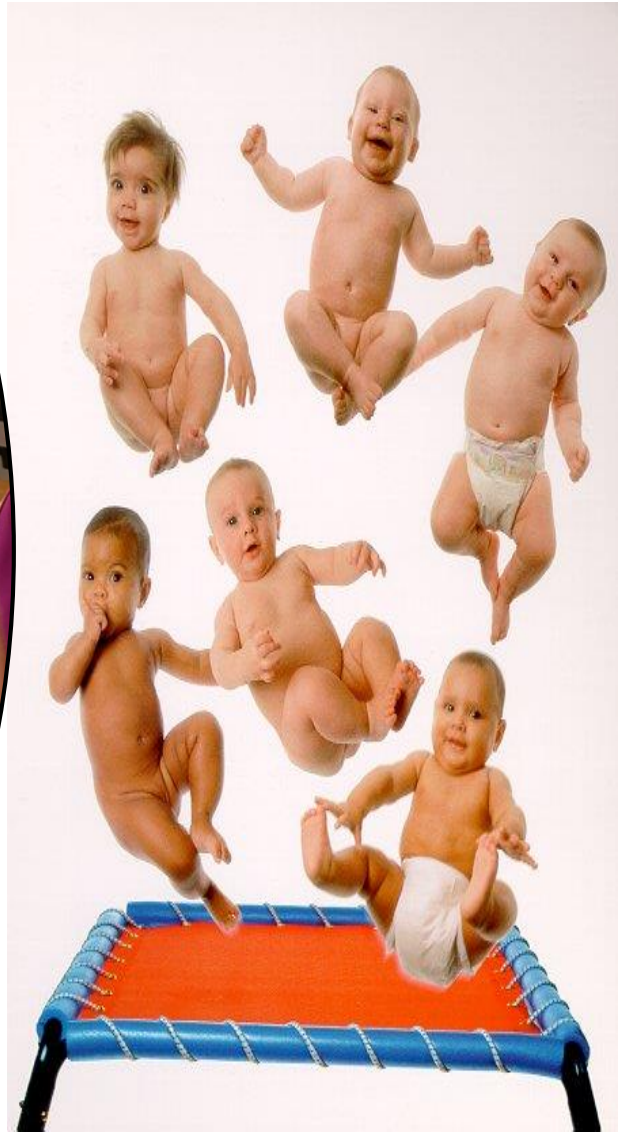
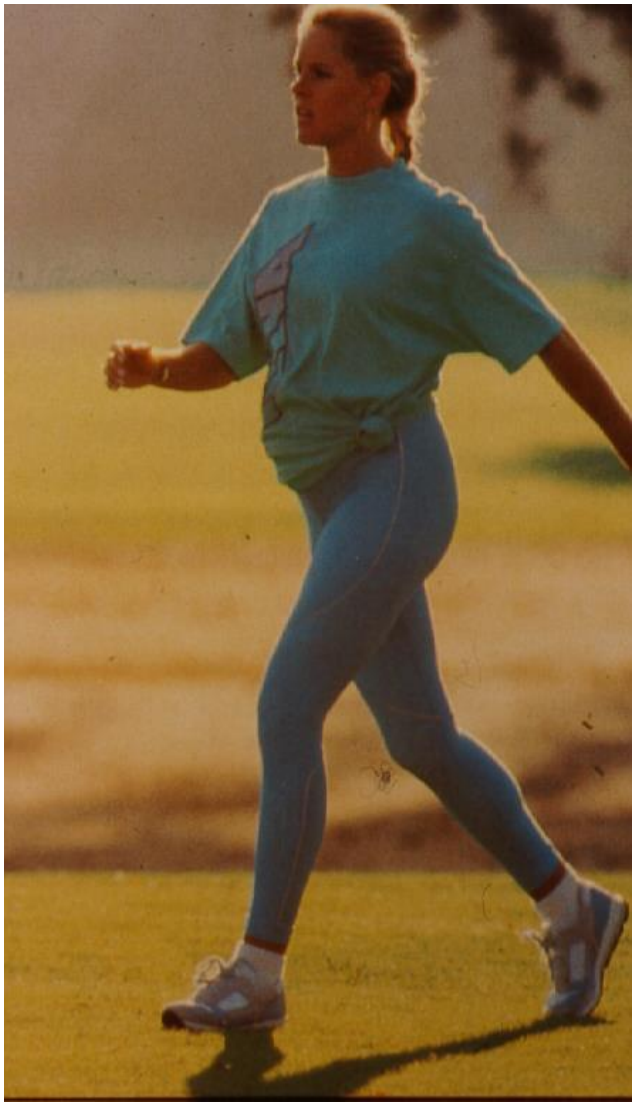
Physical activity during pregnancy





Exercise recommendations

Aerobic physical activity

- **minimum 30 min**
- **moderate intensity**
- **5 days each week**

HEALTHY PREGNANT WOMEN SHOULD ADOPT THE SAME RECOMMENDATIONS!

