samples that consisted predominantly of White women, but they are in agreement with our estimates for Western women at visit 1 (28 minutes/day) and visit 2 (19 minutes/day) (paper III). In contrast, our estimates were lower for ethnic minority women; the corresponding figures at visit 1 and visit 2 for South Asian women were 19 and 11 minutes/day, and for Middle Eastern women, 22 and 11 minutes/day. The MVPA estimates for South Asian women were significantly lower than for Western women at both visits in pregnancy, while the estimate for Middle Eastern women at visit 2 was significantly lower than for Western women.

Longitudinal studies based on self-reported physical activity that span pregnancy and postpartum have yielded ambiguous findings with respect to the physical activity trajectory; some studies have suggested that physical activity increase after birth, while others have reported that postpartum physical activity does not differ from physical activity in pregnancy [95]. Only Melzer and co-workers have presented longitudinal data on physical activity spanning pregnancy and postpartum, and they observed a considerable but non-significant increase in moderate physical activity between gestational week 38 and postpartum week 40 (from 56 to 85 minutes/day) [109]. The change was probably non-significant due to the small sample size (n=27). In the same study they observed a significant increase in vigorous physical activity between the same time points (from 1 to 6 minutes/day) [109]. Interestingly, they also reported a significant increase in physical activity minutes/day at 2.5≤METs <3. The measure of physical activity employed in the present thesis does not differentiate between moderate and vigorous intensities. Nevertheless, our finding that the MVPA estimates postpartum were significantly higher than in mid-pregnancy (visit 2) for Western (43 minutes/day), South Asian (17 minutes/day) and Middle Eastern women (20 minutes/day) supports the results reported by Melzer and co-workers [109]. Alarmingly, estimates of postpartum MVPA among South Asian and Middle Eastern women were not significantly different from
MVPA in early pregnancy (visit 1). This may indicate that habitual physical activity in the non-pregnant state differs minimally from habitual physical activity in early pregnancy for South Asian and Middle Eastern women, or, the recovery of non-pregnant habitual physical activity after birth among these women occurs at a slower rate compared with Western women. Future studies should explore trajectories of physical activity through pre-pregnancy, pregnancy and postpartum stages.

Evenson’s group have published two reports of postpartum MVPA in non-bouts based on repeated accelerometer monitoring among American women (Troiano cut-point). Estimates of MVPA from the first 7 months postpartum and from 12-17 months postpartum indicate an increasing trend for obese women (from 6 to 9 MVPA minutes/day) [111], and for White middle class women (from 13 to 17 MVPA minutes/day) [112]. The different device used for measurement of MVPA in the present thesis makes comparison difficult, but the higher level of MVPA among Western women (43 minutes/day of MVPA in bouts) is surprising given the results for the White American women reported by Evenson and co-workers. A possible explanation is that Norwegian women are entitled to an extended period of subsidized maternity leave during the first year after birth, which may leave more time for recreational activities.

6.2.2. Prognostic modelling of physical activity

The prognostic model developed to predict non-compliance with the physical activity guideline in mid-pregnancy showed that women with South Asian or Middle Eastern background, multiparous women, women with high body fat percent, and women who reported few physically active friends were at increased risk of non-compliance with the physical activity guideline (paper II). At the same time, the tests of discriminatory performance revealed that the predicted outcome was false for one in four women.

While there exist multiple studies of factors associated with physical activity (invariably referred to as determinants, correlates and predictors), no identified studies have tested the discriminatory performance of these factors. In paper II, our aim was to extend previous research by testing the discriminatory performance of a prognostic model of non-compliance with the physical activity guideline. While the validity of the model could
not be assessed in an external sample, the relevance/generalizability of the predictors included in the prognostic model may be suggested by previous studies that originate in other samples. Factors inconsistently associated with physical activity in previous studies are probably less suitable as prognostic factors, since the inconsistent pattern indicate they are well suited in certain populations, but not in others. Behavioural constructs defined as intrapersonal factors, such as intention and self-efficacy did not qualify for the final prognostic model, despite evidence that these factors are central in understanding physical activity behaviour [3, 17]. Also, in contrast with previous evidence of association between physical activity and pregnancy-related conditions such as nausea and pelvic girdle pain [3, 17, 163], we observed no prognostic value of these factors with respect to guideline non-compliance in mid-pregnancy. The review of demographic determinants of physical activity presented by Gaston and Cramp [3] showed that the most consistent determinants of self-reported physical activity were being white, higher education, not having other children in the home, and being physically active prior to pregnancy.

The association between ethnicity and physical activity was elaborated on in the previous paragraph, hence, it will suffice to note here that there is “external” support from studies based on other samples that ethnic group is a relevant predictor of non-compliance with the physical activity guideline.

The consistency of educational level as a determinant of physical activity was not reflected in the prognostic mode. Educational level was one the candidate predictors considered, but did not qualify for inclusion in the final model. This is perhaps surprising, but two studies published after the review by Gaston and Cramp indicate an inverse association between educational level and physical activity [5, 82]. Furthermore, the presence of ethnic group as one of the predictors in the model probably explains why neither educational level nor occupational group qualified, as ethnicity is correlated with these two variables.

We observed a fivefold risk of non-compliance with the physical activity guideline for multiparous compared with nulliparous women (paper II). The consistent finding of a strong inverse association between number of children and physical activity supports this association [3]. One single study, based on accelerometer data, apparently contradicted
this association, but since the positive association between number of children and physical activity reported by Hayes and co-workers included light physical activity, this finding does not refute our finding [5]. Looking after other children in the home may certainly affect total physical activity, but the operationalisation of physical activity employed by Hayes and co-workers precludes the possibility to assess if light or moderate-intensity physical activity is positively influenced. Looking at the findings from the two studies in tandem suggests that light physical activity is more prone to increase in response to looking after children.

We observed that body fat percentage was also positively associated with risk for non-compliance with the physical activity guideline. This finding raise questions concerning the result reported in Gaston and Cramp’s review article; that the association between body weight/BMI and physical activity is inconclusive [3]. The studies reviewed by Gaston and Cramp were based on self-reported physical activity, which may have biased the results. Studies based on objectively recorded physical activity published after this review article have consistently demonstrated an inverse association between BMI and physical activity [99, 100, 102, 105]. Given the evidence stemming from several studies based on objective recording of physical activity, there is reason to assume that body fat percentage is a relevant predictor of non-compliance with the physical activity guideline.

The first three predictors may be conceived of as demographic or anthropometric intrapersonal factors. The socio-ecological framework within which the prognostic model was developed also required consideration of factors at the interpersonal and environmental level. We explored a number of factors, but only one interpersonal factor qualified for the final model: Physically active friends expressed by how many friends the participant perceived to perform regular physical activity. Strictly speaking, a perception reflects an individual’s own assessment, and could therefore be defined as an intrapersonal factor. However, it can be argued that this measure is a proxy measure for an interpersonal dimension. No previous studies based on objectively recorded physical activity have reported a similar finding. However, discrepant results from two previous studies make it less obvious that perception of physically active friends is a predictor with good external validity. Leppanen and co-workers [159] reported that the physical activity level of the spouse was positively associated with physical activity during pregnancy. In
contrast, Haakstad and co-workers [162] found no association between the exercise habits of friends and physical activity in 3rd trimester. The latter cohort was relatively homogeneous in terms of ethnicity and educational level (Scandinavian women with higher education) [162], which may indicate less variation in terms of friends’ exercise habits (given that most highly educated women have friends who perform regular exercise). Furthermore, the use of self-reported physical activity may have introduced bias. Future studies based on objectively recorded physical activity are needed to assess the external validity of physically active friends as a relevant predictor of physical activity outcomes.

Self-reported pre-pregnancy physical activity did not qualify for the final model. This may seem odd, since most studies suggest a strong association between pre-pregnancy physical activity and physical activity during pregnancy [3, 159, 161, 162]. The discrepancy with previous findings may be a result of previous studies’ use of self-reported physical activity, while in the present thesis, physical activity during pregnancy was objectively recorded and pre-pregnancy physical activity was self-reported. Our findings corroborate the results in a previous study based on self-reported pre-pregnancy physical activity and objectively recorded physical activity during pregnancy [106].

As emphasised already, the rationale for developing a prognostic model is not to study mechanisms that can explain or change physical activity behaviour; rather, the aim is to foresee individuals at increased risk of insufficient physical activity. A review of interventions to promote physical activity during pregnancy indicated that none of the effective interventions included high risk groups [247], which could indicate that targeting specific groups and tailoring interventions for specific individuals are needed to successfully promote physical activity. In the STORK-G cohort, we observed that three out of four women did not comply with the physical activity guideline (paper II). The clinical relevance of predicting non-compliance with the physical activity guideline in a population were the proportion who does not comply approaches 75%, may be questioned. The size of this proportion makes a strong argument for population-based and structural strategies to promote physical activity rather than high-risk strategies. Nonetheless, public health initiatives based on a combination of community-based and high-risk strategies in physical activity promotion have been recommended [248]. In
hindsight, it can be seen that a continuous outcome measure would have yielded more nuanced information about the full spectrum of physical activity levels in the cohort. The analysis of a crude binary outcome reduces the amount of information that can be extracted from the prognostic model. A prognostic model that more precisely classified an individual in a specific physical activity segment (e.g. 0-50 MVPA minutes/week or 51-100 MVPA minutes/week) would aid healthcare workers in identifying individuals with the highest likelihood for the lowest physical activity levels.

6.2.3. Access to recreational areas and physical activity

No previous studies of pregnant or postpartum women have demonstrated the positive association reported in paper III between good access to recreational areas and MVPA. Encouragingly, the association remained constant across time points in pregnancy and postpartum, and the association was equally positive for diverse ethnic groups and across socioeconomic position scores. It is important to bear in mind that there was no information about the locations of physical activity participation. Hence, the results did not confirm that recreational areas in the neighbourhoods were the actual location for physical activity. Combination of objective recording of physical activity and GPS data would provide a more direct evidence of this association.

Most previous studies of the influence of the neighbourhood environment on physical activity were purely descriptive in terms of environmental barriers reported by pregnant women [142, 143]. I am aware of only one previous study that report an estimation of the association between the physical neighbourhood environment and physical activity during pregnancy; Laraia and co-workers [144] analysed data from a multi-ethnic sample in the US where 66% were categorised as non-Hispanic Black. They constructed a scale to measure social spaces (i.e. parks, sidewalks and presence of people) in the neighbourhood. Self-reported physical activity referred to the pre-defined activities swimming, jogging, aerobics, fast dancing and moderate to fast bicycling, which were characterised by intensities ≥6 METs. In conflict with our findings, they reported no association between social spaces and physical activity. The analysis of vigorous-intensity physical activity, exclusively, and the crude and binary physical activity outcome (a woman was categorised
as vigorously active if she self-reported at least one of the pre-defined activities) may explain the lack of association.

While our finding is novel with respect to physical activity during pregnancy and postpartum, a number of studies of non-pregnant cohorts exist. According to a review article, there are mixed findings concerning the associations between types of recreational settings and physical activity, but a more consistent positive association between the proximity to recreational areas and physical activity [138]. According to a more recent systematic review, the association between access to parks and physical activity is inconsistent probably as a result of different methods for measuring access [136]. Interestingly, the authors noted stronger associations with physical activity for perceived versus objective measures of the park environment [136]. Also, studies based on GIS data with smaller buffer sizes surrounding home addresses demonstrated stronger associations with physical activity than studies with larger buffer sizes [136]. Several studies of non-pregnant samples also provide support for the particular positive association between recreational areas and physical activity among women [249, 250]. Kaczynski and co-workers [250] noted that the number of neighbourhood parks and total park area within 1 km from residential address had a more positive relationship with respect to women’s physical activity contrasted with men’s physical activity level. They speculated that the higher prevalence of female homemakers and the subsequent likelihood of more frequent use of the neighbourhood was an underlying explanation [250]. This interpretation may have particular relevance during pregnancy and postpartum, during which more women spend more time at home.

The current analysis does not provide details on the mechanisms by which access to recreational areas (objective or perceived) influence physical activity behaviour. However, the analysis of both objective and perceived measures of the environment can enhance the understanding of the interactions between the environment and perceptions of the environment, in line with the socio-ecological approach [15]. We observed no interaction between the two measures of access, both measures were positively associated with MVPA, and a mismatch between the two measures was evident. This finding suggests that initiatives that modify perceptions of access and improve structural access to recreational areas in the neighbourhood both may positively influence physical activity
behaviour [251]. However, interventions must be informed by a more solid understanding of the mechanisms between access to recreational areas and physical activity. Analyses of these mechanisms are beyond the scope of this thesis. Good access to recreational areas may influence physical activity via the creation of social space and the possibility to meet neighbours, make friends and go for walks together [252]. There is also empirical evidence suggesting that the neighbourhood walkability (including access to infrastructure for walking/cycling) modifies the association between self-efficacy and physical activity, and empirical data indicate this is of particular benefit for overweight women with low self-efficacy [253]. Furthermore, evidence suggests that women’s perception of a supportive physical activity environment has particular importance for the physical activity level of women with less favourable psychosocial characteristics (family support, friend support, childcare) [254]. Analysis of these mechanisms have not been conducted on data collected among pregnant women, and there is an evident gap that future research must fill.
7. Summary and conclusion

The objective nature of the physical activity data analysed and reported in the present thesis provides more valid estimates of the level and development of physical activity during pregnancy into postpartum and more valid estimates of the ethnic differences in physical activity and the potential influence of access to recreational areas on physical activity.

The present thesis show that ethnic minority women of South Asian origin are less physically active than Western women in early pregnancy, with respect to MVPA hours/day in non-bouts and steps/day. Across all ethnic groups, MVPA minutes/day in bouts decreased between early and mid-pregnancy before an increase postpartum. However, the increase between mid-pregnancy and postpartum was significantly steeper for Western women compared with South Asian and Middle Eastern women. Postpartum MVPA for South Asian and Middle Eastern women was not significantly different from early pregnancy.

A lower proportion of South Asian (14%) and Middle Eastern (16%) women met the physical activity guideline in mid-pregnancy compared with Western women (35%). A prognostic model that included ethnic background, parity, body fat percent and physically active friends correctly predicted non-compliance with the physical activity guideline for three out of four women.

Objective and perceived access to recreational areas were positively associated with MVPA minutes/day in bouts and the association was constant across time points in pregnancy and postpartum. Women with good objective access to recreational areas performed approximately 60 additional MVPA minutes/week compared with those with limited access. Women who perceived access to recreational areas as high performed approximately 35 additional MVPA minutes/week compared with those who perceived access as low. The association between access to recreational areas and MVPA was equal across ethnic groups and socioeconomic positions. Despite the positive association between both perceived and objective access to recreational areas and MVPA, there was poor agreement between the two measures of access.
8. Implications

Future research

Future research must determine the underlying causal mechanisms that explain the observed ethnic differences in physical activity. Analyses must build on relevant operationalisation of ethnicity, and avoid lumping together different minority groups. Model building should address mediation by incorporation of factors at different levels of the socioecological framework.

