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# Validation of measures of physical activity in pregnancy exemplified by the findings from the Norwegian Mother and Child Cohort study (MoBa)

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# Outline



- Why study physical activity in pregnancy?
- Methods for assessment of physical activity
  - Questionnaires, records, electronic devices
- Validation issues
  - Challenges, techniques, outcomes
  - Validation of recreational exercise in the MoBa study, methods, results and implications
- Conclusions

# Benefits of physical activity



There is strong evidence for substantial health benefit from physical activity in the general population



“Every adult should accumulate 30 minutes or more of moderate intensity physical activity on most, preferably all, days of the week”

Centers for Disease Control and Prevention  
and American College of Sports Medicine



Health authorities in the US, Great Britain, Norway and Denmark recommend the same level of physical activity for pregnant women as for non-pregnant

# Why study physical activity in pregnancy?



- Research over several decades supports the benefits of physical activity during pregnancy (Leiferman & Evenson, 2003; Gavard & Artal, 2008)
- Regular exercise is associated with reduced risk of GDM, preeclampsia, hyperlipidemia and excessive fetal growth (Campbell & Mottola, 2001; Sørensen et al, 2003; Butler et al, 2004)
- Research gaps:
  - Safety and dose of different exercise regimes on pregnancy
  - Impact of maternal exercise on foetal and child health

# What is physical activity (PA)?



- Physical activity include all activity, not just exercise:
  - Any muscle movement beyond rest
  - Fitness training and all exercise activities
  - Domestic work
  - Care giving
  - Leisure activity
  - Work related activity
  - Active transport
- Assessment should ideally cover all features of PA
  - mode, frequency, duration and intensity

# Physical activity in pregnancy



- Different measurement methods and definitions of physical activity and exercise makes comparison across studies difficult
- Pregnancy is associated with reduced levels of physical activity. Mottola & Campbell 2003; King 1994; Owe et al. 2008
- The prevalence of regular exercise varies widely. Ning et al., 2003; Evenson et al., 2004

# Assessment and validation of PA in pregnancy



- Challenges:
  - Physiological changes
  - large variation in individual response to pregnancy - e.g. energy metabolism, plasma volume expansion, iron status
  - PA vary over the course of pregnancy and may also vary within a trimester
- The compendium of physical activities used to assign MET values to activities is based on non-pregnant adults
- Few instruments/questionnaires have been developed and validated in pregnant populations

# Desirable features of PA assessment tools

- Valid: measures what it is intended to measure
- Reliable: consistently gives the same results
- Practical: reasonable costs to study and participants
- Non-reactive: does not alter the population or behavior it seeks to measure
- Sensitive: discriminates differences within and between individuals

# How can pa be measured during pregnancy?

- Doubly labeled water studies
  - total energy expenditure and PA-levels
- Activity Questionnaires or Records
  - Comprehensive questionnaire
  - A few simple questions
  - Detailed hour to hour record of type, intensity and duration
- Objective measures
  - Electronic devices, i.e. pedometers, accelerometers, motion sensors

# Doubly labeled water

Total Energy Expenditure and ratio of TEE/BMR estimated by DLW. Forsum *et al.*, AJCN 1992

	Pre pregnant n=28	22 wk ga n=22	30 wk ga n=22	36 wk ga n=22
TEE (MJ/d)	10.5 ± 2.2	9.6 ± 2.8	12.5 ± 3.4	12.2 ± 4.1
TEE/BMR	1.87 ± 0.42	1.65 ± 0.67	1.82 ± 0.45	1.66 ± 0.52

# Questionnaires

## Questionnaires validated among pregnant women

- The pregnancy physical activity questionnaire (PPAQ). Chasan-Taber et al. Med Sci Sports Exerc 2004
- The Kaiser Physical Activity Survey in pregnant women. Schmidt et al. Med Sci Sports Exerc 2006.
- The leisure time physical activity (LTPA) questionnaire during pregnancy. Aittasalo et al. J Physical Activity Health, 2010
- The MoBa questions regarding recreational exercise week 17 in pregnancy, Scand J Med Sci Sports 2009

**Validation:** The instrument to be validated, the “test” method is compared to more precise or objective “reference” methods

**Test method**

**Reference method**

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**Questionnaire**

**Other questionnaire or diary**  
**Electronic device**

Validation: The instrument to be validated, the “test” method is compared to more precise or objective “reference” methods