ACOG - 2003

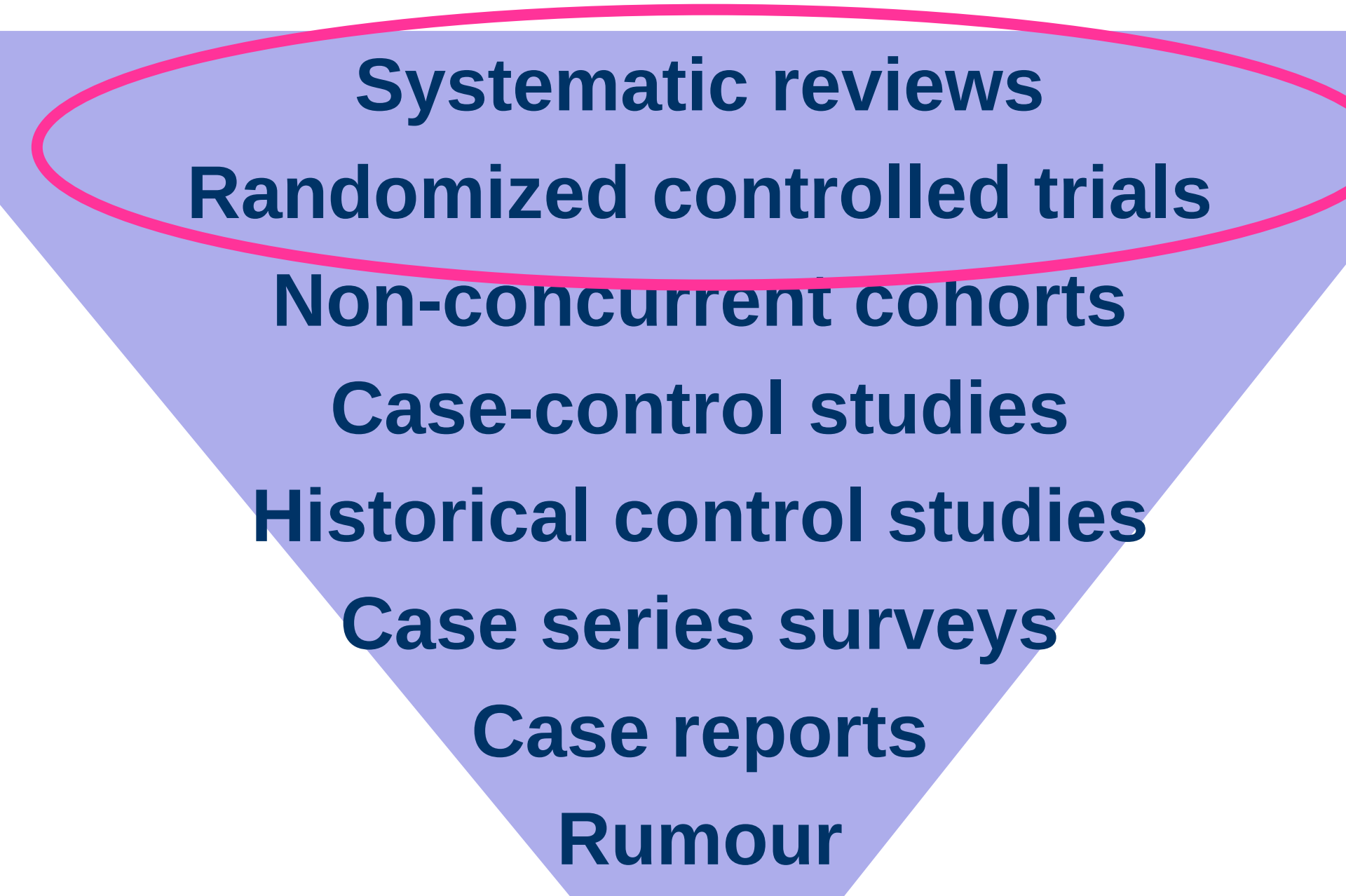
Muscular strength

- **activities that maintain or increase muscular strength**
- **mimimum 2 days each week**

I found this magazine at my local newsagent in June 2013

60 pages with detailed examples of physical exercises week by week during pregnancy

The hierarchy of evidence



Cochrane reviews

Physical activity during pregnancy to prevent or treat

- **Low back pain – 2013**
- **Gestational diabetes – 2012**
- **Preeclampsia – 2006**

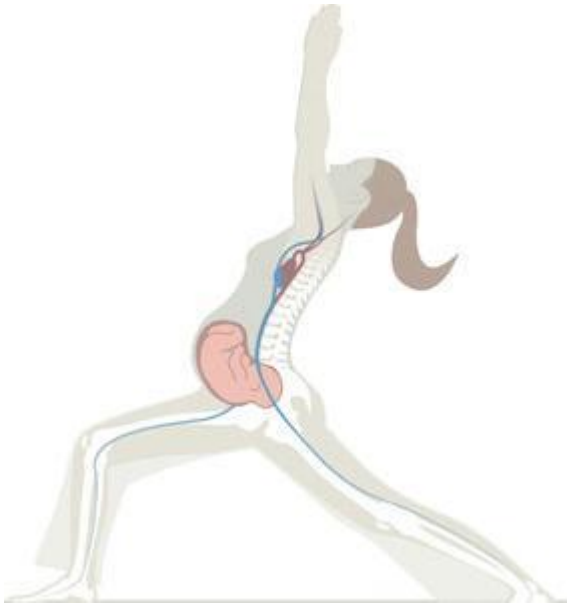
Aerobic exercise during pregnancy

- **Systematic review – 2010**

Physical activity during pregnancy Publications – Salvesen

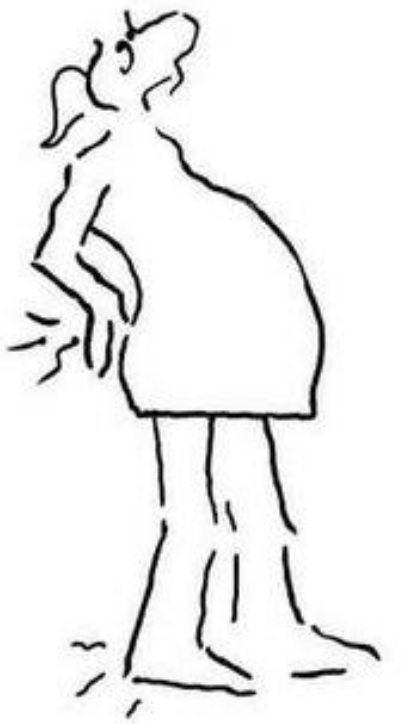
- Duration of labor – AOGS 2013
- Urinary and fecal incontinence – BJOG 2013
- Lumbopelvic pain – AOGS 2012
- Gestational diabetes – Obstet Gynecol 2012
- Postnatal depression – AOGS 2011
- Fetal wellbeing – Br J Sports Med 2011
- Lumbopelvic pain – AOGS 2009
- Duration of labor – BMJ 2004
- Urinary incontinence – Obstet Gynecol 2003

Gestational diabetes



- **Prevalence: 1-14% - dependent on diagnostic criteria and study populations**
- **Physical activity is important in treatment and prevention of type 2 diabetes**
- **No previous RCTs on physical exercise in pregnancy and gestational diabetes in a systematic PubMed search 2006**

Lumbopelvic pain (LPP)



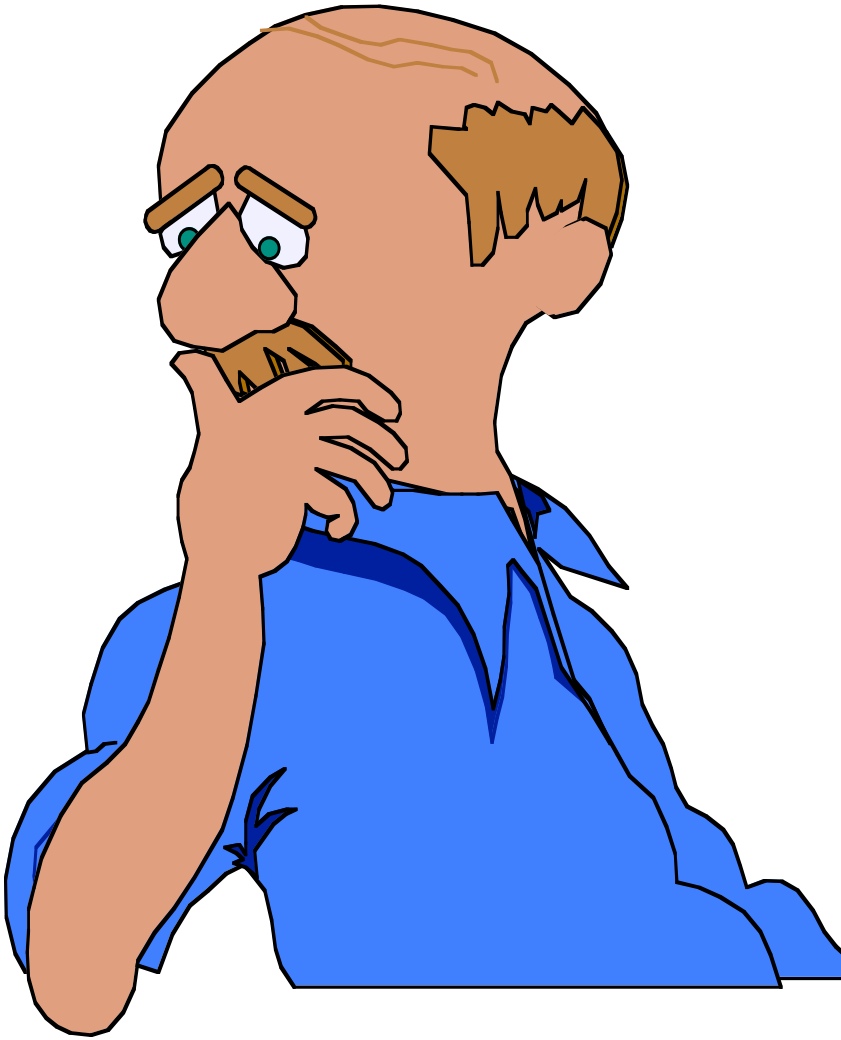
- **2/3 of pregnant women experience low back pain (LBP) and 1/5 experience lumbopelvic pain (LPP)**
- **Pain increases during pregnancy and interferes with work, daily activities and sleep**
- **Most common reason for sick leave during pregnancy**
- **Major public health problem**

Urinary incontinence

- **Prevalence during pregnancy**
  - **20-67%**
- **Prevalence postpartum**
  - **2-44%**
- **Pelvic floor muscle training is effective for**
  - **Treatment**
  - **Prevention**

Other outomes?