The present thesis has demonstrated that a low proportion do not meet the physical activity guideline in mid-pregnancy. While population-wide strategies are required, there is also a need for research that contribute more exact approaches for identifying women that will not achieve the recommended levels of physical activity. Knowledge about the predictability and unpredictability of outcomes (e.g. physical activity behaviour) is fundamental scientific knowledge, per se [150]. The dearth of prognostic studies in the field of physical activity behaviour during pregnancy has left many unanswered questions concerning the prognostic value of many behavioural theoretical constructs. In the future, testing prognostic models in external samples can provide crucial knowledge about the prognostic accuracy and external validity of factors already identified as internally valid physical activity correlates or determinants.

Commonly used measures of association (odds ratios, regression coefficients) do not reflect within-group heterogeneity, hence, integrating measures of discriminatory performance can be used to assess the heterogeneity of crude prognostic factors/categories and to explore how the well prognostic factors and categorisations perform with respect to outcome prediction of physical activity outcomes at the individual level [123].

This thesis includes the first study of the association between access to recreational areas and physical activity in pregnancy and postpartum based on objective methods. The exposure was measured at the neighbourhood level (defined by proportion of residents with good access), but objective data on access to recreational area measured at the individual level would contribute more exact knowledge about the dose-response
relationship with physical activity. Furthermore, research into other neighbourhood features that define walkability, as well as features characterising the social environment of the neighbourhood, are needed to better understand physical activity behaviour in pregnancy/postpartum given the contextual complexities and interactions with individual level factors. In tandem with objective monitoring of physical activity, the possibility to integrate GPS technology to collect data on the location of physical activity can potentially lead to a better understanding of factors to inform public physical activity promotion initiatives.

**Implications for physical activity promotion in pregnancy/postpartum**

While the observational methods that underpin the present thesis inhibits strong causal assumptions, the findings from the present descriptive, explanatory and predictive analysis can inform clinical practice.

The frequent encounters between pregnant women and health workers during pregnancy provides a window of opportunity to promote a healthy lifestyle. The finding that 75% of pregnant women did not meet the physical activity guideline and the reported challenges in accurately predicting who will meet and not meet the physical activity guideline (prediction was wrong for 1 in 4 women), makes a strong case for population-wide strategies to promote physical activity during pregnancy. Motivational interviewing for all pregnant women is but one example of an initiative that reach all pregnant women.

The positive association between access to recreational areas and MVPA was equal across ethnic groups. Since GDM risk is elevated in the same ethnic minority groups, and since walking and GDM are inversely related [176], initiatives that improve structural access to recreational areas may have particular relevance for the health among pregnant women in multi-ethnic city districts.
9. References


10. Appendices

Appendix 1: Case Report Form 1.1 (visit 1) in Norwegian and English
Appendix 2: Case Report Form 1.2 (visit 1) in Norwegian and English
Appendix 3: Physical Activity Questionnaire (visit 1) in Norwegian and English
Appendix 4: Informed consent form
Appendix 5: Approval by Ethical Committee
Appendix 6: Approval by the Norwegian Data Protection Authority
Appendix 7: Electronic supplement to Paper III: additional file 2
STORK Groruddalen

CRF 1. TRIMESTER - SKJEMA 1

Kode intervjuer

Intervjuers initialer

Undersøkelsesdato

Svangerskapsuke

Kvinnens fødselsdato

Bosteds-postnummer

Undersøkelsesbydel


Forklaring til utfyllingen:
Bruk blå eller svart kulepenn. De fleste steder settes kryss eller tall. Bruk ellers store bokstaver og en bokstav per rute. Sett kryss mest mulig nitt i avkryssningsboksen. Dersom feil i utfyllingen, marker dette ved å sette tre streker over boksen og kryss av på vanlig måte i den riktige boksen. Dersom behøv for å notere ned ytterligere informasjon ut over hva det er avsatt plass til på skjemaet, kan du notere dette i marginen. Bare sørger for at du ikke skriver i avkryssningsboksene eller notatfelter. Eksempel på utfylling:

[Ja] [Nei] 2256 gram

Tekst i kursiv under spørsmålet, før svarkategoriene, er informasjon til intervjueren og skal ikke leses opp for kvinnen.

DEMograFI

1. Hvilken sivilstand har du nå?

[ ] Gift  [ ] Partnerskap  [ ] Samboer  [ ] Enslig  [ ] Skilt/soparert  [ ] Enke  [ ] Annet

2. Hvilken utdannelse har du nå?

Kryss først av før høyeste fullførte eller aveluttede-, og evt. pågående utdanning, og angi deretter antall år for disse kategoriene. Se evt. prosedyrebok 2.4.2

<table>
<thead>
<tr>
<th>Antall år</th>
</tr>
</thead>
</table>

- Under 7 års skolegang
- Grunnskole (7-9-års skolegang)
- 1-2-årig gymnasavereg./yrkesskole(10-11år)
- 3-årig gymnasavereg./yrkesskole(12år)
- Distrikthøgskole, universitet, inntil 4 år (Sykepleier, læger, Bachelor)
- Høgskole, universitet > 4 år (Hovedfag, Mester, embetseksamen)
3. Hva var arbeidsituasjonen for deg da du ble gravid?

☐ Under utdanning
☐ Hjemmeværende
☐ Arbeidssøkende/permittart
☐ Attføring/ufør
☐ Ansatt i offentlig virksomhet
☐ Ansatt i privat virksomhet
☐ Annet

Hvis annet, hva?:


Angi Yrkesnummer, normalt med 4 siffer, i forhold til STRYK-klassifisjonen. Se prosedyrebok 2.4.2, øv et eget høste. 1.siffer fremgår av nummer på hovedklassen. Hvis ikke det siste siffer er kjent, skriv de 3 første og la den siste boksen stå tom.

1. Administrative leder og politikere

2. Akademiske yrker

3. Yrker med kortere høyskole og universitetsutdanning og teknikere

4. Kontor- og serviceyrker

5. Salgs-, service- og omsorgsyrker

6. Yrker innen jordbruk, skogbruk og fiske

7. Håndverkere

8. Prosess- og maskinoperatører, transportarbeidere mv

9. Yrker uten krav til utdanning

0. Militære yrker og uoppgitt

Hjemmeværende

Hvis yrket ikke er klassifiserbart, angi:
5. Hvilket trossamfunn/religion tilhører du? Se evt. prosedurebok 2.4.2

- [ ] Kristne kirkesamfunn
- [x] Islam
- [ ] Den Ortodokse kirken
- [ ] Hinduisme
- [ ] Den Koptiske kirken
- [ ] Sikhisme
- [ ] Den Katolske kirken
- [ ] Buddhisme
- [ ] Adventister
- [ ] Taoisme
- [ ] Jehovas vitner
- [ ] Ingen trossamfunn
- [ ] Mormonere

* Følsomt betegnelse, for frimenigheter og statskirken i Norge, samt den anglikanske kirken.
** Spesielt Etiopia, Eritrea og Egypt.
*** Tradisjonell kinesisk religion. Spesielt kinesere og vietnamesere.

6. Hvilket land er du født i?:

- [ ] Sverige
- [ ] Marokko
- [ ] Eritrea
- [ ] Danmark
- [ ] Somalia
- [ ] Etiopia
- [ ] Storbritannia
- [ ] Polen
- [ ] Ghana
- [ ] Tyskland
- [ ] Russland
- [ ] Nigeria
- [ ] Tyrkia
- [ ] Serbia
- [ ] Annet europeisk land
- [ ] Irak
- [ ] Albania
- [ ] Annet afrikansk land
- [ ] Iran
- [ ] Kosovo
- [ ] Annet asiatick land
- [ ] Pakistan
- [ ] Kina
- [ ] Annet amerikansk land
- [ ] Sri Lanka
- [ ] Thailand
- [ ] Oceania/Australia
- [ ] Vietnam
- [ ] Chile

- [ ] Født i Norge av to norske foreldre
- [ ] Født i Norge av to utenlandske foreldre
- [ ] Født i Norge av en norsk + utenlandsk foreldre

7. Statsborgerskap i hvilket land?

- [ ] Sverige
- [ ] Marokko
- [ ] Eritrea
- [ ] Danmark
- [ ] Somalia
- [ ] Etiopia
- [ ] Storbritannia
- [ ] Polen
- [ ] Ghana
- [ ] Tyskland
- [ ] Russland
- [ ] Nigeria
- [ ] Tyrkia
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- [ ] Annet europeisk land
- [ ] Irak
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- [ ] Kosovo
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- [ ] Pakistan
- [ ] Kina
- [ ] Annet amerikansk land
- [ ] Sri Lanka
- [ ] Thailand
- [ ] Oceania/Australia
- [ ] Vietnam
- [ ] Chile
Unikt pas. løpnummer: [ ]

Hvis etnisk skandinavisk, gå til spørsmål 12.

8. Hvilken etnisk gruppe(felles språk, kultur, historie) føler du at du tilhører?

Angi land: [ ]

9. Hva er ditt morasmål?

☐ Urdu
☐ Arabisk
☐ Somali
☐ Tamilsk
☐ Tyrkisk
☐ Vietnamesisk
☐ Sorani
☐ Kinesisk
☐ Persisk
☐ Fransk
☐ Spansk
☐ Portugisisk
☐ Engelsk
☐ Tysk
☐ Flamsk/Nederlandsk
☐ Annet europeisk språk
☐ Annet afrikansk språk
☐ Annet asiatisk språk
☐ Annet

10. Hvis ikke etnisk skandinavisk: Hvordan vi du si dine norskkunnskaper er?

☐ Svært gode
☐ Gode
☐ Middels gode
☐ Litt dårlige
☐ Dårlige

11. Bruker du vanligvis tolk når du er hos lege?

☐ Ja, profesjonell
☐ Ja, familie/venn
☐ Nei

TIDLIGERE SVANGERSKAP/HELSFORHOLD

12. Har du vært gravid tidligere? (Tenk også på svangerskap som endte med aborter eller dødfødsler)

☐ Nei
☐ Ja

Hvis nei, gå til spørsmål 14

Hvis ja:
Antall levende født: [ ]
Antall dødfødt: [ ]
Antall spontanaborter: [ ]
Antall provoserte aborter: [ ]
Antall svangerskap utenfor livær: [ ]
13. Jeg vil nå spørre deg om tidligere svangerskap som har vart mer enn 22 uker.

*Hvis mer enn 1 barn per svangerskap, la twilling 1 telle som det aktuelle nummer på barnet, twilling 2 som neste barn.*

<table>
<thead>
<tr>
<th>1. barn:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fødselsår:</strong></td>
<td></td>
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<tr>
<td><strong>Fødselsåret for fødsel:</strong></td>
<td></td>
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<tr>
<td><strong>Fødselsvekt i gram:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Kjønn:</strong></td>
<td>☐ Gutt ☐ Jente</td>
</tr>
<tr>
<td><strong>Fødested:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Hvis flere tiltak:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Førelsesmåte:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Frisk i første levemyke?</strong></td>
<td>☐ Ja ☐ Nei</td>
</tr>
<tr>
<td><strong>Hvis nei:</strong></td>
<td>☐ Frisk nå ☐ Syk nå ☐ Død</td>
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<tr>
<td>☐ Norge</td>
<td>☐ Twällinger</td>
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<tr>
<td>☐ Eget fødested</td>
<td>☐ Trillinger</td>
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<tr>
<td>☐ Annet</td>
<td>☐ Vakuum</td>
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<td></td>
<td>☐ Keisersnitt</td>
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<th>2. barn:</th>
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<td><strong>Fødselsvekt i gram:</strong></td>
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<td><strong>Hvis flere tiltak:</strong></td>
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<th>3. barn:</th>
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<td><strong>Fødselsvekt i gram:</strong></td>
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<td><strong>Fødested:</strong></td>
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<td><strong>Hvis flere tiltak:</strong></td>
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<td><strong>Førelsesmåte:</strong></td>
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<tr>
<td><strong>Frisk i første levemyke?</strong></td>
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<tr>
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</table>

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<th>4. barn:</th>
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<tr>
<td><strong>Fødselsåret for fødsel:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fødselsvekt i gram:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Kjønn:</strong></td>
<td>☐ Gutt ☐ Jente</td>
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<tr>
<td><strong>Fødested:</strong></td>
<td></td>
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<tr>
<td><strong>Hvis flere tiltak:</strong></td>
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<tr>
<td><strong>Førelsesmåte:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Frisk i første levemyke?</strong></td>
<td>☐ Ja ☐ Nei</td>
</tr>
<tr>
<td><strong>Hvis nei:</strong></td>
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<tr>
<td>☐ Norge</td>
<td>☐ Twällinger</td>
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<tr>
<td>☐ Eget fødested</td>
<td>☐ Trillinger</td>
</tr>
<tr>
<td>☐ Annet</td>
<td>☐ Vakuum</td>
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<tr>
<td></td>
<td>☐ Keisersnitt</td>
</tr>
</tbody>
</table>
Unikt pas. løpenummer: □ □ □ □ □ □ □

5. barn:

<table>
<thead>
<tr>
<th>Fødselsår:</th>
<th>Svangerskapssuka for fødsel:</th>
<th>Fødselsvekt i gram:</th>
<th>Kjenn:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Gutt □ jente</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fødested:</th>
<th>Hvis flerlingefødsel:</th>
<th>Førlesningsmetode:</th>
<th>Frisk i første levaus?:</th>
<th>Hvis nei:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Morge</td>
<td>□ Tvillingar</td>
<td>□ Vanlig vaginal</td>
<td>□ Ja</td>
<td>□ Frisk nå</td>
</tr>
<tr>
<td>□ Eget fødeland</td>
<td>□ Trillingar</td>
<td>□ Tang</td>
<td>□ Nei</td>
<td>□ Syk nå</td>
</tr>
<tr>
<td>□ Annet</td>
<td></td>
<td>□ Vakuum</td>
<td>□ Død</td>
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</tbody>
</table>

**Hvis mer enn 5 barn - legg til ekstraskr og stift dette sammen med resten.**


<table>
<thead>
<tr>
<th>Diabetes type 1</th>
<th>□ Ja □ Nei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes type 2</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Stoffskiftesykdom *</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Astma</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Allergi</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Gjentatte urinveisinfeksjoner</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Kronisk nyresykdom</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Vedvarende høyt blodtrykk</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Leddgikt/Blochterorv</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Bjørkesykdom *</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Epilepsi</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Underlivs-sykdom/operasjon *</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Uforvillig barnløshet &gt; 1 år</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Sykdom i mage/tarm</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Psykisk sykdom *</td>
<td>□ Ja □ Nei</td>
</tr>
<tr>
<td>Annet</td>
<td>□ Ja □ Nei</td>
</tr>
</tbody>
</table>

15. Hvor gammel var du da du fikk din første menstruasjon?

Angi alder i år: □ □
16. Har du hatt svangerskapsdiabetes i tidligere svangerskap?
   Hvis ja - i hvilke(t) svangerskap? I hvilken svangerskapsuke fikk du stilt diagnosen? Brukte du insulin?