**Test method**

**Reference method**

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**PPAQ**

**Actigraph accelerometer  
for 7 days (n=54)**

Correlations:

Total activity:  $r=0.08, 0.32$  or  $0.43$

Light activity:  $r=-0.08, 0.10$  or  $0.22$

Moderate :  $r=0.20, 0,42$  or  $0.49$

Validation: The instrument to be validated, the “test” method is compared to more precise or objective “reference” methods

**Test method**

**Reference methods**

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**The KPAS adapted  
for pregnant women**

**PPAQ  
Actigraph accelerometer**

$r_{\text{KPAS-PPAQ}}=0.84$  for exercise and  $r=0.71$  for household activities

$r_{\text{KPAS-Actigraph}}=0.34, 0.39$  or  $0.51$  for exercise  
= $0.12, 0.24$  or  $0.26$  for household activity  
= $0.26, 0.31$  or  $0.33$  for occupational activity

Validation: The instrument to be validated, the “test” method is compared to more precise or objective “reference” methods

### Test method

### Reference methods

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**LTPA**

IPAQ adapted to pregnancy

**pedometer 7 days (n=45)**

**logbook 7 days (n=47)**

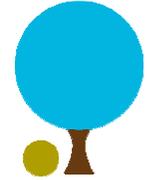
$r_{\text{LTPA-Pedometer}}$  no correlation at all

$r_{\text{LTPA-logbook}}$   $r=0.68$  for frequency of moderate to vigorous activities

Rousham et al.,: PA self report and accelerometers at weeks 12, 16, 25, 34 and 38, n=57 nulliparous women

Gestational week	$r_{\text{selfreport-accelerometer}}$
12 (n=29)	0.55 (p<0.01)
16 (n=56)	0.26 ns
25 (n=53)	0.15 ns
34 (n=43)	0.13 ns
38 (n=33)	0.22 ns

Rousham et al. *EJCN*, 2006



# The Norwegian Mother and Child Cohort Study (MoBa)



Main Goal:

To prevent childhood and adult diseases by understanding early environmental and genetic factors

*Magnus et al., Int J Epidemiol, 2006*

# Questions about leisure exercise in MoBa

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Physical activity

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How often do you usually exercise each week

	In this pregnancy				
	Never	§ once	once	twice	≥ three times
1 Walking	<input type="checkbox"/>				
2 Brisk walking	<input type="checkbox"/>				
3 Running/jogging	<input type="checkbox"/>				
4 Bicycling	<input type="checkbox"/>				
5 Training studio	<input type="checkbox"/>				
6 Special aerobics for pregnant women	<input type="checkbox"/>				
7 Aerobics without jumping	<input type="checkbox"/>				
8 Aerobics with jumping	<input type="checkbox"/>				
9 Dancing	<input type="checkbox"/>				
10 Skiing	<input type="checkbox"/>				
11 Team sports	<input type="checkbox"/>				
12 Swimming	<input type="checkbox"/>				
13 Horse riding	<input type="checkbox"/>				
14 Other:	<input type="checkbox"/>				

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§The same questions are asked at many time points: 3 mo prepregnant, week 17, week 30, 6mo pp, 18 mo pp and 36 mo postpartum

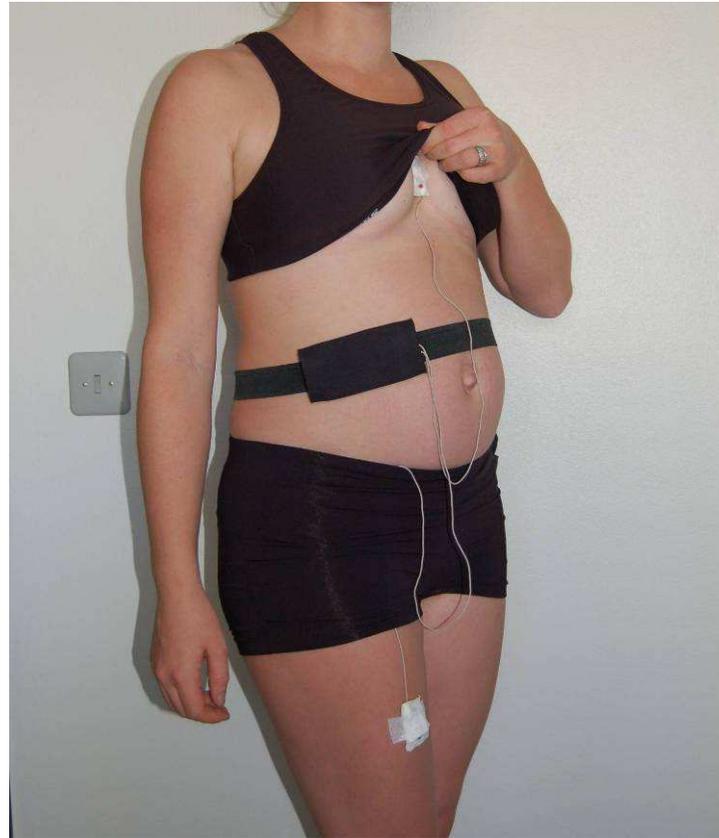
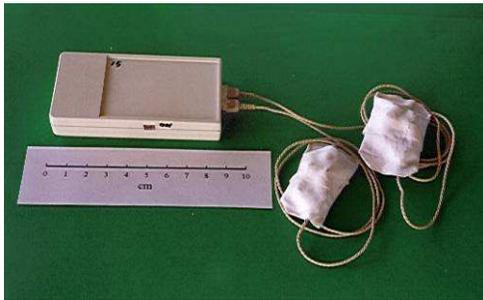
# Validation study in MoBa