- Preeclampsia
- Preterm birth
- Mode of delivery
- Duration of labour
- Anal incontinence
- Postnatal depression
- Is strenous exercise dangerous?



TRIP trial - TRaining In Pregnancy

A randomized controlled trial

Methods

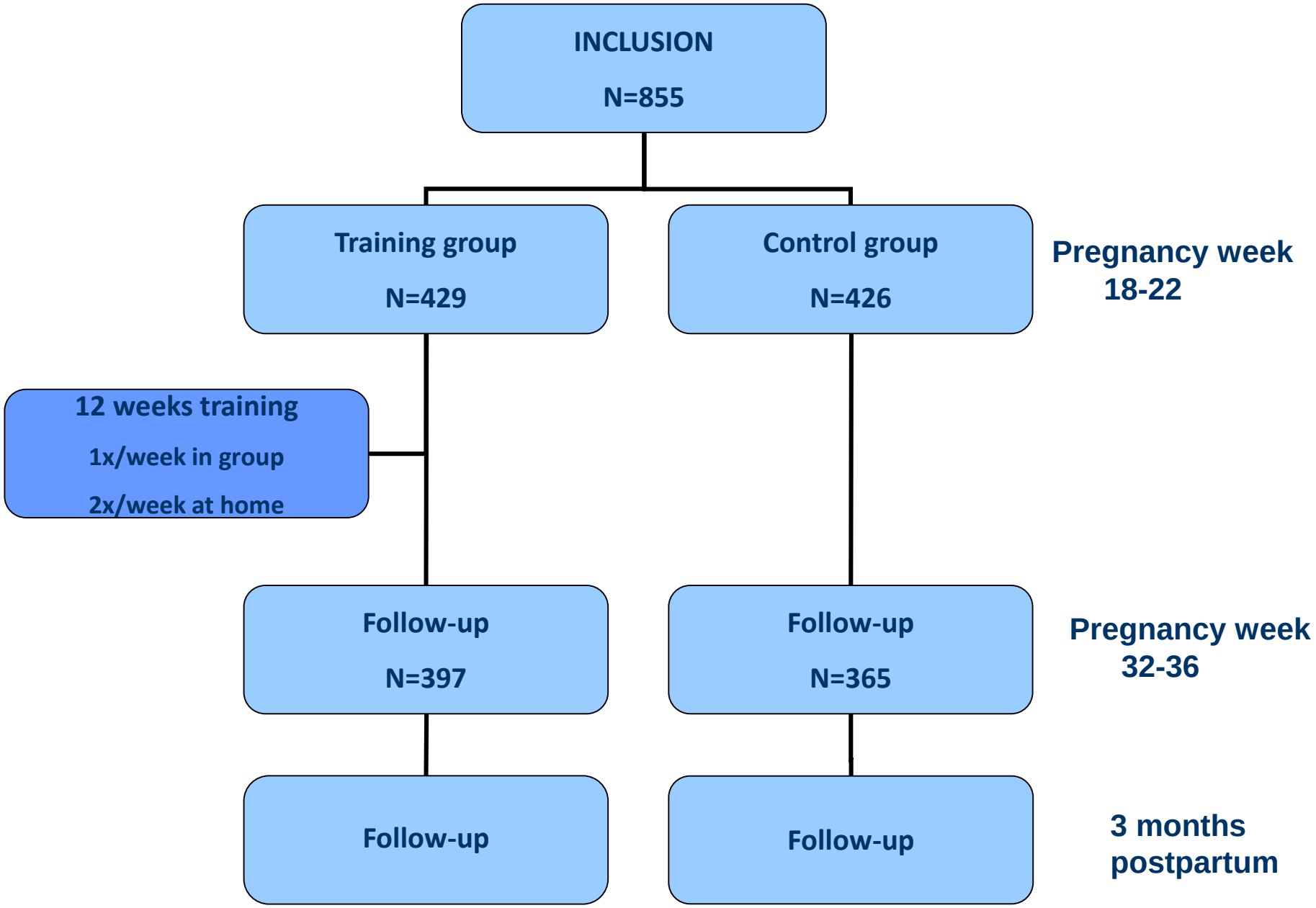
Two-center RCT

- **Trondheim University Hospital**
- **Stavanger University Hospital**

Pregnant women recruited from April 2007 to June 2009

Power calculation

- **GDM reduction from 9 to 4%**
- **Sample size: n = 381 x 2**
- **Women included: N = 855**


INCLUSION
N=855
Training group
N=429
Control group
N=426
Pregnancy week
18-22
12 weeks training
1x/week in group
2x/week at home
Follow-up
N=397
Follow-up
N=365
Pregnancy week
32-36
Follow-up
Follow-up
3 months
postpartum

Training group

Exercise program:

- **30-35 min aerobic activity**
- **20-25 min specific strength training**
- **10 min stretching, body awareness and relaxation exercises**
- **PFMT included**

Control group

Recieved customary information given by midwife or general practitioner

Both groups received written recommendations of:

- **Pelvic floor muscle exercises**
- **Diet in pregnancy**
- **Pregnancy-related LPP**

Group characteristics

	Training group (n=429) Mean (±SD)	Control group (n=426) Mean (±SD)
Age	30.5 (±4.4)	30.4 (±4.3)
Nulliparous (%)	57.6	56.1
Weight		
Test 1	70.4 (±9.8)	70.8 (±10.3)
Test 2	77.2 (±10.0)	77.6 (±10.4)
BMI		
Test 1	24.7 (±3.0)	25.0 (±3.4)
Test 2	27.1 (±3.1)	27.4 (±3.4)

Group characteristics

	Training group (n=429)	Control group (n=426)
Exercise regularly (%)		
T1	53.1	50.7
T2	81.4	45.5
Exercise regularly ≥3 x per week (%)		
T1	14.0	11.7
T2	54.7	9.9

Outcomes

Primary outcome:

Gestational diabetes (GDM)

- **Reduction in GDM**
- **Changes in insulin resistance**

Secondary outcomes:

- **Lumbopelvic pain (LPP)**
- **Urinary incontinence**
- **Anal incontinence**
- **Duration of labor (2nd stage)**

Gestational diabetes

- **Diagnostic criteria (WHO)**
  - **Fasting blood glucose > 6,1 mmol/L**
  - **Oral Glucose Tolerance Test (OGTT) 2 hour value > 7,8 mmol/L**
- **Blood tests at 18-20 and 32-36 weeks**

- **Gestational diabetes at 32-36 weeks**
- **Training group - 7%**
- **Control group - 6% p=0.52**

Regular Exercise During Pregnancy to Prevent Gestational Diabetes

A Randomized Controlled Trial

Signe N. Stafne, PT, MSc, Kjell Å. Salvesen, MD, PhD, Pål R. Romundstad, PhD, Torbjørn M. Eggebø, MD, PhD, Sven M. Carlsen, MD, PhD, and Siv Mørkved, PT, PhD