<table>
<thead>
<tr>
<th>Svangerskapsuke</th>
<th>Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. svangerskap</td>
<td>Ja</td>
</tr>
<tr>
<td>2. svangerskap</td>
<td>Ja</td>
</tr>
<tr>
<td>3. svangerskap</td>
<td>Ja</td>
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<tr>
<td>4. svangerskap</td>
<td>Ja</td>
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<td>5. svangerskap</td>
<td>Ja</td>
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<tr>
<td>6. svangerskap</td>
<td>Ja</td>
</tr>
<tr>
<td>7. svangerskap</td>
<td>Ja</td>
</tr>
<tr>
<td>8. svangerskap</td>
<td>Ja</td>
</tr>
</tbody>
</table>

17. Er det arvelige sykdommer i familien?
   □ Ingen kjente □ Ja

   Hvis ja, angi:
   □ Hjerte-kar sykdom □ øyksk sykdom
   □ Diabetes □ Leddssykdom
   □ Krevetssykdom □ Muskelssykdom
   □ Nervologisk sykdom □ Annet

   Hvis annet, angi:

Hvis diabetes eller hjertesykdom, henvis til CRF 1.3 for mer detaljer

18. Er du og barnets far i slekt?
   □ Ja □ Nei

   Hvis ja, er barnesfaren din:
   □ Føtter □ 3-menn □ 4-menn □ Onkel □ Nevs □ Annet

19. Har du noen gang røykt/brukt snus?

   Røyk:
   □ Aldri □ Av og til □ Ja, daglig

   Snus:
   □ Aldri □ Av og til □ Ja, daglig

   Hvis aldri på begge, gå til spørsmål 23.

20. Røykte du/brukte du snus de siste 3 månedene før du ble gravid denne gangen?

   Røyk:
   □ Aldri □ Ja, av og til □ Ja, daglig

   Snus:
   □ Aldri □ Ja, av og til □ Ja, daglig
21. Røyker du/snuser du nå?
   Røyk: □ Aldri □ Ja, av og til □ Ja, daglig
   Snus: □ Aldri □ Ja, av og til □ Ja, daglig

22. Hvor gammel var du da du begynte å røyke? Angi alder:   
   Hvis du har røykt tidligere, men ikke røyker nå, hvor gammel var du da du sluttet? Angi alder:   

23. Ditt alkoholforbruk:
   Siste 3 mnd før svangerskap:
      □ Aldri □ Av og til □ Ja, daglig
      Antall alkoholenheter vanligvis:   
   Nå:
      □ Aldri □ Av og til □ Ja, daglig
      Antall alkoholenheter vanligvis:   
   Antall alkoholenheter - 1 enhet er: 1 glass vin, 0,331 øl, 1 likørglass

24. Siste menstruasjons 1. blødningsdag:
   Dato:   

25. Termin før ultralyd:
   Dato:   □ Sikker □ Usikker

26. Anslå din vekt i kg:
   Rett før du ble gravid:   25 år gammel:   18 år gammel:   

27. Anslå din høyeste og laveste vekt (i kg) utenom graviditet etter at du var 18 år.
   Høyeste:   Laveste:   
   Kommentar hvis forskjell >20kg

EVENTUELLE VIKTIGE SUPPLERENDE KOMMENTARER TIL SVAR PÅ SPØRSMÅL:

Spørsmålsnummer: □ Kommentar □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □

Du kan også gi ytterligere utfyllende kommentarer her:

TAKK FOR AT DU HAR TATT DEG TID TIL Å SVARE PÅ SPØRSMÅLENE!
FORM 1.1 (CRF 1.1)
(For information: If*: The interviewer must fill in the right category/code)

1. **What is your current marital status?**
   - □ Married
   - □ Partnership
   - □ Cohabitant
   - □ Single
   - □ Divorced/separated
   - □ Widow
   - □ Other

2. **What is your level of education?**
   - [ ] □ Completed
   - [ ] □ Attending now
   - [ ] □ No. of years
   - [ ] □ Less than 7 years’ schooling
   - [ ] □ Primary school (7-9 years’ schooling)
   - [ ] □ 1-2 years’ upper sec./vocational school (10-11 yrs)
   - [ ] □ 3-year upper sec./vocational school (12 years)
   - [ ] □ District college, university, up to 4 years
     - (Nurse, teacher, Bachelor’s degree)
   - [ ] □ University college, university, more than 4 years
     - (Master’s, PhD)

3. **What was your work situation when you became pregnant?**
   - □ Attending educational institution
   - □ Housewife
   - □ Job-seeker/laid off
   - □ Rehabilitation/disabled
   - □ Employed in the public sector
   - □ Employed in the private sector
   - □ Other
     - If other, what?: ………………………

4. **What is your occupation? State occupation/job title**
   - √ ………………………………………
   (Answer even if you are temporarily not working due to illness/leave)

5. **Which religious community/religion do you belong to?**
   ………………………………………

6. **Which country were you born in? Indicate which country**
   ………………………………………
   If Norway:
   - □ Born in Norway of two Norwegian parents
   - □ Born in Norway of two foreign-national parents
   - □ Born in Norway of one Norwegian + one foreign-national parent

7. **Citizenship in which country? Indicate which country**
   ………………………………………
8. (If the country of birth and ethnic group do not appear to agree (e.g. “Indian” but born in Kenya, Uganda, South-Africa) Which ethnic group (common language, culture, history) do you feel you belong to?: …………………………………………………………………………..

9. What is your native language? State language* …………………………………

10. How do you rate your Norwegian language skills? □ Very good □ Good □ Fair □ Not very good □ Poor

11. Do you normally use an interpreter for doctor’s appointments? □ Yes, professional □ Yes, family/friend □ No

12. Have you been pregnant before? (Also consider pregnancies that ended in miscarriage/abortion or with a stillbirth)
□ No □ Yes If yes:
Number born alive: □□ Number stillborn: □□ Number of spontaneous miscarriages: □□ Number of induced abortions: □□ Number of ectopic pregnancies (outside the uterus): □□

13. I am now going to ask you about earlier pregnancies that have lasted more than 22 weeks.
(If more than 1 child per pregnancy, count twin 1, twin 2.)
(For each child)
Year of birth: □□□□ Pregnancy week for birth □□ Baby’s weight in grams □□□□
Gender: Boy □ Girl □ Place of birth: □ Norway □ Own native country □ Other
Method of delivery: □ Normal vaginal □ Forceps □ Vacuum □ Caesarean section
If multiple birth: □ Twins □ Triplets
Healthy the first week?: □ Yes □ No If no: □ Healthy now □ Ill now □ Dead

14. Do you have/have you had any of the following illnesses? (Some diagnoses will mean that the woman cannot take part in the study) (If yes, state the year the diagnosis was made).

<table>
<thead>
<tr>
<th>Illness</th>
<th>Yes</th>
<th>No</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes type 1</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Diabetes type 2</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Allergy</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Repeated urinary tract infections</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Prolonged high blood pressure</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
</tbody>
</table>
Heart disease □ Yes □ No
Arthritis/Bechterew’s disease □ Yes □ No
Epilepsy □ Yes □ No
Disease of the uterus/operation □ Yes □ No
Involuntary infertility more than 1 year □ Yes □ No
Mental illness □ Yes □ No
Abdominal/intestinal disorder □ Yes □ No
Metabolism disorder □ Yes □ No
Other: ……………… □ Yes □ No

15. How old were you when you menstruated for the first time? State age in years: □□

16. Have you had pregnancy diabetes during a previous pregnancy?
If yes - which pregnancy? In which pregnancy week were you diagnosed? Did you use insulin?

<table>
<thead>
<tr>
<th>Pregnancy week</th>
<th>Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>2nd pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>3rd pregnancy</td>
<td>□□</td>
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<tr>
<td>4th pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>5th pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>6th pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>7th pregnancy</td>
<td>□□</td>
</tr>
<tr>
<td>8th pregnancy</td>
<td>□□</td>
</tr>
</tbody>
</table>

17. Are there any inheritable diseases in the family?
□ None I know of □ Yes If yes, tick the appropriate box/boxes:

□ Cardio-vascular disease □ Diabetes
□ Cancer □ Neurological disease
□ Mental illness □ Arthritis
□ Muscular disorder □ Other If other, state:…………………………

18. Are you and the father of the child related?
□ Yes □ No

If yes, is the father of the child your:
19. Have you ever smoked/used snus?
Smoked: □ Never □ Sometimes □ Yes, daily
Snus: □ Never □ Sometimes □ Yes, daily

If the answer is never to both, go to question 23.

20. Did you smoke/use snus during the last 3 months before this pregnancy?
Smoking: Snus:
□ Never Number of cigarettes/daily □ Never
□ Yes, sometimes □□ □ Yes, sometimes
□ Yes, daily □□ □ Yes, daily

21. Do you smoke/use snus now?
Smoking: Snus:
□ Never Number of cigarettes/daily □ Never
□ Yes, sometimes □□ □ Yes, sometimes
□ Yes, daily □□ □ Yes, daily

22. How old were you when you started to smoke? State age: □□
If you have smoked previously, but do not smoke now, how old were you when you quit?
State age: □□

23. Your alcohol consumption:
Last 3 months before pregnancy:
□ Never □ Sometimes □ Yes, daily Amount of alcohol units, normally: □□

Now: □ Never □ Sometimes □ Yes, daily Amount of alcohol units, normally □□

(Number of alcohol units – 1 unit is: 1 glass of wine, 0.33 litres of beer, 1 glass of liquor)

24. Last menstruation’s 1st day of bleeding:
Date:………..

25. Term before ultrasound:
Date:……….. □ Certain □ Uncertain

26. Estimate your weight in kilos:
Right before you became pregnant: □□□ 25 years old: □□□ 18 years old: □□□
27. Estimate your highest and lowest weight (in kilos), not including pregnancies, after you turned 18 years of age.

Highest: □□□  Lowest: □□□

Comment if the difference as greater than 20 kilos ………………………………………

THANKS FOR TAKING THE TIME TO ANSWER THESE QUESTIONS!
Appendix 2
Case report form 1.2
(Norwegian/English)
Unikt pas. løpenumner: 

STORK Groruddalen

CRF 1. TRIMESTER - SKJEMA 2

Kode intervjuer  
Intervjuers initialer  
Undersøkelsesdato  
Svangerskapsuke  

Kvinnens fødselsdato  
Bosteds-postnummer  
Undersøkelsebydel  


Forklaring til utfyllingen:
Bruk blå eller svart kulepenn. De fleste steder settes kryss eller tall. Brukellers store bokstaver og en bokstav per rute. Sett kryss mest mulig midt i avkryssningsboksen. Dersom feil i utfyllingen, marker dette ved å sette tre streker over boksen og kryss av på vanlig måte i den riktige boksen. Dersom behov for å notere ned ytterligere informasjon ut over hva det er avsatt plass til på skjemaet, kan du notere dette i margen. Bare sørg for at du ikke skriver i avkryssningsboksene eller notatfelter. Eksempel på utfylling:

☐ ja  ☐ nei  2256 gram

NB: Tekst i kursiv under spørsmålet, før svarkategoriene, er informasjon til intervjueren og skal ikke leses opp for kvinnen.

DEMOGRAFI

31. Hvis i lønnet arbeid - hvor stor stillingsandel hadde du de siste 3 måneder før du ble gravid?
Hvor stor stillingsandel har du nå? Gjelder uavhengig av evt. sykmelding

Før svangerskapet ☐ ☐ %  Nå ☐ ☐ %

32. Hvis i lønnet arbeid - er du fraværende fra ditt vanlige arbeid nå?
☐ Ja  ☐ Nei  ☐ Delvis

33. Hvis svart ja eller delvis på spørsmål 32: Hva er årsaken til fraværet? Sett evt. flere kryss:
☐ Sykmelding  ☐ Førnavn  ☐ Sykt barn  ☐ Annet

34. Hvis i lønnet arbeid - har du vært sykmeldt i tilsammen mer enn 2 uker i løpet av dette
svangerskapet? Se evt. prosedyrebk 2.4.2

Helt sykmeldt: ☐  Delvis sykmeldt:

Hvis ja, angi ca antall uker: ☐  Hvis ja, angi ca antall uker: ☐

Angi Yrkesifører, normalt med 4 siffer, i forhold til STRYK-klassifikasjonen. Se eget hæfte.
1. Siffer fremgår av nummer på hovedklassen. Hvis ikke det siste siffer er kjent, skriv de 3 første og la den siste boksen stå tom. Se evt. prosedyrebok 2.4.2

<table>
<thead>
<tr>
<th>1. Administrative ledere og politikere</th>
<th>MOR</th>
<th>FAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Akademiske yrker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Yrker med kortere høyskole og universitetsutdanning og teknikere</td>
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<td></td>
</tr>
<tr>
<td>4. Kontor- og serviceyrker</td>
<td></td>
<td></td>
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<tr>
<td>5. Salgs-, service- ogomsorgsyrker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Yrker innen jordbruk, skogbruk og fiske</td>
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<td></td>
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<tr>
<td>7. Håndverkere</td>
<td></td>
<td></td>
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<tr>
<td>8. Proses- og maskinoperatører, transportarbeidere mv</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Yrker uten krav til utdanning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0. Militære yrker og uoppgitt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hjemmeværende</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hvis yrket ikke er klassifiserbart, angi (MOR):

Hvis yrket ikke er klassifiserbart, angi (FAR):

37. Tenk på deg selv som 10 åring. Hvor mange oppholdsrom var det i leiligheten/boligen deres?

Ikke regn med kjøkken og evt. bad. Angi antall rom

Hvor mange personer bodde i leiligheten/boligen?

Angi antall personer

Eide din mor/far evt. dine foresatte bil?