A validated motion sensor ActiReg® was included in the validation study of a new food frequency questionnaire



# ActiReg® assigns each minute an activity factor based on 60 recordings of body movement and position

Two sensors and a storage unit

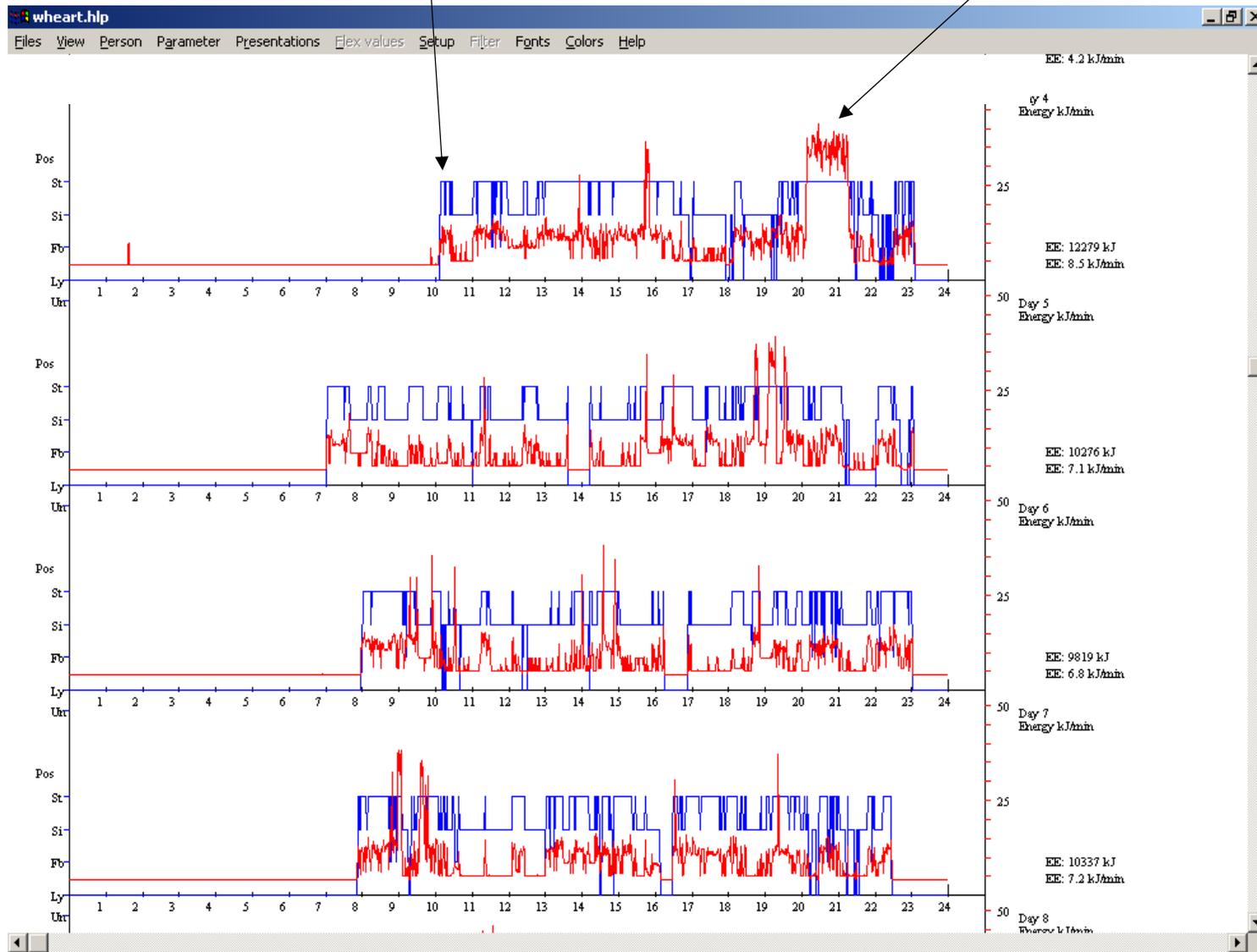


Study participants were asked to wear the motion sensor for 4 days

# ActiReg output

Blue line shows body position

Red line shows the intensity of movement and position changes



## Results: Participant characteristics, n=112 women in the Validation study

	Mean (SD)	Median	Min-max
Age (year)	31.2 (4.0)	31	23-42
Body weight <sup>a</sup> (kg)	69.9 (9.9)	69	21-111
Body height (m)	1.68 (0.07)	1.70	1.50-1.81
BMI (kg m <sup>2</sup> )	24.8 (3.5)	24.1	18-41
REE <sub>WHO</sub> (kJ/day)	6 000 (510)	5 900	4 880-7 640

<sup>a</sup> weight at time of the validation study

REE<sub>WHO</sub> = resting energy expenditure calculated according to the WHO-equation

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Weeks pregnant when answering the PA questions	16 (2)	16	14 - 23
Weeks pregnant when wearing the motion sensor	20 (2)	20	18 - 27
	N (%)		
Daily smoker before pregnancy	9 (8)		
Nulliparous	63 (56)		
Education >12 years	94 (84)		

<sup>a</sup> weight at time of the validation study

REE<sub>WHO</sub> = resting energy expenditure calculated according to the WHO-equation

Results: Participant characteristics, n=112 women in the Validation study

	Mean (SD)	Median	Min-max
Sum of all recreational exercises incl walking (times/week)	3.5 (2.6)	3.1	0 -13
Total MET-minutes from exercise (minutes/week)	560 (230)	350	0 - 2450
Motion sensor output:			
TEE <sub>AR</sub> (kJ/day)	10,020 (1,015)	10,100	7,870-12,880
PAEE <sub>AR</sub> (kJ/day)	4,020 (820)	4,080	2,080-6,150
PAL <sub>AR</sub> (TEE/REE)	1.66 (0.13)	1.66	1.29- 1.96
VPA <sub>AR</sub> (min/day)	20.2 (13.5)	16.9	0.5-62.5