Table 2. Primary Outcomes Measured at 32–36 Weeks of Gestation in a Complete Case Analysis*

	Crude Analysis				Adjusted for Baseline Values			
	Intervention Group	Control Group	Difference Between Groups		Intervention Group	Control Group	Difference Between Groups	
			Mean (95% CI)	p			Mean (95% CI)	p
HOMA-IR†	2.56 (0.06)	2.87 (0.09)	−0.30 (−0.52 to −0.09)	.006	2.63 (0.06)	2.78 (0.06)	−0.15 (−0.33 to 0.03)	.10
Fasting insulin (international units/mL‡)	13.4 (0.3)	14.9 (0.4)	−1.5 (−2.5 to −0.5)	.004	13.6 (0.3)	14.6 (0.3)	−1.0 (−1.9 to −0.1)	.03
OGTT glucose level (mmol/L)								
0 min§	4.30 (0.02)	4.32 (0.02)	−0.02 (−0.09 to 0.03)	.40	4.30 (0.02)	4.31 (0.02)	−0.01 (−0.06 to 0.04)	.65
120 min‖	5.64 (0.06)	5.80 (0.06)	−0.16 (−0.34 to 0.02)	.08	5.66 (0.06)	5.79 (0.06)	−0.13 (−0.28 to 0.03)	.12

Gestational diabetes and insulin resistance

Table 3. Primary Outcomes Estimated in a Linear Mixed-Effects Model

	Intervention Group	Control Group	Difference Between Intervention and Control Groups		Difference Between Groups Corrected for Baseline Values*	
			Mean (95% CI)	*P*	Mean (95% CI)	*P*
HOMA-IR	2.58	2.87	−0.29 (−0.50 to −0.08)	.007	−0.12 (−0.30 to 0.06)	.19
Fasting insulin (international units/mL)	13.5	14.9	−1.4 (−2.4 to −0.4)	.005	−0.74 (−1.68 to 0.20)	.12
OGTT glucose level (mmol/L)						
0 min	4.30	4.32	−0.02 (−0.07 to 0.04)	.56	−0.01 (−0.06 to 0.05)	.81
120 min	5.66	5.78	−0.13 (−0.30 to 0.05)	.16	−0.13 (−0.30 to 0.04)	.13

CI, confidence interval; HOMA-IR, homeostasis model of assessment–insulin resistance; OGTT, oral glucose tolerance test.
Data are mean unless otherwise specified.
* The baseline adjusted difference between intervention group and control group was estimated using the interaction between treatment group and time (using baseline and follow-up values as dependent variables).

Outcome measures - Questionnaire

- **Lumbopelvic pain (LPP)**
  - **Prevalence**
  - **Disability Rating Index (DRI)**
  - **Sick leave during pregnancy**
- **Urinary incontinence**
  - **Prevalence**
  - **Sandvik's severity index**
- **Anal incontinence**
  - **Prevalence**
  - **St. Marks score**

LPP: Intention-to-treat analysis

	Training group (N=397) Mean (±SD)	Control group (N=365) Mean (±SD)	P-value
LPP (%)			
T1	56.9	60.6	0.27
T2	73.6	74.5	0.76
DRI			
T1	11.1 (±13.7)	12.3 (±14.4)	0.27
T2	27.2 (±20.1)	28.5 (±20.0)	0.46
Sick leave due to LPP (%)			
T1	3.0	5.6	0.06
T2	22.4	30.8	0.009

LPP: Per protocol analysis

	Training group (N=217) Mean (±SD)	Control group (N=365) Mean (±SD)	P-value
LPP (%)			
T1	59.0	60.6	0.70
T2	69.1	74.5	0.16
DRI			
T1	10.2 (±12.5)	12.3 (±14.4)	0.08
T2	22.5 (±17.9)	28.5 (±20.0)	0.002
Sick leave due to LPP (%)			
T1	2.8	5.6	0.103
T2	18.0	30.8	0.001

Urinary incontinence

Results

The groups were similar in baseline characteristics except severe MUI and SUI which was more frequent in the control group. At follow-up, 55% of training group women exercised 3 days per week compared to 10% of control group women (p < 0.001).

	Intervention group		Control group		Unadjusted			Adjusted for baseline values		
	N = 397		N = 365							
	n	%	n	%	OR	95% CI	P-value	OR adjusted	95% CI	P-value
MUI	166	42	192	53	0.7	(0.5, 0.9)	0.004	0.6	(0.4, 0.9)	0.004
MUI ≥ 1 time per week	44	11	68	19	0.5	(0.4, 0.8)	0.004	0.6	(0.4, 0.9)	0.02
SUI	102	28	128	37	0.7	(0.5, 0.9)	0.01	0.7	(0.5, 0.9)	0.02
SUI ≥ 1 time per week	25	7	45	13	0.5	(0.3, 0.8)	0.006	0.6	(0.3, 1)	0.04
UUI	11	3	20	6	0.5	(0.2, 1)	0.06	0.6	(0.2, 1)	0.06
UUI ≥ 1 time per week	0	0	3	1	1	(1, 1)	0.07	-	-	

MUI denotes mixed urinary incontinence, SUI stress urinary incontinence and UUI urge urinary incontinence.

Reduced prevalence of urinary incontinence after training in pregnancy

Pregnancy outcomes

Table 4. Pregnancy Outcomes

	Intervention Group (n=429)	Control Group (n=426)	Odds Ratio (95% CI)
Gestational age at birth (d)*	280±13	281±22	—
Birth weight (g)*	3,515±534	3,523±546	—
Birth weight at least 4,000 g	71 of 426 (16.7)	78 of 425 (18.4)	0.9 (0.7–1.2)
Gestational hypertension†	11 of 385 (2.9)	11 of 340 (3.2)	0.9 (0.4–2.0)
Preeclampsia	16 of 426 (3.8)	16 of 426 (3.8)	1.0 (0.5–2.0)
Operative vaginal delivery	62 of 426 (14.6)	50 of 425 (11.8)	1.2 (0.9–1.8)
Cesarean delivery	45 of 426 (10.6)	50 of 425 (11.8)	0.9 (0.6–1.3)
Apgar score less than 7 after 5 min	3 of 422 (0.7)	4 of 414 (1.0)	0.7 (0.2–3.3)
Admission to NICU	14 of 421 (3.3)	18 of 417 (4.3)	0.8 (0.4–1.5)

No influence of training in pregnancy on outcomes, such as mode of delivery or status of the newborn

Conclusions from the TRIP trial

Physical exercise during pregnancy

- **No reduction in prevalence of GDM**
- **No effects on insulin resistance**
- **No reduction in prevalence of LPP, but reduced sick leave due to LPP**
- **Reduction in self-reported urinary incontinence at 32-36 weeks**
- **No effect on anal incontinence**
- **No effects on other outcomes, ie. preeclampsia, preterm birth, mode of delivery or status of the newborn**

Limitations

Generalizability (external validity)

- **855 (7%) of 12 000 eligible women**
- **Mean BMI 24.8**
- **32% exercised regularly at moderate intensity 2-3 x per week before the pregnancy**
- **Only 55% of training group women followed the exercise protocol**

What if?

- **Training program started < 12 weeks**
- **Including only women with high BMI**

Systematic review or single RCTs?

Heterogeneity between studies

- Study populations
- Training programs

Inclusion of trials in reviews

Example: Cesarean delivery

- AJOG 2014 – Domenjoz et al.