Ja  Noi

38. Hva var din mors alder da du ble født?


40. Hvilket nummer i søskenflokken var du? (Med samme mor)

41. Hvor lenge har du samlet bodt i: (Angi antall år)

Den bydelen du nå bor i:     Oslo:     
42. Hvor bodde du det meste av tiden før du fylte 16 år?
Se øv. liste over bydeler i områder i Oslo i prosedyrebok 2.4.2. Ved * eller ** gå til helt markert

☐ I samme bydel som nå  ☐ I annen bydel/område i Oslo*  ☐ I annet fylke i Norge  ☐ Utenfor Norge **

*Angi ev. tidligere bydel:
☐ Indre Øst (Gamle Oslo, Sagene, Torshov, Grunerløkka-Sofienberg)
☐ Indre Vest (Frogner, Majorstua-Urlandeborg, St. Haugen)
☐ Ytre Øst (Grunerløkka, Norder, Østensjø, Lambertseter, Bærum, Sandre Nordstrand)
☐ Ytre Vest (Ullern, Rena, Vinderen, Sogn, Greifen-Kjelsås, Nordstrand, Ekeberg-Ekkelaget)

**Nvis utenfor Norge:
☐ I eget fødested  ☐ Annet

43. Hva deler du husholdning med? Sett øv. flere kryss

☐ Ektefelle/samboer  ☐ Foreldre  ☐ Sverigeforeldre  ☐ Barn  ☐ Ingen  ☐ Andre, beskriv:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

44. Hvor mange personer er der i husholdningen? Tell med deg selv

Antall personer 18 år eller over ☐ ☐ Antall personer 12-17 år ☐ ☐

Antall personer 6-11 år ☐ ☐ Antall personer under 6 år ☐ ☐

45. Hvor mange oppholdsrør (ikke regnet med kjøkken og øv. bad) er der i leiligheten/boligen der du bor? Angi antall rom

Boligtype:
☐ Leilighet i blokk/hus med flere boenheter, som 4mannsboeliig  ☐ Røkkehus  ☐ Svebelig  ☐ Annet

Eier eller leier du/dere boligen? ☐ Eier  ☐ Leier

Nvis født i Norge av to norske foreldre, gå til sp. 52

46. Hvis 1. generation innvandrer: Hvor lenge har du bodd i Norge?
Angi antall år ☐ ☐

Nvis mor ikke er 1. eller 2. generation innvandrere, gå til sp. 52

47. Er du utdannet etter innvandrerforeldre/foreldre som ikke er født i Norge?

☐ Ja  ☐ Nei

Nvis ja:
☐ Født i Norge, men begge foreldre født i utlandet
☐ Utenlandsfødt med en norskfødt forelder
☐ Norskfødt med en utenlandsfødt forelder
☐ Utenlandsfødt med utenlandske foreldre
☐ Utenlandsadopptatt
Hvis du er født i Norge, men begge foreldre er født i utlandet, angi fødeland for dine foreldre:

- [ ] Norge  [ ] Vietnam  [ ] Chile  [ ] Norge  [ ] Vietnam  [ ] Chile
- [ ] Sverige  [ ] Marokko  [ ] Eritrea  [ ] Sverige  [ ] Marokko  [ ] Eritrea
- [ ] Danmark  [ ] Somalia  [ ] Etiopia  [ ] Danmark  [ ] Somalia  [ ] Etiopia
- [ ] Storbritannia  [ ] Polen  [ ] Ghana  [ ] Storbritannia  [ ] Polen  [ ] Ghana
- [ ] Tyskland  [ ] Russland  [ ] Nigeria  [ ] Tyskland  [ ] Russland  [ ] Nigeria
- [ ] Tyrkia  [ ] Serbia  [ ] Annet eur. land  [ ] Tyrkia  [ ] Serbia  [ ] Annet eur. land
- [ ] Irak  [ ] Albanie  [ ] Annet afrik. land  [ ] Irak  [ ] Albanie  [ ] Annet afrik. land
- [ ] Iran  [ ] Kosovo  [ ] Annet asia. land  [ ] Iran  [ ] Kosovo  [ ] Annet asia. land
- [ ] Pakistan  [ ] Kina  [ ] Annet amer. land  [ ] Pakistan  [ ] Kina  [ ] Annet amer. land
- [ ] Sri Lanka  [ ] Thailand  [ ] Oceania/Australia  [ ] Sri Lanka  [ ] Thailand  [ ] Oceania/Australia

Sp 48 gjelder hvis mor er 1. og 2. generasjons innvandrer (person som selv er født utenfor Norge eller med en eller begge foreldre som født utenfor Norge). Gjelder ikke hvis adoptert.

48. Hvis ikke født i Norge og ikke norske foreldre, på hvilket grunnlag kom du til Norge?
- [ ] Arbeid
- [ ] Ektekap med norsk
- [ ] Familiegjenforening
- [ ] Flyktning
- [ ] Opphold på humanitært grunnlag
- [ ] Annet

49. Hvis 1. eller 2. generasjons innvandrer (uten norske foreldre) Hvor ofte har du i løpet av det siste året:

- [ ] Lest avis på eget språk/foreldres morasmål
- [ ] Daglig  [ ] Ukentlig  [ ] Sjeldene  [ ] Aldri
- [ ] Lest norsk avis/sett på norsk TV
- [ ] Daglig  [ ] Ukentlig  [ ] Sjeldene  [ ] Aldri
- [ ] Hatt basisk av minst en nordmann
- [ ] Daglig  [ ] Ukentlig  [ ] Sjeldene  [ ] Aldri
- [ ] Fått hjelp/støtte av minst en nordmann
- [ ] Daglig  [ ] Ukentlig  [ ] Sjeldene  [ ] Aldri
- [ ] Deltatt i møter arrangert av egne/foreldres landsmann
- [ ] Daglig  [ ] Ukentlig  [ ] Sjeldene  [ ] Aldri

50. Har du har i landet opplevd å bli nektet å leie eller kjøpe bolig på grunn av din innvandrerbakgrunn?
- [ ] Ja, helt sikkert  [ ] Ja, jeg har mistanke om det  [ ] Nei  [ ] Vet ikke
51. Har du hør i landet i løpet av de siste 5 årene opplevd å få nei til en jobb du søkte på grunn av din innvandrerkjønns?  
☐ Ja, helt sikkert  ☐ Ja, jeg har mistanke om det  ☐ Nei  ☐ Vet ikke

AKTUELLE SVANGERSKAP

52. Hvordan var helsen din de siste 3 måneders før svangerskapet?  
☐ Dårlig  ☐ Ikke helt god  ☐ God  ☐ Svært god  

53. Var dette svangerskapet planlagt?  
☐ Ja  ☐ Nei  ☐ Delvis  ☐ Evt. kommentar: ____________________________

54. Hvis planlagt, hvor lenge har du prøvd å bli gravid? Angi antall måneder  
__________________________

55. Har du i dette svangerskapet smertet i noen av de følgende kroppsdeler?  
Intervjuer bør kvinnen peke på aktuelt sted på egen kropp og planse, se prosedyrebok 2.4.2.  
Sett kryss for aktuelt kylslasjon. Du kan sette flere kryss.

| I korsryggen uten utstråling til bein(a) | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| I korsryggen med utstråling til bein(a) | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| Foran i bakkenet, over kjønnbeinet(symfysen) | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| Bak, over det ene bakkenledet | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| Bak, over begge bakkenledene | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| Foran og bak på ene siden av bakkenet | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |
| Foran og bak på begge sider av bakkenet | ☐ Nei  ☐ En del plaget  ☐ Sterkt plaget |

56. Tenk tilbake på de siste 14 dager. Har du tatt/brukt tran/trankapser og/eller andre kosttilskudd i løpet av disse dagene? Hvis ja, angi antall kapser/tabletter/skjeer per dag på sitt frukvens  

<table>
<thead>
<tr>
<th>Tran/Trankapser</th>
<th>Aldri</th>
<th>&lt;1g/uke</th>
<th>1-2g/uke</th>
<th>3-4g/uke</th>
<th>5-6g/uke</th>
<th>Daglig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiskeoljekapser</td>
<td></td>
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<tr>
<td>Seloljekapser</td>
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<td>Folat</td>
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<tr>
<td>Jønntilskudd* Angi evt. navn på neste side</td>
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<tr>
<td>Multivitaminer uten mineraler (som Sanasol,BioVit,Vitaplex osv)</td>
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<tr>
<td>Multivitaminer m/mineraler (som Vitaminmineral,Kostpluss, Solaray Spektro osv)</td>
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<tr>
<td>Andre kosttilskudd Angi evt. navn på neste side</td>
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57. Har du brukt faste medisiner, inkludert preventjon, de siste 3 måned for svangerskapet? 
Angi legemiddel navn - og evt. sykdom/plage

<table>
<thead>
<tr>
<th>Angi legemiddelnavn</th>
<th>Evt sykdom/plage</th>
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<tbody>
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<tr>
<td>F-pillor</td>
<td>Minipiller</td>
</tr>
</tbody>
</table>

58. Har du brukt faste medisiner i dette svangerskapet? Angi legemiddel navn - for sykdom/plage

<table>
<thead>
<tr>
<th>Angi legemiddelnavn</th>
<th>Evt sykdom/plage</th>
</tr>
</thead>
<tbody>
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</table>
59. Har du opplevd noen av de følgende livshendelser eller problemer i løpet av de siste 6 månedene?

- Du har selv vært utsatt for alvorlig sykdom, skade eller overfall

- En i din nærste familie (mor eller far, ektefelle/samboer, barn eller søskne) har vært alvorlig syk, utsatt for skade eller overfall

- En i din nærste familie (mor eller far, ektefelle/samboer, barn eller søskne) er avgått ved døden

- Du er separert/skilt, eller har brutt et langvarig forhold

- Du har hatt problemer/store bekymringer med barna dine (oppdragelse, skole, disiplin)

- Du har blitt arbeidsledig, eller søkt forfølgelses uttar jobb i mer enn 1 måned

- Du har opplevd andre belastende forhold, som et alvorlig problem med en nær venn, nabo, slekting eller partner, alvorlige økonomiske bekymringer, noe du satte stor pris på ble mistet eller stjålet, dødsfall hos annen nærstående, eller opplever store problemer på jobb

EVENTUELLE VIKTIGE SUPPLERENDE KOMMENTARER TIL SVAR PÅ SPØRSMÅL:

Sporomålnummer: [ ] Kommentar [ ]

Sporomålnummer: [ ] Kommentar [ ]

Sporomålnummer: [ ] Kommentar [ ]

Sporomålnummer: [ ] Kommentar [ ]

TAKK FOR AT DU HAR TATT DEG TID TIL Å SVARE PÅ SPØRSMÅLENE!
Case Record FORM 1.2

31. If you are in paid employment – how large a percentage of fulltime employment did you have during the last three months before you became pregnant? What percentage do you have now? (Applies regardless of any sick leave)
Before pregnancy: □□□ %  Now: □□□ %

32. If you are in paid employment – are you currently absent from your normal job?
□ Yes  □ No  □ Partly

33. (If your answer to question 32 was “Yes” or “Partly”) What is the reason for your absence?
□ Sick leave  □ Leave  □ Sick child  □ Other

34. If you are in paid employment – have you been on sick leave for more than two weeks during this pregnancy?
Full sick leave:  Partial sick leave:
If yes, state the approx. number of weeks: □□  If yes, state the approx. number of weeks: □□

36. Think back to when you were 10 years old. What occupation did your mother/father have?
MOTHER…………… FATHER…………..

37. Think back to when you were 10 years old. How many rooms did your flat/dwelling have? (Don’t count kitchen and bathroom).
How many people lived in the flat/dwelling?
Did your mother/father/guardian own a car?
□ Yes  □ No

38. How old was your mother when you were born? □□ years of age

39. How many brothers and sisters (siblings) do you have? (With the same mother)
□□

40. Which number were you among your siblings? (With the same mother)
□□

41. How long have you lived in: (State the number of years)
The city district you currently live in: □□  Oslo: □□

42. Where did you live for most of the time before you turned 16 years of age?
□ In the same city district as now  □ In another city district/area of Oslo  □ In another county in Norway
□ Outside Norway

State any previous city districts:………………..
If outside Norway: □ In own country of origin □ Other

43. Who do you share your household with?
□ Spouse/cohabitant □ Parents □ Parents-in-law □ Child/children □ No one
□ Other(s), describe:………………

44. How many persons are there in your household? Count yourself as well
Number of persons 18 or older: □□ Number of persons 12-17 years of age: □□
Number of persons 6-11 years of age: □□ Number of persons under 6 years of age: □□

45. How many rooms are there (don’t count kitchen and bathroom) in the flat/dwelling where you live? State number of rooms: □□

Type of dwelling:
□ Flat in a block of flats/house with several housing units, e.g. quadruplex (four units)
□ Terrace/row house
□ Detached house □ Other

Do you own or rent your dwelling? □ Own □ Rent

46. If you are a first generation immigrant: How long have you lived in Norway?
State number of years: □□

47. Are you the descendant of immigrant parents/parents who were not born in Norway?
□ Yes □ No

If yes:
□ Born in Norway, but both parents born abroad
□ Born abroad with one parent born in Norway
□ Born in Norway with one parent born abroad
□ Born abroad of foreign-national parents

If you were born in Norway, with both parents born abroad, state the country of origin of your parents:
Country of origin for: your mother:……………… your father:………………

48. On what grounds did you come to Norway?
□ Work
□ Married a Norwegian
□ Family reunification
□ Refugee
□ Residence on humanitarian grounds
□ Other

49. How often in the course of the last year have you:
Read a newspaper in your own language/parents’
native language: □ Daily □ Weekly □ Less than weekly □ Never
Been visited by at least one Norwegian:
Read a Norwegian newspaper/watched
Norwegian TV:
Received help/support from at least one
Norwegian:
Participated in a meeting arranged by your
own/parents’ countrymen:

50. Have you here in Norway experienced being denied a chance to rent or buy a dwelling because
of your immigrant background?
□ Yes, definitely □ Yes, I suspect so □ No □ Don’t know

51. During the last five years in Norway have you experienced being denied a job you applied for
due to your immigrant background?
□ Yes, definitely □ Yes, I suspect so □ No □ Don’t know

52. What was your state of health the last three months before your pregnancy?
□ Poor □ Not too good □ Good □ Very good

53. Was this pregnancy planned?
□ Yes □ No □ Partially Any comments:....................

54. If planned, how long have you been trying to get pregnant? State number of months: □□

55. Have you had any pain in any of the following parts of your body during your pregnancy?

In the lower back not radiating to the leg(s) □ No pain □ Some pain □ Much pain
In the lower back with it radiating to the leg(s) □□□□
In the front of the pelvic bone, over the pubic bone
(symphysis) □□□□
Back, over one pelvic joint □□□□
Back, over both pelvic joints □□□□
Front and back of one side of the pelvic bone □□□□
Front and back of both sides of the pelvic bone □□□□
56. Think back over the last 14 days. Have you taken cod-liver oil/cod-liver oil capsules/pills (tran) and/or other dietary supplements during this time? If yes, state the number of capsules/pills/spoons per day and the correct frequency.

Cod-liver oil/Cod-liver oil capsules: □ Never □ <Once a week □ 1-2 times a week □ 3-4 times a week □ 5-6 times a week □ Every day
Fish oil capsules:
Seal oil capsules:
Folate (vitamin B):
Iron supplement:
Multi-vitamins with minerals (e.g. Vitamineral, Kostpluss, Solaray Spektro etc.):
Multi-vitamins without minerals: (e.g. Sanasol, BioVit, Vitaplex etc.)
Other dietary supplement:

State the name of the dietary supplement:………………
State the name of any iron supplements:………………

57. Have you taken medication regularly, including birth-control, the last three months before your pregnancy?
State the name of the medication…………… – and the illness/disorder, if any…………………………

□ The pill □ Mini-pill □ IUD/coil Brand/name:……………..

58. Have you taken medication regularly during this pregnancy?
State the name of the medication…………… – and the illness/disorder, if any…………………………

59. Have you experienced any of the following events or problems in your life during the last six months?
You have been stricken with a serious illness, been injured or assaulted □ Yes □ No
One of your closest family members (mother or father, spouse/cohabitant, children or brothers/sisters) has been seriously ill, injured or the victim of an assault □ Yes □ No
One of your closest family members (mother or father, spouse/cohabitant, children or brothers/sisters) has died □ Yes □ No
You have separated/divorced, or have broken off a long-term relationship □ Yes □ No
You have had problems/major concerns about your children (upbringing, school, discipline) □ Yes □ No
You have become unemployed or been searching in vain for a job for more than one month □ Yes □ No
You have experienced other difficult circumstances, e.g. a serious problem with a close friend, neighbour, relative or partner, serious financial concerns, something you valued dearly has been lost or stolen, death of someone close to you, or have major problems at work

□ Yes □ No

ANY IMPORTANT SUPPLEMENTAL COMMENTS ON YOUR ANSWERS TO THE QUESTIONS:

Question number: □□ Comment……………………
You can also add more detailed comments here: ........................................