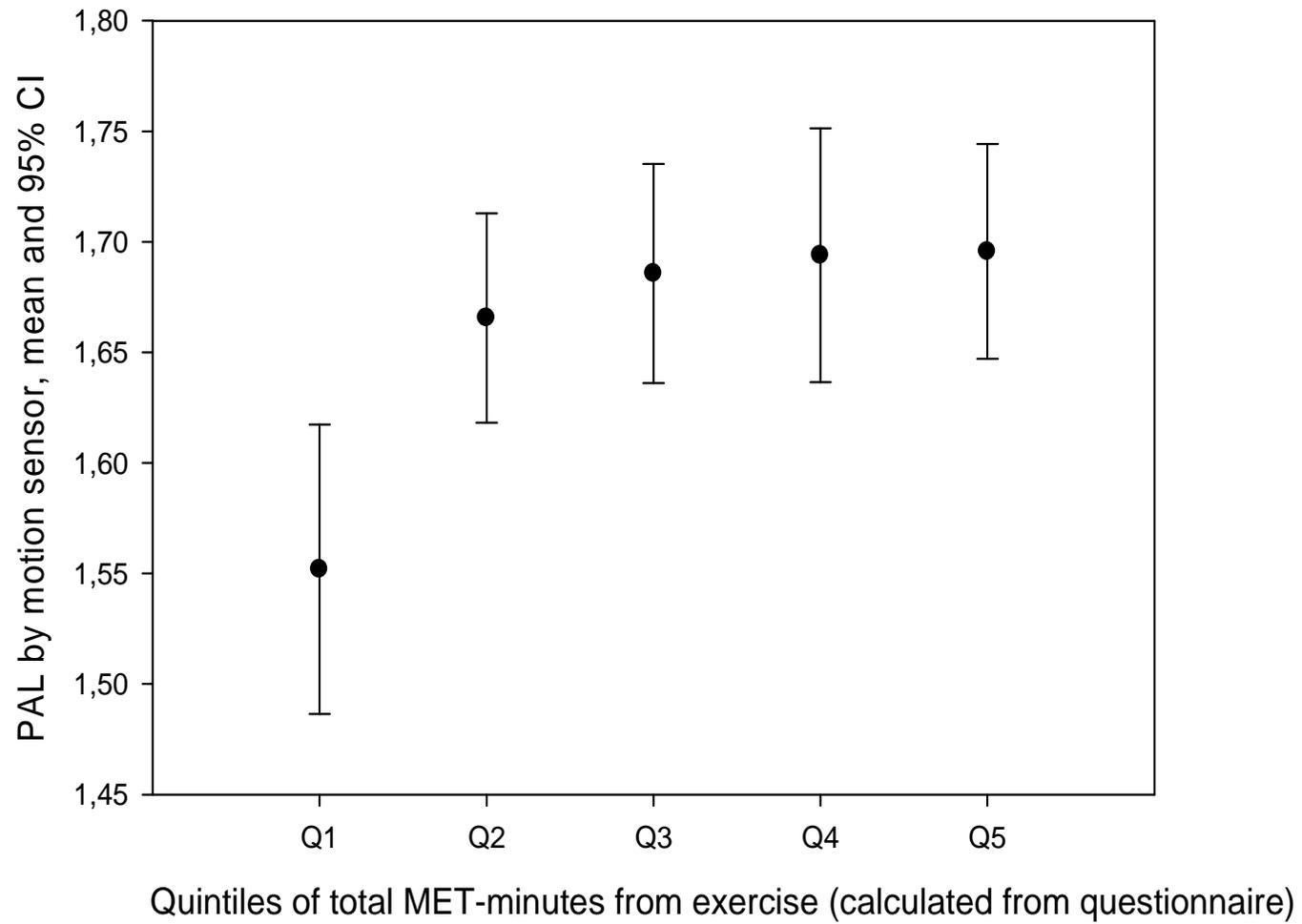
TEE<sub>AR</sub> = total energy expenditure computed by the motion sensor ActiReg®

PAEE<sub>AR</sub> = physical activity energy expenditure: TEE<sub>AR</sub> - REE<sub>WHO</sub>

PAL<sub>AR</sub> = Physical activity level, TEE<sub>AR</sub> / REE<sub>WHO</sub>

VPA<sub>AR</sub> = minutes of vigorous physical activity corresponding to 6+ METs

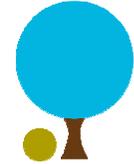
# Results



**Pearson correlations (crude and adjusted) between the ActiReg® measures and the questionnaire data in 112 pregnant women in the validation study**

	<b>TEE<sub>AR</sub></b> <b>(kJ/day)</b>	<b>PAEE<sub>AR</sub></b> <b>(kJ/day)</b>	<b>PAL<sub>AR</sub></b>	<b>VPA<sub>AR</sub></b> <b>(min/day)</b>
	<b>Pearson r</b>			
<b>Sum of all weekly exercises</b>	<b>r=0.17</b>	<b>r=0.26**</b>	<b>r=0.30**</b>	<b>r=0.32**</b>
<b>Total weekly MET-minutes, exercise</b>	<b>r=0.18</b>	<b>r=0.29**</b>	<b>r=0.34**</b>	<b>r=0.25**</b>
	<b>Partial correlation r<sup>§</sup></b>			
<b>Sum of all weekly exercises</b>	<b>r=0.27**</b>	<b>r=0.26**</b>	<b>r=0.27**</b>	<b>r=0.25**</b>
<b>Total weekly MET-minutes, exercise</b>	<b>r=0.33**</b>	<b>r=0.32**</b>	<b>r=0.32**</b>	<b>r=0.19*</b>

<sup>§</sup> Adjusted for age, height, parity, BMI, education, and smoking status



## Conclusions



- Validation of PA instruments is essential even if precise assessment of PA is impossible in epidemiological studies, and even more difficult in pregnant study groups



- Electronic devices do not capture all activities well and cannot be worn while swimming, compliance can be a problem



- High correlations between self-reported and objective measures cannot be expected

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