  (16 trials, N = 3359)
- ACTA manuscript 2014
- (9 trials, N = 2305)

Cochrane reviews

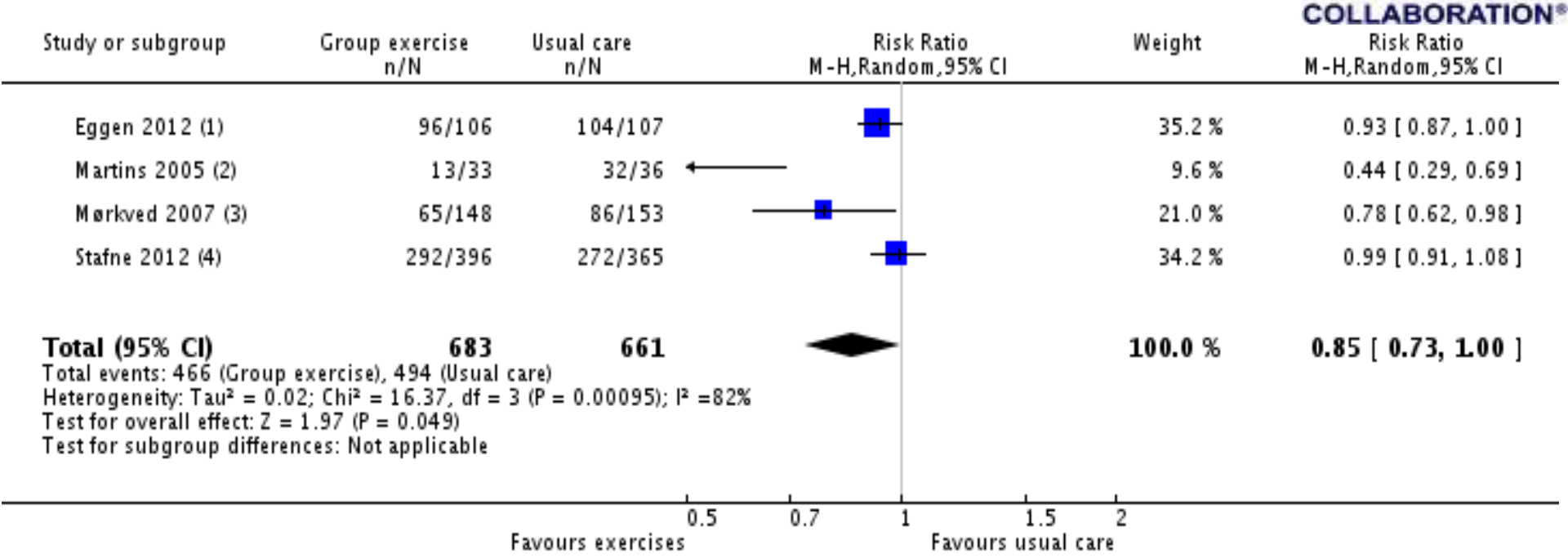
Physical activity during pregnancy to prevent or treat

- **Low back pain – 2013**
- **Gestational diabetes – 2012**
- **Preeclampsia – 2006**

Aerobic exercise during pregnancy

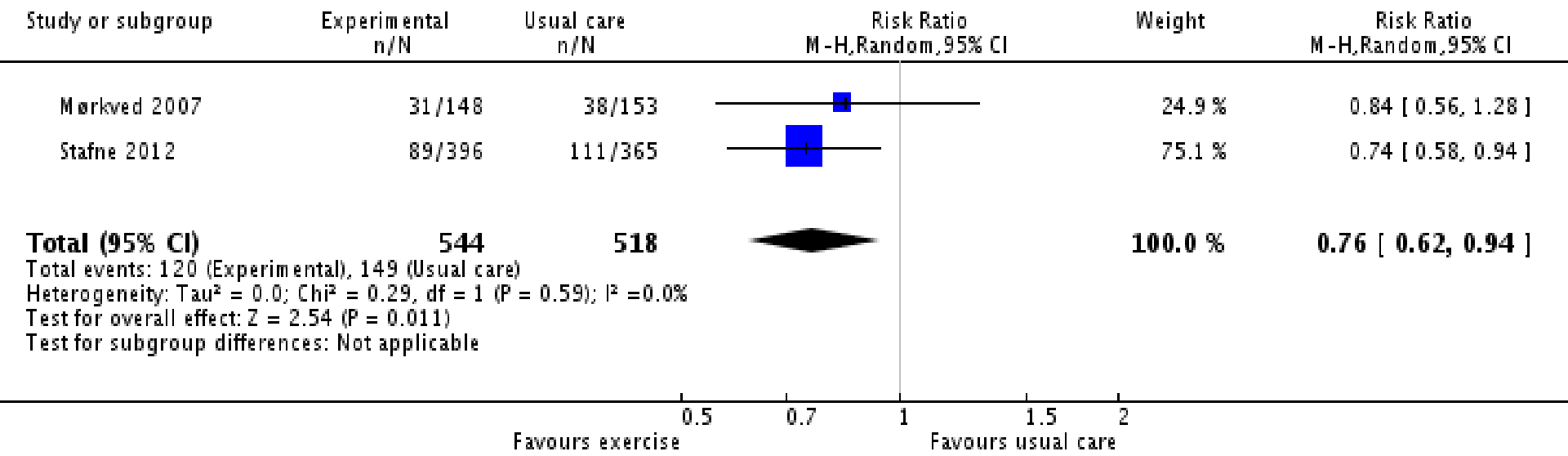
- **Systematic review – 2010**

Lumbopelvic pain (LPP)



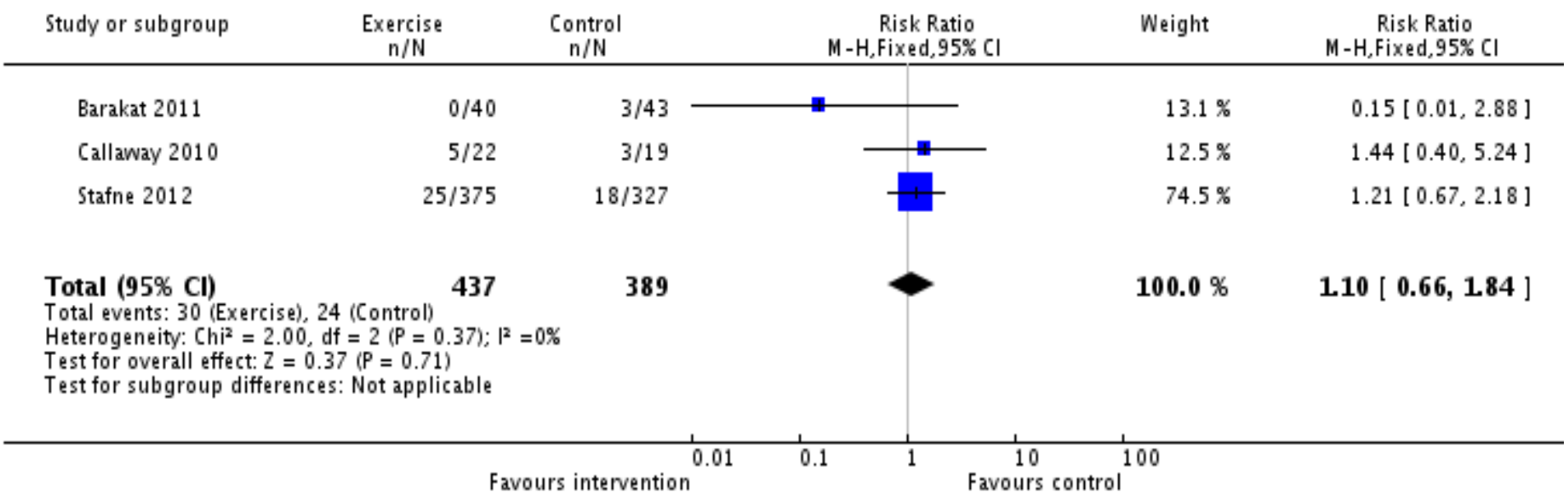
Borderline statistical significant 15% reduction in LPP after physical exercise during pregnancy