THANKS FOR TAKING THE TIME TO ANSWER THESE QUESTIONS!
STORK Groruddalen - Fysisk aktivitet
Skjema 1 Uke 10-14

Kode intervjuer  ●  Intervjuers initialer  ●  Undersøkelsesdato  ●  Svangerskapsuke
Kvinnens fødselsdato  ●  Bosteds-postnummer  ●  Undersøkelsesbydel

Dette intervju-skjemaet forescker å fange opp kvinnens fysiske aktivitet før svangerskapet og i dette svangerskapet og hennes holdninger til fysisk aktivitet.

Fysisk aktivitet skal i tillegg registreres objektivt med Armband, helst i uken etter intervjuet. De fleste spørsmålene gjelder kvinnens subjektive opplevelse. Man i spørsmålene 3-5 ønsker vi å kunne danne oss et bilde av hennes aktivitetsnivå, blant annet for å finne ut om hun er så aktiv som helsemyndighetene anbefaler (sp 6).

Fysisk aktivitet omfatter både:
1. Fysisk aktivitet i hverdagen (i arbeid, fritid og hjemme, samt hvordan man forflytter seg til og fra arbeid og fritidssyssler)
2. Planlagte mosjonsaktiviteter (som å gå turer, svømming, dansing etc.)
3. Trening (for å bedre fysisk form, muskelsært og andre ferdigheter)

Forklaring til utfyllingen:
Bruk blå eller svart kulepenn. De fleste steder settes kryss eller tall. Bruk ellers store bokstaver og en bokstav per rute. Sett kryss mest mulig midt i avkrysningsboksen. Dersom feil i utfyllingen, marker dette med å sette tre streker over boksen og kryss av på vanlig måte i den riktige boksen. Dersom behov for å notere ytterligere informasjon ut over hva det er avsett plans til på skjemaet, kan du notere dette i marga. Bare sørge for at du ikke skriver i avkrysningsboksene eller notatfelter. Eksempel på utfylling:

[ ] ja  [ ] nej  2256 gram

NB: Tekst i kursiv under spørsmålet, før svarkategori, er informasjon til intervjuer og skal ikke leses opp for kvinnen.

FYSISK AKTIVITET/FYSISK FORM FØR/UNDER SVANGERSKAP

Selvvaluert fysisk aktivitet og fysisk form

1. Hvordan anser du at ditt fysiske aktivitetsnivå for tiden er?
   [ ] Lavt  [ ] Ganske lavt  [ ] Middels  [ ] Ganske høyt  [ ] Høyt

   [ ] Mange dårligere  [ ] Litt dårligere  [ ] Som andre kvinner på min alder  [ ] Litt bedre  [ ] Mange bedre
### Aktivitet - type, frekvens og varighet

3. Hvor ofte var du fysisk aktiv i de siste 3 månedene før dette svangerskapet?

Spør om alle aktiviteter og fyll enten ut "aldri" eller angi frekvens og gjennomsnittlig varighet for aktuell aktivitet. Vi er særlig interessert i å kartlegge aktivitet som er moderat (som ved rask gange) eller mer intensiv. Å sykle eller gå til jobb, og å gå på jobben kan inkluderes hvis minst 10 minutters varighet av gangen. Se evt. intervjuguide i prosedyrebok.

<table>
<thead>
<tr>
<th>Aktivitet</th>
<th>Aldri</th>
<th>1-3 x /mnd</th>
<th>1 x pr uke</th>
<th>2 x pr uke</th>
<th>3-6x pr uke</th>
<th>Daglig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Løp/jogg/orientering</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Sykling</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Helsestudio/styrketrening</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Aerobics</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Dans (jazz, swing, rock ol.)</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Ballspill/måtballspill</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Svømning</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Rask gange/turgang/ski</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Rolig gange</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
<tr>
<td>Annet</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
<td></td>
</tr>
</tbody>
</table>

Hvis annet, hva?:

---

### Tidbruk (minutter):

4. Hvor ofte har du vært fysisk aktiv de siste 7 dager?

Spør om alle aktiviteter og fyll enten ut "aldri" eller angi frekvens og gjennomsnittlig varighet for aktuell aktivitet. Dette spørsmålet skal sammen med sp. 5 også brukes til å vurdere om kvinnene er så aktiv som helsemyndighetene anbefaler (sp. 6). For at aktiviteten da skal regnes med, må den være av moderat (som ved rask gange) eller hard intensitet. Den siste aktivitetsstype (rolig gange/spasertur) har ikke høy nok intensitet til å kunne regnes med, men enhver aktivitet er bedre enn ingen, ikke minst i forhold til energiregnskapet. Å sykle eller gå til jobb, og gå på jobben kan inkluderes hvis minst 10 minutters varighet av gangen. Se evt. intervjuguide i prosedyrebok.

<table>
<thead>
<tr>
<th>Aktivitet</th>
<th>Aldri</th>
<th>1 x pr uke</th>
<th>2 x pr uke</th>
<th>3-6x pr uke</th>
<th>Daglig</th>
</tr>
</thead>
<tbody>
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<td>3-6x pr uke</td>
<td>Daglig</td>
</tr>
<tr>
<td>Sykling</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
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<td>Aerobics</td>
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<td>Daglig</td>
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<tr>
<td>Dans (jazz, swing, rock ol.)</td>
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<td>Aldri</td>
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<td>3-6x pr uke</td>
<td>Daglig</td>
</tr>
<tr>
<td>Svømning</td>
<td>Aldri</td>
<td>1 x pr uke</td>
<td>2 x pr uke</td>
<td>3-6x pr uke</td>
<td>Daglig</td>
</tr>
</tbody>
</table>
39114

Unikt pas. løsenummer: [ ]

Rask gange/turgangSKI
☐ Aldri ☐ 1 x pr uke ☐ 2 x pr uke ☐ 3-6 x pr uke ☐ Daglig

Rollig gange
☐ Aldri ☐ 1 x pr uke ☐ 2 x pr uke ☐ 3-6 x pr uke ☐ Daglig

Annet
☐ Aldri ☐ 1 x pr uke ☐ 2 x pr uke ☐ 3-6 x pr uke ☐ Daglig

Hvis annet, hva?

5. Hvis du tenker på den siste måneden, var aktivitetsnivået ditt i fritiden de siste 7 dagene:
☐ Nye mindre enn vanlig ☐ Litt mindre enn vanlig ☐ Vanlig ☐ Litt mer enn vanlig ☐ Mye mer enn vanlig

Nå skal vi bruke svarene dine på spørsmål 4 og 5 og se på om du kan sies å være regelmessig fysisk aktiv, slik vi vil definere det her. Da må noe av din aktivitet minst være av moderat intensitet, som ved rask gange.

Hvis kroppen har avtatt "nye mindre aktiv" eller "nye mer aktiv" i siste uke, bo henne legge det vanlige aktivitetsnivået den foregående måneden til grunn.

6. Tænk på din fysiske aktivitet i dette svangerskapet. Er du i:

Moderat intensiv aktivitet 30 minutter minst 5 av ukens dager?
☐ Ja ☐ Nei

Moderat intensiv aktivitet totalt minst 2,5 timer/uke fordelt på minst 3 dager?
☐ Ja ☐ Nei

Hard aktivitet minst 20 minutter x 3/uke? (eks. som ved jogging)
☐ Ja ☐ Nei

Aktivitet av både hard og moderat intensitet (eks. hard aktivitet 1 gang /ukene og moderat intensiv aktivitet 2 ganger/uke)
☐ Ja ☐ Nei

Hvis kroppen svarer nei på alle 4 alternativene, går til sp.7 og la kroppen finne det alternativet blant disse som passer best.

Hvis kroppen svarer ja om minst ett av de 4 alternativene, går til sp. 8 og la kroppen finne det alternativet blant disse som passer best.

7. Tænk på deg selv i dette svangerskapet. For å regne deg som regelmessig fysisk aktiv, må du ha svart ja på minst ett av alternativene under sp. 6.

Kryst av og gå direkte til spørsmål 10.

☐ Jeg er ikke regelmessig fysisk aktiv (minst moderat intensitet) og har ingen planer om å bli det
☐ Jeg er ikke regelmessig fysisk aktiv (minst moderat intensitet), men overveier en forandring
☐ Jeg er noe fysisk aktiv (minst moderat intensitet), men mindre enn angitt under 6


☐ Jeg er regelmessig fysisk aktiv, men har vært det i mindre enn 6 måneder
☐ Jeg er regelmessig fysisk aktiv og har vært det i mer enn 6 måneder

Hvis kroppen svarer ja på det første av disse 2 alternativene, går til sp.10
9. Hvor lenge har du vært regelmessig fysisk aktiv?
   □ < 1 år  □ 1-5 år  □ 6-10 år  □ Mer enn 10 år

10. Har du endret fysisk aktivitetsnivå etter at du ble gravid?
   □ Mindre aktiv nå  □ Øndret  □ Mer aktiv nå

11. Hvis du er mindre aktiv nå enn før du ble gravid - hva er hovedgrunnen(s) til det?

La kvinner svare på spørsmålet, for du presenterer de ulike kategoriene. Sett inn til 3 kryss

   Svangerskapsrelaterte plager (tretthet/oppplaghet, kvalme) ....... □ Ja  □ Nei
   Smarter som øker ved fysisk aktivitet ................................ □ Ja  □ Nei
   Nyopptatt sykdom knyttet til svangerskapet ...................... □ Ja  □ Nei
   Andre helseproblemer før deg ...................................... □ Ja  □ Nei
   Har fått råd av venn/familie om å være mindre fysisk aktiv i svangerskapet .................................................. □ Ja  □ Nei
   Har fått råd av helsepersonell om å være mindre fysisk aktiv i svangerskapet .................................................. □ Ja  □ Nei
   Bekymring for barnet .................................................... □ Ja  □ Nei
   Har ikke tid ....................................................................... □ Ja  □ Nei
   Annet ............................................................................. □ Ja  □ Nei

**MOTIVASJON FOR FYSISK AKTIVITET**

Nå skal jeg først komme med en rekke påstander som du så skal si i hvilken grad du er enig i. Vi bruker skalaer med 3 til 7 punkter.

**Individuelle faktorer**

Den første skalaen har 7 punkter fra "Ikke i det hele tatt" til "Veldig sikker"

12. Tenk deg selv nå for tiden. Tenk deg alle former for aktivitet. Ta stilling til påstanden: Jeg er sikker på at jeg kan gjennomføre planlagt fysisk aktivitet selv om:

   Jeg er trett  □ 1  □ 2  □ 3  □ 4  □ 5  □ 6  □ 7
   Jeg føler meg nedtrykt □ 1  □ 2  □ 3  □ 4  □ 5  □ 6  □ 7
   Jeg er bekymret ...... □ 1  □ 2  □ 3  □ 4  □ 5  □ 6  □ 7
   Jeg er sint på grunn av noe □ 1  □ 2  □ 3  □ 4  □ 5  □ 6  □ 7
   Jeg føler meg stresset □ 1  □ 2  □ 3  □ 4  □ 5  □ 6  □ 7
Også denne skalaen har 7 punkter fra "Helt enig" til "Helt uenig"

13. Tenk på deg selv nå for tiden. Tenk på alle former for aktivitet. For hver påstand, angi i hvilken grad du er enig/uenig.

<table>
<thead>
<tr>
<th></th>
<th>Helt enig</th>
<th></th>
<th>Helt uenig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Om jeg er regelmessig fysisk aktiv eller ikke er helt opp til meg selv</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Hvis jeg ville, hadde jeg ikke hatt noen problemer med å være regelmessig fysisk aktiv</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Jeg ville likt å være regelmessig aktiv, men jeg vet ikke riktig om jeg kan få det til</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Jeg har full kontroll over å være regelmessig fysisk aktiv</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Å være regelmessig fysisk aktiv er vanskelig for meg</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Nå har skalaen 5 punkter fra "Passer dårlig" til "Passer bra"

14. Tenk på deg selv nå for tiden. I hvilken grad beskriver disse påstandene deg som person?

<table>
<thead>
<tr>
<th></th>
<th>Passer dårlig</th>
<th></th>
<th>Passer bra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeg ser på meg selv som en person som er opptatt av å være fysisk aktiv.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Jeg tenker på meg selv som en person som er opptatt av å holde seg i god fysisk form</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Å være fysisk aktiv er en viktig del av hvem jeg er</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Nå har skalaen 3 punkter fra "Stor effekt" til "Ingen effekt"

15. I hvilken utstrekning mener du at daglig fysisk aktivitet kan ha gunstig effekt for å forebygge følgende sykdommer?

_Hvis kvinnene har problemer med å angi dette kan du tilføye:_
_Hvis du synes dette er vanskelig å svare på, kan du svari "Vet ikke"

<table>
<thead>
<tr>
<th></th>
<th>Stor effekt</th>
<th>Liten effekt</th>
<th>Ingen effekt</th>
<th>Vet ikke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hjerte - karsykdom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muskel-skjelettsidelser</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes type 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Høyt blodtrykk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psykiske lidelser</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oversvømt og fedme</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mage-/tarmesykdommer</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Astma og allergeri</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Sosiale faktorer

I de neste utsagnene har skalaen 5 punkter fra "Aldri" til "Veldig ofte". Først er det 6 utsagn om familien din, deretter 6 utsagn om vunnene dine.