Sick leave due to LPP



25% reduction in sick leave due to LPP after physical exercise during pregnancy

Gestational diabetes



No effect on gestational diabetes after physical exercise during pregnancy

Preeclampsia

Cochrane review 2006

- Two small trials (N = 45)
- No association with physical activity

Systematic review AOGS 2012, N = 17 papers

6 case-control studies OR 0.77 95% CI (0.64-0.99)

10 cohort studies OR 0.99 95% CI (0.93-1.05)

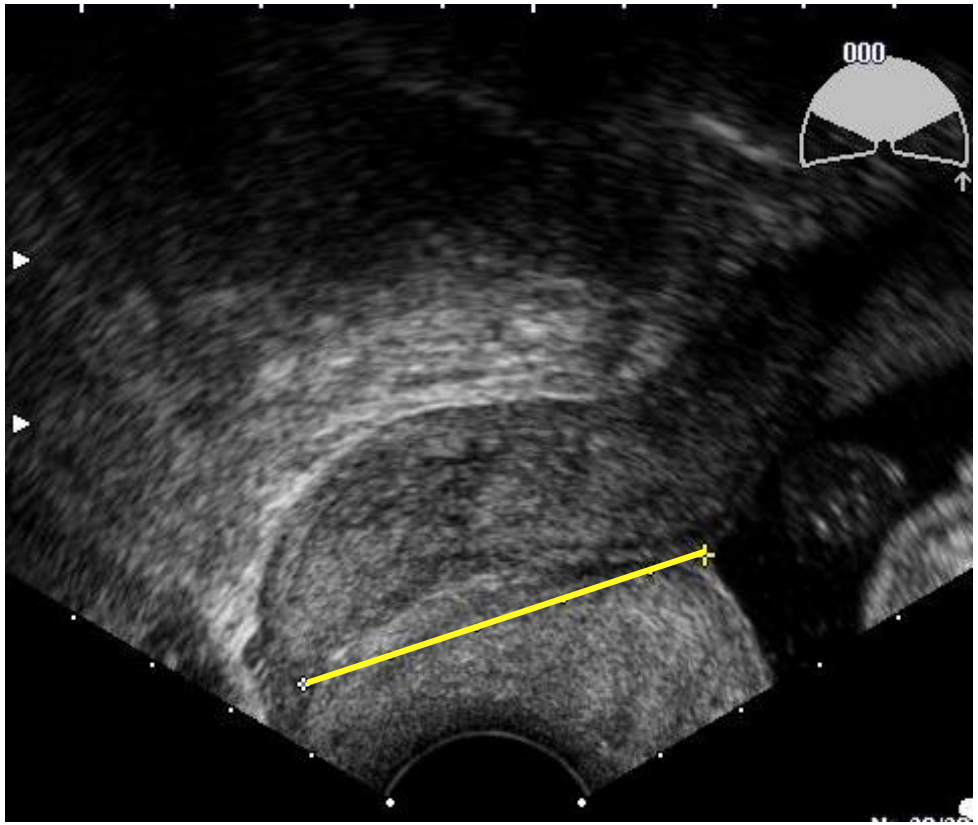
1 RCT (stretching) No association

MoBa study Norway, Am J Epidemiol 2008

- N = 59 573, OR 0.79 95% CI (0.65-0.96)
- No association for obese women (BMI>30)

No association with preterm birth

Can physical exercise influence cervical length?



Student thesis, NTNU 2009. Halgunset, Stoum, Salvesen

Cx length after 12 weeks of exercise

Cx length 32-36 weeks – Cx length 18-22 weeks

N = 50	Mean (mm)	SD (mm)
Training group	-4,6	1,4
Controls	-4,5	1,7

Cx length before/after one work out

N = 20	Before	After	Difference
Mean (mm)	38,5	41,0	2,5
SD (mm)	6,5	6,6	3,5

Student thesis, NTNU 2009. Halgunset, Stoum & Salvesen

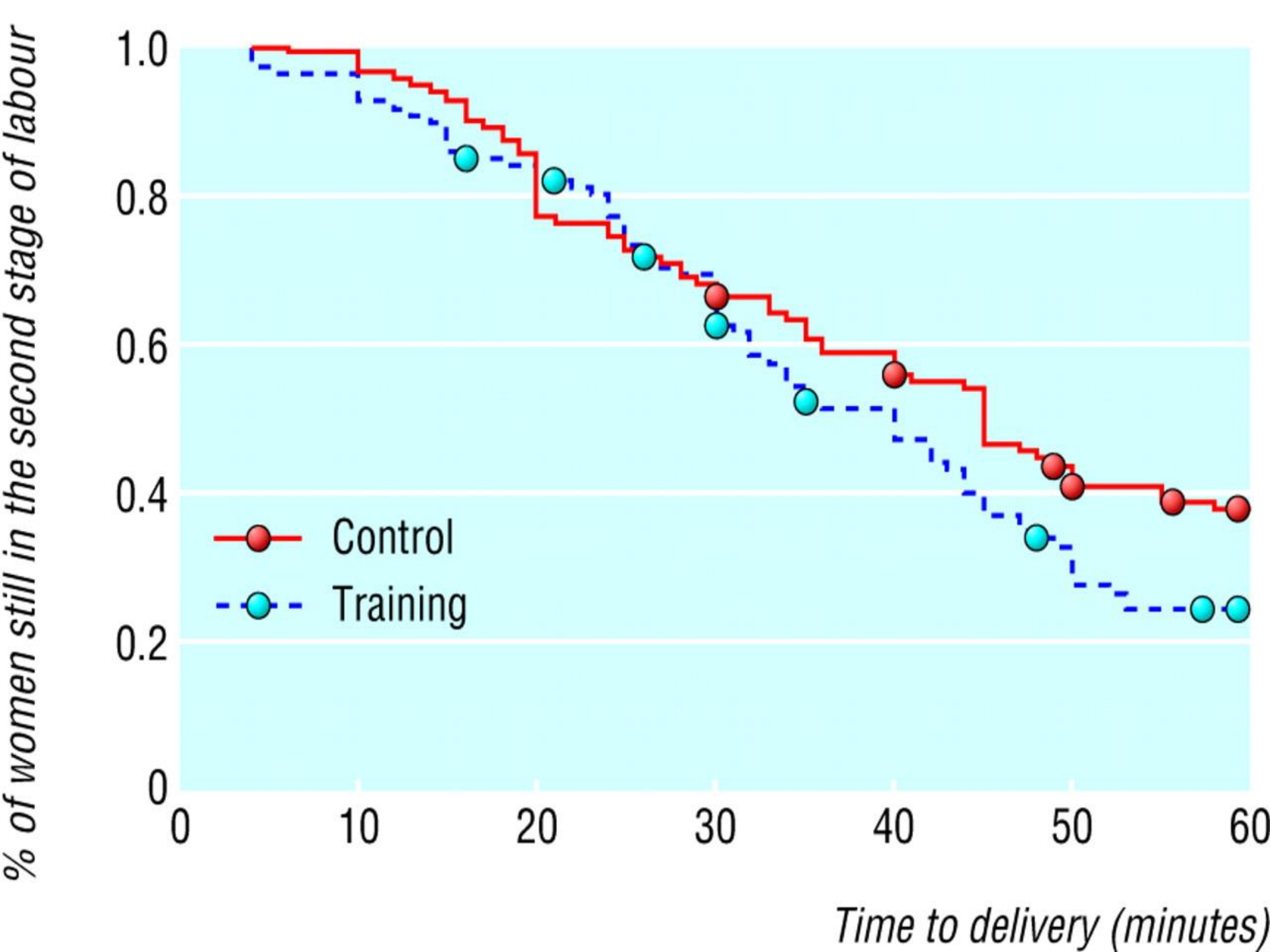
Duration of labor

In theory

- **Strong pelvic floor muscles may fascilitate (or obstruct) labor**
- **Abdominal wall muscle strength may improve active pushing (2nd stage labor)**
- **Good aerobic capacity may shorten duration of labor**