16. Tenk på deg selv nå for tiden. Har familien din (medlemmer i husstanden):

_Hvis kvinnen har problemer med å angi dette kan du tilføye:_

_Hvis du synes dette er vanskelig å svare på, kan du svare "Passer ikke"

<table>
<thead>
<tr>
<th>1. Oppmuntrer deg til å være fysisk aktiv?</th>
<th>Aldri</th>
<th>Sjelden</th>
<th>Noen få ganger</th>
<th>Ofte</th>
<th>Veldig ofte</th>
<th>Passer ikke</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Diskutert fysisk aktivitet sammen med deg?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
<tr>
<td>3. Forandret planene sine, slik at dere kunne drive fysisk aktivitet sammen?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
<tr>
<td>5. Såg at fysisk aktivitet vil være bra for helsen din?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
</tbody>
</table>

17. Tenk på deg selv nå for tiden. Har vennene dine/bakjente/familiesmedlemmer utenfor husstanden:

_Hvis kvinnen har problemer med å angi dette kan du tilføye:_

_Hvis du synes dette er vanskelig å svare på, kan du svare "Passer ikke"

<table>
<thead>
<tr>
<th>1. Foreslått at dere skulle drive fysisk aktivitet sammen?</th>
<th>Aldri</th>
<th>Sjelden</th>
<th>Noen få ganger</th>
<th>Ofte</th>
<th>Veldig ofte</th>
<th>Passer ikke</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Oppmuntrer deg til å være fysisk aktiv?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
<tr>
<td>3. Gitt deg hjelpemøte påminnelses om fysisk aktivitet som &quot;Skal du mosjongere i kveld?&quot;</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
<tr>
<td>4. Forandret planene sine, slik at dere kunne drive fysisk aktivitet sammen?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
<tr>
<td>5. Såg at fysisk aktivitet vil være bra for helsen din?</td>
<td>Aldri</td>
<td>Sjelden</td>
<td>Noen få ganger</td>
<td>Ofte</td>
<td>Veldig ofte</td>
<td>Passer ikke</td>
</tr>
</tbody>
</table>
39114

Unikt pas. løpenummer: [ ]

Har har skalaen 4 punkter fra "Helt uenig" til "Helt enig"

18. Tenk på deg selv nå for tiden. Folk som er viktige for meg:

- Syner jeg bor være fysisk aktiv
  - Helt uenig
  - Litt uenig
  - Litt enig
  - Helt enig

- Syner det er bra om jeg er fysisk aktiv
  - Helt uenig
  - Litt uenig
  - Litt enig
  - Helt enig

- Vil at jeg skal være fysisk aktiv
  - Helt uenig
  - Litt uenig
  - Litt enig
  - Helt enig

- Syner det er upassende at jeg er fysisk aktiv
  - Helt uenig
  - Litt uenig
  - Litt enig
  - Helt enig

- Liket ikke at jeg er fysisk aktiv
  - Helt uenig
  - Litt uenig
  - Litt enig
  - Helt enig

Her har skalaen 5 punkter fra "Ingen" til "Alle"

19. Av folk du kjenner godt – hvor mange er fysisk aktive minst 3 ganger i uka?

- Ingen
- Noen få
- En god del
- De aller fleste
- Alle

Av folk på din alder som du kjenner godt – hvor mange er fysisk aktive minst 3 ganger i uka?

- Ingen
- Noen få
- En god del
- De aller fleste
- Alle

Av kvinner på din alder som du kjenner godt – hvor mange er fysisk aktive minst 3 ganger i uka?

- Ingen
- Noen få
- En god del
- De aller fleste
- Alle

20. Hvor ofte ser du voksne i nabolaget ditt i en eller annen form for fysisk aktivitet?

- Veldig ofte
- Ofte
- Noen ganger
- Sjelden
- Aldri

21. Hvor ofte ser du andre kvinner på din egen alder i nabolaget ditt i en eller annen form for fysisk aktivitet?

- Veldig ofte
- Ofte
- Noen ganger
- Sjelden
- Aldri

22. Hvor mange ganger per uke er din ektefelle/samboer/barnets far i fysisk aktivitet nå for tiden?

- Mer enn 3 g/uke
- 1-3 g/uke
- 1-3 g/mand
- Sjeldnere
- Vet ikke

Opplevelse av omgivelsene i ditt nærmiljø i forhold til fysisk aktivitet

23. Omterat hvor lang tid vil det ta for deg å gå hjemmemot til:

- Rutikk for dagligværer
  - 1-5 min
  - 6-10 min
  - 11-20 min
  - 21-30 min
  - > 30 min
  - Vet ikke

- Eet frisør/krave/park/turveri
  - 1-5 min
  - 6-10 min
  - 11-20 min
  - 21-30 min
  - > 30 min
  - Vet ikke

- Helsestudio/træningssenter/svømmehall
  - 1-5 min
  - 6-10 min
  - 11-20 min
  - 21-30 min
  - > 30 min
  - Vet ikke
24. Er det i ditt nærmiljø:

- Trygge steder å gå (park/frisører, turvei, fortau) som er tilstrækkelig belyst
- Mange steder der du kan være fysisk aktiv (utendørs, svømmehall etc.)
- Flere tilrettelagte tilbud om trening og fysisk aktivitet (som kunne være aktuelle for deg)
- Greit å gå til butikker (10-15 min å gå, fortau langs de fleste veiårene)
- Litt tilgang til gang- eller sykkelveier
- Så mye trafikk i gatene at det er vanskelig eller lite hyggelig å gå
- Fotgjengerovergangar og lyssignal som gjør det enklere å krysse veier.

25. Disponerer du en sykkel?
- Ja  Nei

Er du vant til å sykle?
- Ja  Nei

26. Eier du/barnefaren egen bil?
- Ja  Nei

27. Min kommune/bydel tilrettelægger for lite for fysisk aktivitet
- Helt uenig  Litt uenig  Litt enig  Helt enig

TAKK FOR AT DU HAR TATT DEG TID TIL Å SVARE PÅ SPØRSMÅLENE!
PHYSICAL ACTIVITY – FORM NO. 1

Information for the interviewer:
The aim of this interview questionnaire is to ascertain the physical activity of the woman before her pregnancy and during the pregnancy, and to ascertain what her attitude is to physical activity. The physical activity shall also be registered objectively with the armband, preferably the week after this interview. Most of the questions refer to the woman’s subjective understanding. But the aim of questions 3-5 is to form a picture of her activity level, to find out, among other things, if she is as active as the health authorities recommend (question 6).

Physical activity means:
1. Physical activity in day-to-day life (at work, leisure time and in the home, and how one gets to and from work and leisure activities)
2. Planned exercise activities (such as going for walks, swimming, dancing etc.)
3. Exercising (to improve your physical shape, strengthen muscles and improve other skills)

Text in italics is information for the interviewer and is not to be read to the woman being interviewed.

1. How would you rate your physical activity level at present?
☐ Low ☐ Fairly low ☐ Average ☐ Quite high ☐ High

2. Think back over the last three months before this pregnancy. What physical shape were you in compared to other women of your age? Think, for example, about your capacity when you walked up stairs or hills.
☐ Much worse ☐ A little worse ☐ The same as other women of my age
☐ A little better ☐ Much better

3. How often were you physically active during the last three months before this pregnancy?
We are especially interested in activity that is moderate (e.g. brisk walking) or more intense. Bicycling or walking to work, and walking on the job can be included if at least 10 minutes’ duration each time.

Time used (minutes):
☐ Never ☐ 1-3 x/month ☐ 1 x per week ☐ 2 x per week ☐ 3-6 x per week ☐ Daily ☐ ☐ ☐

Run/jog/orienteering
Bicycling
Fitness centre/weight-lifting
Aerobics
Dance (jazz, swing, rock etc)
Ball sports/netball
Swimming
Brisk walking/hiking/skiing
Strolling
Other
If other, what?........
4. How often have you been physically active the last 7 days?

This question will be used with question 5 to assess if the woman is as active as the health authorities recommend (question 6.) For the activity to be taken into consideration, it must be of moderate (e.g. brisk walking) or hard intensity. The last type of activity (strolling/walking) does not have a high enough intensity to be included, but any activity is better than nothing at all, not least in terms of energy use. Bicycling or walking to work, and walking on the job can be included if of at least 10 minutes’ duration each time.

Time used (minutes):

- □ Never
- □ 1 x per week
- □ 2 x per week
- □ 3-6x per week
- □ Daily
- □□□

Run/jog/orienteering
Bicycling
Fitness centre/weight-lifting
Aerobics
Dance (jazz, swing, rock etc.)
Ball sports/netball
Swimming
Brisk walking/hiking/skiing
Strolling
Other
If other, what?......

5. If you think back over the last month, was your leisure-time activity level during the last 7 days:

- □ Much less than usual
- □ A little less than usual
- □ The usual
- □ A little more than usual
- □ More than usual

Now we will use your answers to questions 4 and 5 to see if it can be said that you are physically active on a regular basis as we define it here. In this case, some of your activities must be of moderate intensity, as for example brisk walking.

If you have answered “Much less than usual” or “Much more than usual” over the last week, we will ask you to use the activity level from the previous month as the basis for your answers below.

6. Think about your physical activity during this pregnancy. Do you practise:

- □ Moderately intensive activity for 30 minutes at least 5 days of the week?
  - □ Yes □ No
- □ Moderately intensive activity in total at least 2.5 hours/week over at least 3 days?
  - □ Yes □ No
- □ Hard activity (e.g. jogging) at least 20 minutes 3 times a week?
  - □ Yes □ No
- □ Activity of both hard and moderate intensity (e.g. hard activity once a week and moderately intensive activity twice a week)
  - □ Yes □ No

If the woman answers “no” to all four alternatives, go to question 7 and let her find the one of the three alternatives that fits her best.

If the woman answers “yes” to at least one of the four alternatives, go to question 8 and let her find the alternative that fits her best.
7. Think about yourself during this pregnancy. To count yourself as regularly physically active, you must have answered yes to at least one of the alternatives under question 6.

□ I am not regularly physically active (at least moderate intensity) and have no plans for being so
□ I am not regularly physically active (at least moderate intensity) but I am considering a change
□ I am somewhat physically active (at least moderate intensity), but less than stated under question 6

8. To be filled in if the woman has answered “yes” to one or more of the alternatives in item 6.

□ I am regularly physically active, but have been so for less than 6 months
□ I am regularly physically active and have been so for more than 6 months

If the woman answers “yes” to the first of these two alternatives, go to question 10

9. How long have you been regularly physically active?

□ Under 1 year □ 1-5 years □ 6-10 years □ More than 10 years

10. Have you changed your physical activity level after you became pregnant?

□ Less active now □ Unchanged □ More active now

11. If you are less active now than before you became pregnant – what is the main reason/reasons for this?

Let the woman answer the question before you present the categories below. Tick up to three boxes

Pregnancy related disorders (fatigue/drowsy, nauseous)....................... □ Yes □ No
Pain which increases with physical activity........................................... □ Yes □ No
New illness connected to the pregnancy............................................. □ Yes □ No
Other health problems you have......................................................... □ Yes □ No
Have been advised by friends/family to be less physically active during your pregnancy.......................................................... □ Yes □ No
Have been advised by health care staff to be less physically active during your pregnancy.......................................................... □ Yes □ No
Worried about the baby.......................................................... □ Yes □ No
Don’t have time.......................................................... □ Yes □ No
Other.......................................................... □ Yes □ No

Now I am going to read a number of statements for which I want you to indicate the degree to which you agree with them. We use scales with 3 to 7 points.

The first scale has 7 points ranging from "Not at all" to "Very sure".
12. Think about how things are for you now. Think about all the types of activity. Decide how you would answer each statement: I’m sure that I can carry out the planned physical activity even if:

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th></th>
<th>Very sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am tired</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I feel depressed</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I’m worried</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I’m angry because of something</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I feel stressed</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
</tbody>
</table>

This scale also has 7 points ranging from "Totally agree" to "Totally disagree".

13. Think about how things are for you now. Think about all the types of activity. For each statement, state the degree to which you agree/disagree.

<table>
<thead>
<tr>
<th></th>
<th>Totally agree</th>
<th></th>
<th>Totally disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether I am regularly physically active or not, is entirely up to me</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>If I want to, I would have no problems being regularly physically active</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I would have liked to have been regularly physically active, but I’m not really sure if I can manage</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I have full control over being regularly physically active</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>Being regularly physically active is difficult for me</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
</tbody>
</table>

Now the scale has 5 points ranging from "Does not fit well" to "Fits well".

14. Think about how things are for you now. To what degree do these statements describe you as a person?

<table>
<thead>
<tr>
<th></th>
<th>Does not fit well</th>
<th></th>
<th>Fits well</th>
</tr>
</thead>
<tbody>
<tr>
<td>I see myself as a person who is concerned about being physically active</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>I think of myself as a person who is concerned about keeping in good physical shape</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
<tr>
<td>Being physically active is an important part of who I am</td>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
</tr>
</tbody>
</table>
Now the scale has 3 points ranging from "Great effect" to "No effect"

15. To what degree do you feel that daily physical activity can have a beneficial effect in preventing the following illnesses?

*If the woman has problems answering this, you can add:* If you think this is difficult to answer, you can answer "Don’t know".

- □ Great effect
- □ Little effect
- □ No effect
- □ Don’t know

Cardio-vascular illnesses
Muscular/skeletal disorders
Diabetes type 2
Cancer
High blood pressure
Mental disorders
Being overweight/obese
Abdominal/intestinal illnesses
Asthma and allergies

In the next statements the scale has 5 points ranging from "Never" to "Very often".
First there are 6 statements about your family, and then 6 statements about your friends.

16. Think about how things are for you now. Have your family (members of your household):

*If the woman has problems answering this, you can add:* If you think this is difficult to answer, you can answer "Does not fit well".

- □ Never
- □ Seldom
- □ A few times
- □ Often
- □ Very often
- □ Does not fit well

1. Encouraged you to be physically active?

2. Discussed physical activity with you?

3. Changed their plans so that you could take part in physical activity together?

4. Taken over chores for you, so that you have more time to be physically active?

5. Said that physical activity would be good for you health?

6. Talked about how much they like being physically active?
17. **Think about how things are for you now. Have your friends/acquaintances/family members outside the household:**

*If the woman has problems answering this, you can add:* If you think this is difficult to answer, you can answer "Does not fit".

- **□** Never
- **□** Seldom
- **□** A few times
- **□** Often
- **□** Very often
- **□** Does not fit

1. Suggested that you should take part in physical activity together?

2. Encouraged you to be physically active?

3. Given you such helpful reminders about physical activity as: "Shall we go for a walk tonight?"

4. Changed their plans so that you could take part in physical activity together?

5. Said that physical activity would be good for your health?

6. Talked about much they like being physically active?

Here the scale has 4 points ranging from "Totally disagree" to "Totally agree"

18. **Think about how things are for you now. People who are important to me:**

- **□** Totally disagree
- **□** Slightly disagree
- **□** Slightly agree
- **□** Totally agree

Think I should be physically active
Think it is good if I’m physically active
Want me to be physically active
Think it improper that I’m physically active
Do not like that I’m physically active

19. **Here the scale has 5 points ranging from "None" to "Everybody"**

Of people you know well – how many are physically active at least 3 times a week?

- **□** None
- **□** A few
- **□** Quite a few
- **□** Just about everybody
- **□** Everybody

Of people your age who you know well – how many are physically active at least 3 times a week?

- **□** None
- **□** A few
- **□** Quite a few
- **□** Just about everybody
- **□** Everybody

Of women your age who you know well – how many are physically active at least 3 times a week?