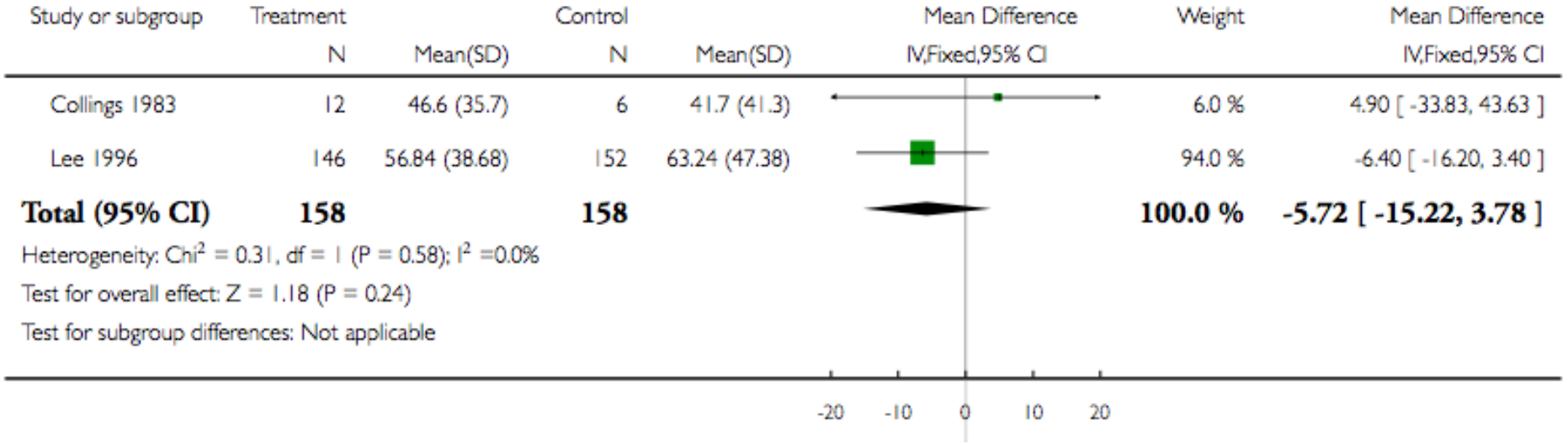
Salvesen & Mørkved. BMJ 2004; 329: 378-80

- **RCT (N=301) – Pelvic floor muscle training**
- **PFMT shortened active 2nd stage labor**


% of women still in the second stage of labour
1.0
0.8
0.6
0.4
0.2
0
Control
Training
0
10
20
30
40
50
60
Time to delivery (minutes)

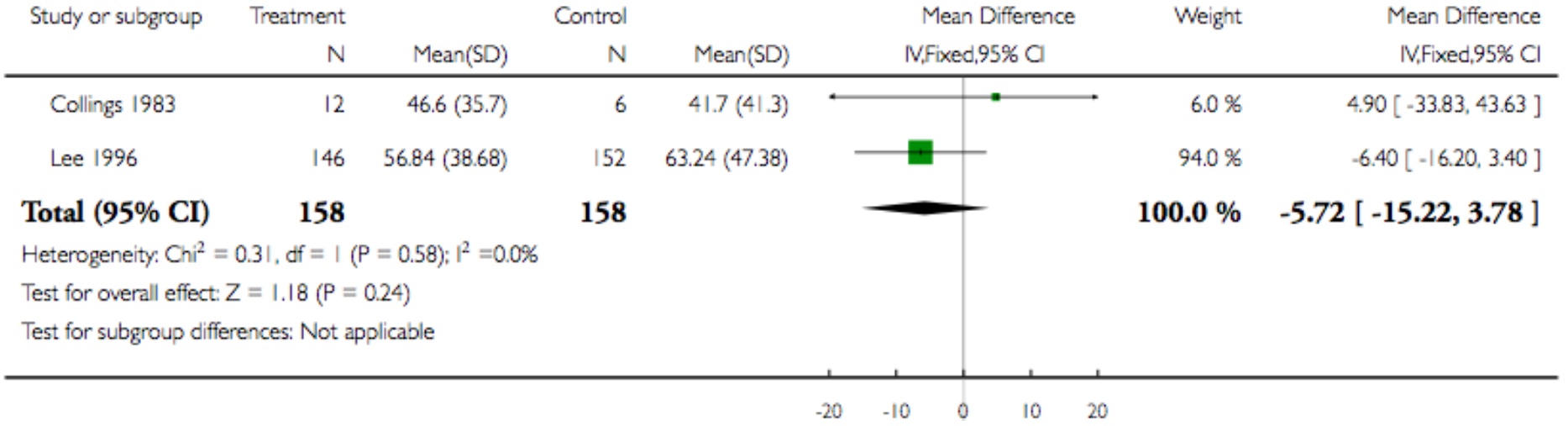
Aerobic exercise – duration of 2nd stage

Cochrane 2010



Aerobic exercise – duration of 2nd stage

Cochrane 2010



AOGS MAIN RESEARCH ARTICLE

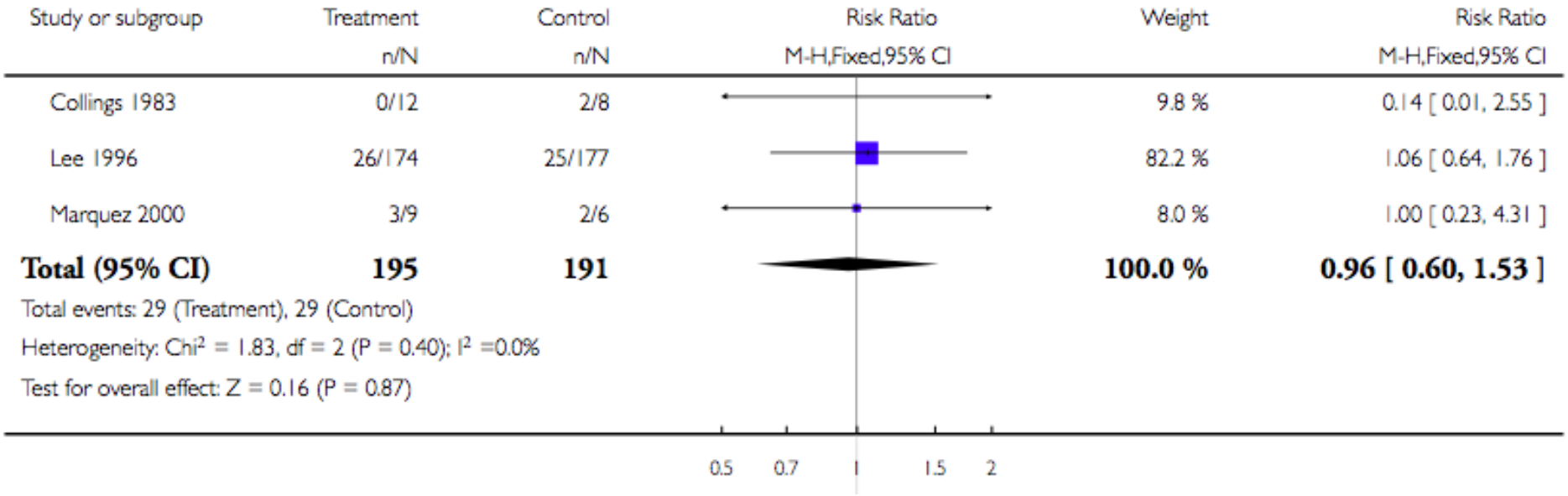
Does regular exercise in pregnancy influence duration of labor? A secondary analysis of a randomized controlled trial