- **□** None
- **□** A few
- **□** Quite a few
- **□** Just about everybody
- **□** Everybody
20. How often do you see adults in your neighbourhood in one or another form of physical activity?
□ Very often □ Often □ Sometimes □ Seldom □ Never

21. How often do you see other women your age in your neighbourhood in one or another form of physical activity?
□ Very often □ Often □ Sometimes □ Seldom □ Never

22. How many times a week does your spouse/cohabitant/the child’s father take part in a physical activity these days?
□ More than 3 times a week □ 1-3 t/week □ 1-3 t/month □ Less often □ Don’t know

23. About how long would it take you to walk from home to:
□ 1-5 min □ 6-10 min □ 11-20 min □ 21-30 min □ > 30 min □ Don’t know
The grocer’s
A recreational area, park or walking/hiking path
Fitness centre, swimming pool

24. Do you find the following in your neighbourhood:
□ Totally disagree □ Slightly disagree □ Slightly agree □ Totally agree
Safe places to walk (park, recreational area, hiking path, pavement) which is adequately lit
Many places where you can be physically active (outdoor areas, swimming pool etc.)
Several exercise and physical-activity programmes (which could interest you)
Easy to walk to shops (10-15 minutes to walk, pavement along most of the streets)
Easy access to walking or bicycle paths
So much traffic in the streets that it is difficult or unpleasant to walk there
Pedestrian crossings and traffic lights that make it easier to cross the streets

25. Do you have a bicycle you can use? □ Yes □ No
Are you used to bicycling? □ Yes □ No

26. Do you/the child’s father own a car? □ Yes □ No

27. My municipality/city district does not do enough to promote physical activity
□ Totally disagree □ Slightly disagree □ Slightly agree □ Totally agree

THANKS FOR TAKING THE TIME TO ANSWER THESE QUESTIONS!
Til deg som er gravid og bor i bydelene Stovner, Grorud og Bjerke

Forespørsel om å delta i forskningsprosjektet ”STORK Groruddalen”

Hensikten med studien


Vi som arbeider på helsestasjonene i bydelene Stovner, Grorud og Bjerke, ønsker i samarbeid med universitetssykehusene i Osloområdet å kartlegge disse problemene, hvordan de påvirker helsetilstanden for mor og barn på kort og lang sikt, og finne årsakene til at svangerskapsdiabetes og type 2 diabetes øker. Aker universitetssykehus er ansvarlig for studien.

Hva innebærer studien?


Hva skjer med prøvene og informasjonen om deg?


Frivillig deltakelse


Mer informasjon om studien finnes i Kapittel A
Mer informasjon om biobank, personvern økonomi og forsikring finnes i Kapittel B
Kapittel A- utdypende forklaring om hva studien innebærer


Alle gangene vil vi stille deg spørsmål om din helse og intervjuer deg om kostholdet ditt og din fysiske aktivitet, og kartlegge din fysiske aktivitet med et armbånd som bæres på overarmen. Vi vil også stille noen spørsmål om helseforhold og sykdom i familien, veie deg med en spesialvekt som angir fettinnholdet i kroppen, og måle hudtykkelsen med en enkel ytre målemetode.


Du vil også bli tilbudt 3 ekstra ultralydundersøkelser for å se på barnets vekst. Etter fødselen vil vi i samarbeide med sykehuset du føder på innhente journalopplysninger fra svangerskapet om resultatene av ultralydundersøkelsene, fødselsforløpet, din helse og barnets lengde, vekt, hodeomkrets, fordeling av kroppsfett og helsetilstand. Det tas også blodprøver fra barnets navlestreng og mørkake ved fødselen.

Etter fødselen ønsker vi å kartlegge hvor lenge barnet får morsmelk, og hvordan barnet vokser (lengde og vektutvikling) i barnealderen. Dette skjer ved den vanlige barnekontrollen på helsestasjonen. Vi ønsker å kunne gjøre noen tilleggsundersøkelser av barnet ved 6 og 10 års alder (kost, fysisk aktivitet og blodprøver). Kvinner som får påvist svangerskapsdiabetes vil få utført ny blodsukkerbelastning ca.3 måneder etter fødselen. Vi vil senere også innkalde dem en gang i året i 5 år, og så hvert 5. år for nye prøver for å avklare om de har fått type 2 diabetes.

Ved oppfølgingsstudiene vil vi komme tilbake med ny henvendelse med spørsmål om å delta.

**Mulige fordeler og ubehag/ulemper**

- Økt kunnskap om fysisk aktivitet, sann kost og helse.
- Ekstra nøyte oppfølgning av de som får påvist svangerskapsdiabetes
- Blodsukkerbelastningen (uke 28 og 3 mand) etter fødsel kan utløse kvalme
- Ingen av de andre undersøkelsene gir ubehag eller risiko utover vanlig blodprøvetakning.
- Ved blodprøver av barnet ved 6 og 10 års alder vil barnet på forhånd kunne få lokalbedøvende salve på huden.
Kapittel B - Personvern, biobank, økonomi og forsikring

Personvern

Behandling av materiale og opplysninger hos andre
 Hvis du sier ja til å delta i studien, gir du også ditt samtykke til at aidentifiserte opplysninger og prøver kan oppbevares og behandles hos ulike forskere og samarbeidspartnere tilknyttet prosjektet, i Norge og i utlandet. Dette er nødvendig for å oppfylle formålet med studien. Vi vil stille samme strenge krav til beskyttelse av informasjonen til våre samarbeidspartnere, også i land med lover som ikke gir like god personvernbeskyttelse som her.

Biobank

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver
 Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har også rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi, prosjektleders rolle og forsikring
Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Jeg bekrer å ha gitt informasjon om studien

(Signert, rolle i studien, dato)
Appendix 5
Approval: Ethical committee
Regional komité for medisinsk forskningsetikk
Øst-Norge (REK Øst)
Postboks 1130 Blindern
NO-0318 Oslo
Telefon: 228 44 667
Telefaks: 228 44 661
E-post: i.s.nyquist@medisin.uio.no
Nettadresse: www.etikkom.no

Prediktorer for svangerskapsdiabetes og fostervekst i en multietnisk befolkning (STORK Groruddalen)

Søknad om opprettelse av forskningsbiobank

Vi viser til søknad mottatt 29.08.07 med følgende vedlegg: Protokoll, informasjonsskriv med samtykkeerklæring, spørreskjema, CRF med oversikt over analyser og søknad om opprettelse av forskningsbiobank nr. 2029, datert 29.08.07.

Komiteen behandlet søknaden i sitt møte torsdag 08.10.07 etter lov om behandling av etikk og redelighet i forskning, med tilhørende forskrift, og etter Kunnskapsdepartementets retningslinjer for de regionale komiteer for medisinsk og helsefaglig forskningsetikk.

Komiteen har ingen kommentarer til prosjektopplegget, men vil bemerke følgende til informasjonsskrivet:

Det opplyses under punkt 9 i skjemaet at man planlegger kliniske substudier, blant annet langtidsoppfølgning av kvinner med svangerskapsdiabetes, og av vekstutviklingen hos barna. Det bes opplyst i informasjonsskrivet at man planlegger oppfølgingstidene, og at man i den forbindelse vil komme tilbake med en ny henvendelse med spørsmål om de vil delta.

Ord som "invitere" bør ikke benyttes ved rekrutering til forskning. Istedet kan det stå "forespørre" (vedlegg A).

Komiteen har vurdert søknaden om opprettelse av forskningsbiobank, og har ingen innsigelser mot at den opprettes.

Vedtak:
Komiteen godkjenner at prosjektet blir gjennomført med den tilføyelsen i informasjonsskrivet som er nevnt ovenfor.
Komiteen vil videresende skjema for opprettelse av forskningsbiobank og kopi av komiteens vedtak til Sosial- og helsedirektoratet for endelig behandling av biobanken.

Med vennlig hilsen

Eirik Monn
professor dr.med.
estleder

Ida Nyquist
sekretær

Kopi: Sosial -og helsedirektoratet v/ Nina Strand Ølnes
Norges idrettshøgskole v/ Kari Bø
Konsesjon til å behandle helseopplysninger

Datatilsynet viser til Deres søknad av 8. september 2007 om konsesjon til å behandle helseopplysninger.

Datatilsynet har vurdert søknaden og gir Dem med hjemmel i helseregisterlovens § 5, jf. medisinsk fødselsregisterforskrift § 3-5, jf. dødsårsaksregisterforskriftens § 3-5, jf. reseptregisterforskriftens § 5-1, jf. personopplysningslovens § 33, jf. § 34, konsesjon til å behandle helseopplysninger i forbindelse med forskningsprosjektet: "STORK Groruddalen".

Databehandlingsansvarlig er Aker universitetssykehus HF ved øverste leder. Gjennomføringen av det daglige ansvaret kan delegeres.

Konsesjonen er gitt under forutsetning av at behandlingen foretas i henhold til søknaden og de bestemmelser som følger av helseregisterloven med forskrifter.

Konsesjonen omfatter ikke bruk av opplysninger fra Norsk Pasientregister da forskrift om bruk av opplysninger fra dette registeret ikke er endelig regulert og vedtatt enda. Det må søkes om utvidelse av denne konsesjonen for bruk av opplysninger fra Norsk Pasientregister. Den omsøkte bruken kan ikke vurderes av Datatilsynet før reguleringen er på plass.

Konsesjonen er gitt under forutsetning av at prosjektet blir tilråda av regional komité for medisinsk forskningsetikk (REK) og at det sendes melding om opprettelse av forskningsbiobank.

Videre presiseres det at det kun er gitt konsesjon for utlevering av anonymt / statistisk materiale på utvalget i medhold reseptregisterforskriftens § 5-1, annet ledd.

Dersom det skjer endringer i behandlingen i forhold til de opplysninger som er gitt i søknaden, må dette fremmes i ny konsesjonssøknad. Det presiseres at konsesjonen, i samsvar med søknaden, er tidsbegrrenset til 31.12.2030. Personidentifiserbare data må da slettes eller anonymiseres.
I medhold av helseregisterlovens § 5, jf. § 36, jf. personopplysningslovens § 35, fastsettes i tillegg følgende vilkår for behandlingen:

1. Den databehandlingsansvarlige skal hvert tredje år sende personvernombudet bekreftelse på at behandlingen skjer i overensstemmelse med søknaden og helseregisterlovens regler.

Datatilsynet tar forbehold om at konsesjonen kan bli trukket tilbake eller at nye og endrede vilkår kan bli gitt dersom dette er nødvendig ut fra personvernhensyn.

Dette vedtak kan påklages til Personvernmennda i medhold av forvaltningslovens kapittel IV. Eventuell klage må sendes til Datatilsynet senest tre uker etter mottaket av dette brev.

Med hilsen

[Signature]

Knut Brede Kaspersen
avdelingsdirektør

[Signature]

Monica Fornes
rådgiver

[Kopi: Ullevål universitetssykehus HF - Konsern IT / Heidi Thorstensen, 0407 OSLO]
**Additional file 2: Analyses of missing data and sensitivity**

**Introduction**

The originally fitted models presented in the paper built on analyses of data from three time points, restricted to participants with complete observations at each time point (complete case analysis).

The data material suffers from extensive missing data on MVPA. Missing data mechanisms describe the possible associations between measured variables and the probability of missing data [1]. Three missing mechanisms have been described [2]: **Missing completely at random (MCAR)** indicates that the probability of missing data on a variable Y is unrelated to other measured variables and the values of Y itself. **Missing at random (MAR)** indicates that the probability of missing data on a variable Y is related to one or several measured variable(s) in the model, but not the values of Y. **Missing not at random (MNAR)** is indicated if the probability of missing data on a variable Y is related to the values of Y after adjustments for other variables.

It is not possible to verify the missing data mechanism [1, 3], but it is recommended to explore whether the MAR assumption is plausible or not. Multiple imputation can, potentially, reduce bias in epidemiological models of association, but factors associated with both missing data and the outcome variable must be included as auxiliary variables in the imputation model [2].

It is recommended, also, to assess the robustness of inferences in analysis based on the MAR assumption to possible departures from the MAR assumption by assessing the models’ sensitivity to MNAR mechanisms [4]. Numerous MNAR scenarios are possible and it is not feasible to assess sensitivity to all kinds of scenarios [5].

In this supplement, we describe analyses of missing data, and two forms of sensitivity analyses: First, we assessed bias arising from the complete case analysis by performing analyses of datasets generated by multiple imputation. Second, we assessed the models sensitivity to a specified MNAR mechanism: We tested the sensitivity to the worst-case scenario were we assumed that all participants with missing data on MVPA would have recorded 0 MVPA min/day. The analyses presented are based on recommendations by Sterne and colleagues [4].

**1. Analyses of missing data and reasons for missing**

**Frequency of missing data**

Data collected at three time points from 709 participants were included in the analysis. Hence, there was potential for 2127 data observations. Among the variables included in the original analyses, we observed extensive missing data on objectively recorded moderate-to-vigorous intensity physical activity (MVPA), which is the focus in this additional file. A flowchart [additional file 1] presents the dropout of participants from the Stork-Groddal study, and reported reasons for missing MVPA data at the each time point.

Table 1a presents the frequency and percentage of missing data, both with reference to the total number of observations and the total number of participants analysed.
Table 1a: Missing data presented as frequency and percentages of total observations (n=2127) and total participants (n=709)

<table>
<thead>
<tr>
<th></th>
<th>Observations with missing data (% of 2127 observations)</th>
<th>Participants with missing data (% of 709 participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectively recorded MVPA(^1)</td>
<td>660 (31.3)</td>
<td>-</td>
</tr>
<tr>
<td>Objectively recorded MVPA time point 1</td>
<td>-</td>
<td>69 (9.7)</td>
</tr>
<tr>
<td>Objectively recorded MVPA time point 2</td>
<td>-</td>
<td>186 (26.2)</td>
</tr>
<tr>
<td>Objectively recorded MVPA time point 3</td>
<td>-</td>
<td>405 (57.1)</td>
</tr>
<tr>
<td>Gest./ postpartum week of PA(^2) recording</td>
<td>142 (6.7)</td>
<td>-</td>
</tr>
<tr>
<td>Gestational week time point 2</td>
<td>-</td>
<td>30 (4.2)</td>
</tr>
<tr>
<td>Postpartum week time point 3</td>
<td>-</td>
<td>112 (15.8)</td>
</tr>
<tr>
<td>Season</td>
<td>142 (6.7)</td>
<td>-</td>
</tr>
<tr>
<td>Season time point 2</td>
<td>-</td>
<td>31 (4.4)</td>
</tr>
<tr>
<td>Season time point 3</td>
<td>-</td>
<td>111 (15.7)</td>
</tr>
<tr>
<td>Perceived access to recreational areas</td>
<td>-</td>
<td>36 (5.1)</td>
</tr>
</tbody>
</table>

\(^1\)MVPA=Moderate-to-vigorous intensity physical activity
\(^2\)PA=Physical activity

Missing pattern
With respect to MVPA, the missing patterns show that missing data at time point 3 and missing data at time point 2 and 3 together represent 51 percent of the patterns. In total, 34% of the sample had no missing data on MVPA (Table 1b).

Table 1b: Missing pattern of moderate-to-vigorous physical activity (n=709)

<table>
<thead>
<tr>
<th>Frequency of pattern</th>
<th>Percent</th>
<th>Cumulative percent</th>
<th>Pattern(^3) by time point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>243</td>
<td>34.3</td>
<td>34.3</td>
<td>O</td>
</tr>
<tr>
<td>217</td>
<td>30.6</td>
<td>64.9</td>
<td>O</td>
</tr>
<tr>
<td>143</td>
<td>20.2</td>
<td>85.1</td>
<td>O</td>
</tr>
<tr>
<td>45</td>
<td>6.4</td>
<td>91.4</td>
<td>M</td>
</tr>
<tr>
<td>37</td>
<td>5.2</td>
<td>96.6</td>
<td>O</td>
</tr>
<tr>
<td>18</td>
<td>2.5</td>
<td>99.2</td>
<td>M</td>
</tr>
<tr>
<td>6</td>
<td>0.9</td>
<td>100.0</td>
<td>M</td>
</tr>
</tbody>
</table>

\(^3\) O=observed; M=missing

Predictors of missing data and values on variables with missing data
We performed multiple logistic regression analyses to identify predictors of missing MVPA values at each time point, and predictors of incomplete MVPA data (i.e. missing on at least one time point). We explored predictors of missing data on perceived access to recreational areas by the same method. Parity status, socioeconomic position, and ethnicity were independently associated with missing (Table 1c).
Table 1c: Predictors of missing data

<table>
<thead>
<tr>
<th>Parity</th>
<th>Socioeconomic position</th>
<th>Ethnicity</th>
<th>Body mass index</th>
<th>Age</th>
<th>Objective access to recreational areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MVPA</th>
<th>Time point 1</th>
<th>Time point 2</th>
<th>Time point 3</th>
<th>Incomplete MVPA</th>
<th>Perceived access to recreational areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x³</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

1 x indicates significant (p<0.05) association with missing data assessed by multiple logistic regression analysis

Association with MVPA min/day was determined by multiple linear regression analyses. Ethnicity and body mass index (BMI) were associated with MVPA min/day (Table 1d). Association with perceived access to recreational areas was determined by multiple logistic regression analyses, but no significant predictors were identified (Table 1d).

Table 1d: Predictors of observed values on variables with missing data

<table>
<thead>
<tr>
<th>Parity</th>
<th>Socioeconomic position</th>
<th>Ethnicity</th>
<th>Body mass index</th>
<th>Age</th>
<th>Objective access to recreational areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MVPA min/day</th>
<th>Time point 1</th>
<th>Time point 2</th>
<th>Time point 3</th>
<th>Perceived access to recreational areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x³</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

1 x indicates significant (p<0.05) association with observed value

Except for BMI, all the predictors of missing data and observed values on variables with missing data were already included as confounders in the original models in the paper.
2. Comparison of participants by missing data on MVPA

<table>
<thead>
<tr>
<th>Table 2a: Comparison of participants by missing MVPA at time point 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Valid MVPA(^1) data from time point 3 (n=304)</td>
</tr>
<tr>
<td>Missing MVPA data from time point 3 (n=405)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Age at inclusion (years)</strong></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>30.7</td>
</tr>
<tr>
<td><strong>BMI pre-pregnancy</strong></td>
</tr>
<tr>
<td>24.7</td>
</tr>
<tr>
<td><strong>Objective access to recreational areas</strong></td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Limited access</td>
</tr>
<tr>
<td>Good access</td>
</tr>
<tr>
<td><strong>Perceived access to recreational areas</strong></td>
</tr>
<tr>
<td>Low perception</td>
</tr>
<tr>
<td>High perception</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
</tr>
<tr>
<td>Western</td>
</tr>
<tr>
<td>South Asian</td>
</tr>
<tr>
<td>Middle Eastern</td>
</tr>
<tr>
<td>Other ethnicity</td>
</tr>
<tr>
<td><strong>Education</strong></td>
</tr>
<tr>
<td>&lt;10 years</td>
</tr>
<tr>
<td>10-12 years</td>
</tr>
<tr>
<td>University or college</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
</tr>
<tr>
<td>Elementary occup./homemakers</td>
</tr>
<tr>
<td>Clerical/care occupations</td>
</tr>
<tr>
<td>Manager/degree occupations</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Parity</strong></td>
</tr>
<tr>
<td>None (nulliparous)</td>
</tr>
<tr>
<td>1 (uniparous)</td>
</tr>
<tr>
<td>≥2 (multiparous)</td>
</tr>
<tr>
<td><strong>Housing</strong></td>
</tr>
<tr>
<td>Flat</td>
</tr>
<tr>
<td>Semi-detached or detached housing</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Health pre-pregnancy</strong></td>
</tr>
<tr>
<td>Poor/not too good</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Very good</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Smoking behaviour pre-pregnancy</strong></td>
</tr>
<tr>
<td>Non-smoker</td>
</tr>
<tr>
<td>Daily or irregular smoker</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
</tbody>
</table>

\(^1\) Moderate-to-vigorous intensity physical activity data based on ≥2 valid days
\(^2\) Independent samples t-test
\(^3\) Chi-square test

Selective dropout at time point 3 was evident. In addition to non-Western women and women with ≤12 year’s education, we observed that homemakers and women with elementary occupations had a higher dropout rate than women in other occupations (Table 2a).
3. Sensitivity analysis methods
Since predictors of missing MVPA and MVPA values were included in the original models as confounders, the plausibility of the MAR assumption was supported. However, since BMI predicted MVPA (Table 1d) but was not considered to be a relevant confounder in the original models, inclusion of BMI as an auxiliary variable in the multiple imputation analysis was warranted. Inclusion of BMI would strengthen the plausibility of the MAR assumption of the models based on imputed data. The procedure is described in this section, and results are presented in section 4.

Multiple imputation
As STATA 13 does not account for clustering of data in the imputation phase, we used the software REALCOM-IMPUTE (http://www.bristol.ac.uk/cmm/software/realmcom/imputation.html), which accounts for 2-level data structures. Since the software does not allow for more than two levels, the imputation phase did not account for the clustering of participants within neighbourhoods. Effect estimates from complete case analyses of models not taking into account neighbourhood-level clustering matched the effect estimates from the original three-level models presented in the paper. Hence, we considered it appropriate to use 2-level models in the sensitivity analyses.

The variables included in the imputation model were imported to REALCOM-IMPUTE. Following imputation, the imputed datasets were imported into STATA 13, with which we pooled the estimates from the imputed datasets and performed subsequent analyses.

For the imputation, we defined repeated measurements (i.e. time point 1-3) as level 1, while participants were defined as level 2. To reduce sampling variability we imputed 50 datasets [4]. Five hundred burn-in iterations preceded the first imputed dataset to allow sufficient time for the parameter estimates to stabilize [1], and 500 between-imputation iterations separated the remaining 49 imputed datasets (in total 25,000 iterations) [6, 7].

Variables with missing data were defined as response variables in the imputation model (MVPA, week, season and perceived access to recreational areas) [8]. Variables with complete data were included as auxiliary variables (socioeconomic position, age, time point, ethnicity, parity, objectively recorded access to recreational areas and BMI) [4]. A random intercept term for each individual was also included. Binary and categorical response variables were included in the imputation model in accordance with the prescribed procedure [8]. While MVPA was positively skewed, we preferred the original variable to a normalized transformation in the imputation model, since empirical evidence indicates that normality violations do not pose serious threats to the accuracy of multiple imputation parameter estimates [1]. We included no statistical interactions in the imputation model

Worst-case scenario
We performed worst-case sensitivity analyses to test the robustness of the estimates from the original model and the multiple imputation models to departures from the MAR assumption. The sensitivity analyses were performed by assessment of a specified worst-case scenario where we imputed missing values on MVPA by replacing the missing value with values with 0 MVPA
This worst-case scenario originated from the hypothesis that participants with missing MVPA data “would have” recorded no MVPA in bouts of at least 10 minutes.

With respect to missing data on perceived access to recreational areas, the same procedure was used, and missing values were replaced with the score 0, i.e. low perception of access to recreational areas. For missing data on season and week we kept the imputed values generated by multiple imputation, since these were considered to vary randomly.

4. Results of sensitivity analyses

We have presented estimates of the associations between explanatory variables and MVPA for the four original models (complete case analyses) in tables 4a to 4d, alongside estimates based on multiple imputation and the worst-case scenario.

Table 4a: Association between ethnicity and moderate-to-vigorous physical activity (min/day)

<table>
<thead>
<tr>
<th>Ethnicty (ref: Western)</th>
<th>Original model</th>
<th>Multiple imputation model</th>
<th>Worst-case scenario model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>95% CI</td>
<td>β</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>-6.05</td>
<td>-13.11 , 1.00</td>
<td>-7.20*</td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>-7.58*</td>
<td>-14.17 , -0.99</td>
<td>-8.23*</td>
</tr>
<tr>
<td>Time point (ref: Early pregnancy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postpartum</td>
<td>14.82**</td>
<td>10.11 , 19.54</td>
<td>12.46**</td>
</tr>
</tbody>
</table>

| Interactions (Ref: Western * Early pregnancy) | Original model | Multiple imputation model | Worst-case scenario model |
|                                             | β   | 95% CI | β   | 95% CI | β   | 95% CI |
| South Asian * Mid-pregnancy                 | 1.12  | -5.97 , 8.20 | 0.88  | -6.54 , 8.31 | 1.65  | -4.37 , 7.68 |
| South Asian * Postpartum                    | -16.67** | -25.53 , -7.81 | -8.10  | -16.65 , 0.44 | -8.90** | -14.91 , -2.89 |
| Middle Eastern * Mid-pregnancy              | -2.26  | -10.78 , 6.25 | -1.20  | -9.81 , 7.43  | -0.96  | -8.03 , 6.12  |
| Other * Mid-pregnancy                       | 2.73   | -5.10 , 10.57 | 2.07   | -5.93 , 10.07 | 4.39   | -2.21 , 11.01 |
| Other * Postpartum                          | -14.03** | -23.51 , -4.55 | -7.58  | -16.81 , 1.65 | -6.46  | -13.06 , 0.14 |

1. Three-level linear mixed effects regression models
2. Two-level linear mixed effects regression model based on 50 datasets created by multiple imputations
3. Adjusted for gestational/postpartum week, socioeconomic position, ethnicity, season, parity, age
4. Worst-case scenario: For participants with missing MVPA data the imputed value is 0

With respect to ethnic differences, the multiple imputation model supported the original model, replicating differences in MVPA min/day between Western women and South Asian women and women with other ethnicity, respectively (Table 4a). Although the interaction between ethnicity and time point was not significant in the multiple imputation model, it was close to the result of original model, as the confidence intervals for the interaction between ethnicity and postpartum indicated a trend towards a widening gap postpartum between Western women and women from the other ethnic groups.

The worst-case scenario model indicated that the ethnic differences in early pregnancy were robust to the potential MNAR mechanism (Table 4a). Significant interactions between time point
and ethnicity was demonstrated with respect to South Asian and Middle Eastern women, but the effect size was smaller compared with the original model.

### Table 4b: Association between objective access to recreational areas and moderate-to-vigorous physical activity (min/day)

<table>
<thead>
<tr>
<th>Objective access to recreational areas (ref: limited access)</th>
<th>Original model 1 1,3</th>
<th>Multiple imputation model 1 2,3</th>
<th>Worst-case scenario model 1 4,4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good access</td>
<td>β  95% CI</td>
<td>β  95% CI</td>
<td>β  95% CI</td>
</tr>
</tbody>
</table>

1 Three-level linear mixed effects regression models
2 Two-level linear mixed effects regression model based on 50 datasets created by multiple imputations
3 Adjusted for gestational/postpartum week, socioeconomic position, ethnicity, season, parity, age
4 Worst-case scenario: For participants with missing MVPA data the imputed value is 0.
   * p<0.05
   ** p<0.01

With respect to the association between objective access to recreational areas and MVPA, there were no substantial differences between the results in the original model and the multiple imputation model (Table 4b and 4d). The worst-case scenario model showed that the association between objective access to recreational areas and MVPA remained significant and within the confidence intervals of the estimates in the original model and the multiple imputation model. The worst-case scenario model supported the robustness of the association between objective access to recreational areas and MVPA.

### Table 4c: Association between perceived access to recreational areas and moderate-to-vigorous physical activity (min/day)

<table>
<thead>
<tr>
<th>Perceived access to recreational areas (ref: Low perception)</th>
<th>Original model 2 1,3</th>
<th>Multiple imputation model 2 2,3</th>
<th>Worst-case scenario model 2 4,4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β  95% CI</td>
<td>β  95% CI</td>
<td>β  95% CI</td>
</tr>
<tr>
<td>High perception</td>
<td>4.75*</td>
<td>0.68, 8.82</td>
<td>4.43*</td>
</tr>
</tbody>
</table>

1 Three-level linear mixed effects regression models
2 Two-level linear mixed effects regression model based on 50 datasets created by multiple imputations
3 Adjusted for gestational/postpartum week, socioeconomic position, ethnicity, season, parity, age
4 Worst-case scenario: For participants with missing MVPA data the imputed value is 0. For participants with missing perceived access to recreational area the imputed value is set to low perception
   * p<0.05
   ** p<0.01

The association between perceived access to recreational areas and MVPA remained significant in the multiple imputation model, in line with the original model (Tables 4c and 4d). The worst-case
scenario model indicated that the associations observed in the original model and the multiple imputation model were not robust to potential departures from the MAR assumption; the β-coefficients supported the positive trend, but the associations were not statistically significant in the worst-case scenario model.

| Table 4d: Mutually adjusted perceived and objective access to recreational areas and association with moderate-to-vigorous physical activity (min/day) |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Objective access to recreational areas (ref: limited access) | Original model 3 | Multiple imputation model 3 | Worst-case scenario model 3 |
| Good access                                             | β    | 95% CI | β    | 95% CI | β    | 95% CI |
| Perceived access to recreational areas (ref: Low perception) | β    | 95% CI | β    | 95% CI | β    | 95% CI |
| High perception                                         | 4.40* | 0.34,8.45 | 4.07* | 0.23,7.92 | 2.49 | -0.61,5.59 |

1 Three-level linear mixed effects regression models
2 Two-level linear mixed effects regression model based on 50 datasets created by multiple imputations
3 Adjusted for gestational/postpartum week, socioeconomic position, ethnicity, season, parity, age
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5. Conclusion

Plausibility of the missing at random assumption (multiple imputation)
The observation that missing data and observed values on variables with missing data were systematically associated with other measured variables show that there is no support for the MCAR assumption (Table 1c and 1d). In accordance with previous studies, we observed that several factors (i.e. socioeconomic position, ethnicity and age) predicted missing data [9]. The inclusion of predictors of missing data and values on MVPA in the original models and in the multiple imputation models supported the plausibility of the MAR assumption of these models. Probably, the addition of BMI as an auxiliary variable in the multiple imputation procedure further strengthened the plausibility of the MAR assumption of the multiple imputation models. While interactions between ethnicity and time point were not significant in the multiple imputation model (Table 4a), the overall picture shows that the original models and the multiple imputation models yielded similar results, suggesting that missing data did not bias the results of the original models.

Robustness to potential missing not at random (worst-case scenario)
The original model of the association between ethnicity and MVPA at time point 1 was robust to the specified MNAR mechanism (Table 4a). The effect estimate given the worst-case scenario remained significant and within the 95% confidence interval observed in the original model. The interaction between ethnicity (South Asian and Middle Eastern women) and time point observed...
in the original model was also replicated, indicating that the interaction effect was robust to the specified MNAR mechanism.

The association between objective access to recreational areas and MVPA was robust to the specified MNAR mechanism (Table 4b and 4d). However, the effect estimates were attenuated in model 1 and 3, but in both tests, they remained within the 95% confidence intervals observed in the original models and the imputation models. The association between perceived access to recreational areas and MVPA showed a positive trend, but the association was no longer significant (Table 4c and 4d), indicating that the original model estimate of this association is less robust to the specified MNAR mechanism.

References
11. Errata
12. Papers