KJELL Å. SALVESEN[1,2], SIGNE N. STAFNE[3,4], TORBJØRN M. EGGEBØ[5] & SIV MØRKVED[3,4]

- RCT (N = 855) - Aerobic exercise + PFMT
- No association with duration of 2nd stage

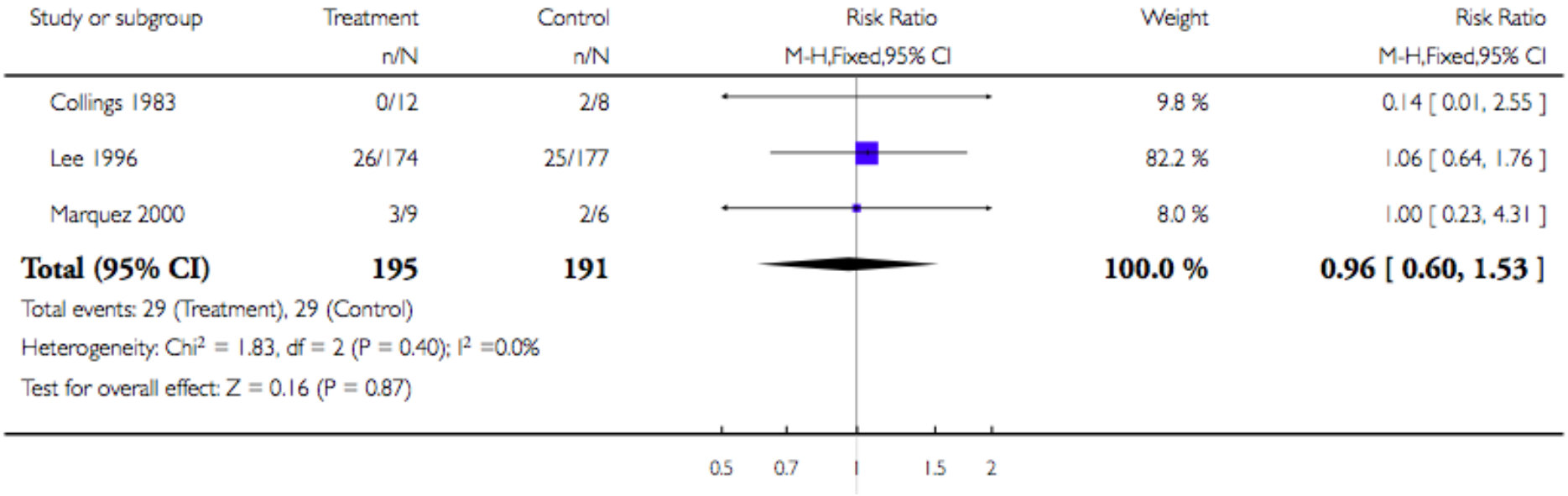
Aerobic exercise – Cesarean section

Cochrane 2010



Aerobic exercise – Cesarean section

Cochrane 2010



Domenjoz et al. Am J Obstet Gynecol 2014

- Systematic review: 16 trials with N = 3359
- Cesarean delivery OR 0.85 95% CI (0.73-0.99)

Conclusions

Physical exercise during pregnancy may reduce

- **Lumbopelvic pain and sick leave**
- **Urinary incontinence during pregnancy**
- **Cesarean deliveries (15%) ?**

No effects on other outcomes: gestational diabetes, preeclampsia, preterm birth, duration of labor or status of the newborn

Conclusions

Physical exercise during pregnancy may reduce

- **Lumbopelvic pain and sick leave**
- **Urinary incontinence during pregnancy**
- **Cesarean deliveries (15%) ?**

No effects on other outcomes: gestational diabetes, preeclampsia, preterm birth, duration of labor or status of the newborn

Limitations

- **Healthy non-obese women**
- **Training program differences (start, duration, intensity)**

Is there a training intensity maximum for pregnant elite athletes? Br J Sports Med 2012

Fetal wellbeing may be compromised during strenuous exercise among pregnant elite athletes

Kjell Å Salvesen,[1,2] Erlend Hem,[3] Jorunn Sundgot-Borgen[3]

ABSTRACT

Objectives To study fetal wellbeing and uteroplacental blood flow during strenuous treadmill running in the second trimester.

Methods Six pregnant Olympic-level athletes in endurance events aged 28–37 years and training 15–22 h per week before the pregnancy were tested once at 23–29 weeks of pregnancy. The women ran three to five submaximal workloads on a treadmill with approximately 60–90% of maximal oxygen consumption. The maternal–fetal circulation was assessed with Doppler ultrasound of the uterine and umbilical arteries before, during and after exercise.

Results Mean uterine artery volume blood flow was reduced to 60–80% after warming up and stayed at 40–75% of the initial value during exercise. Fetal heart rate (FHR) was within the normal range (110–160 bpm) as long as the woman exercised below 90% of maximal maternal heart rate (MHR). Fetal bradycardia and high umbilical artery pulsatility index (PI) occurred when the woman exercised more than 90% of maximal MHR and the mean uterine artery volume blood flow was less than 50% of the initial value. FHR and umbilical artery PI normalised quickly after stopping the exercise.

Conclusions Exercise at intensity above 90% of maximal MHR in pregnant elite athletes may compromise fetal wellbeing

during exercise. Target MHR zones and guidelines for exercise during pregnancy have been published.[11 12]

Volume blood flow to the pregnant uterus during exercise has been sparsely studied. One experimental study in pregnant sheep found reduced volume blood flow by 15–20% in response to different exercise regimens.[13] Studies in pregnant women have produced contradictory results.[14–16] There are several Doppler ultrasound studies on exercise-related changes in umbilical and uterine artery waveforms,[17–20] but we have found no studies on uterine artery volume blood flow during strenuous exercise in pregnancy.

The primary aim of the present study was to examine the effects of strenuous treadmill running on fetal wellbeing in pregnant elite athletes. The secondary aim was to assess volume blood flow to the pregnant uterus during intensive exercise.

METHODS

Seven pregnant athletes representing Norwegian national teams in endurance events (cross-country skiing, duathlon, long distance running and race walking) were invited to participate in the study from October 2002 to March 2006. Women were

Maximal maternal heart rate (MHR) during training in pregnancy

- **< 140-150 bpm ACOG 2002**
- **< 160 bpm Prior 1997**
- **Recommendation depends on**
  - **Age**
  - **Training background**
  - **Gestational length**

Study population

- 6 athletes - 28-37 years
- 21 medals from Olympics or WC in endurance sports
- Trained 15-22 hours/week before pregnancy
- Tested once between 23-29 weeks

Testing

3-5 submax intervals:

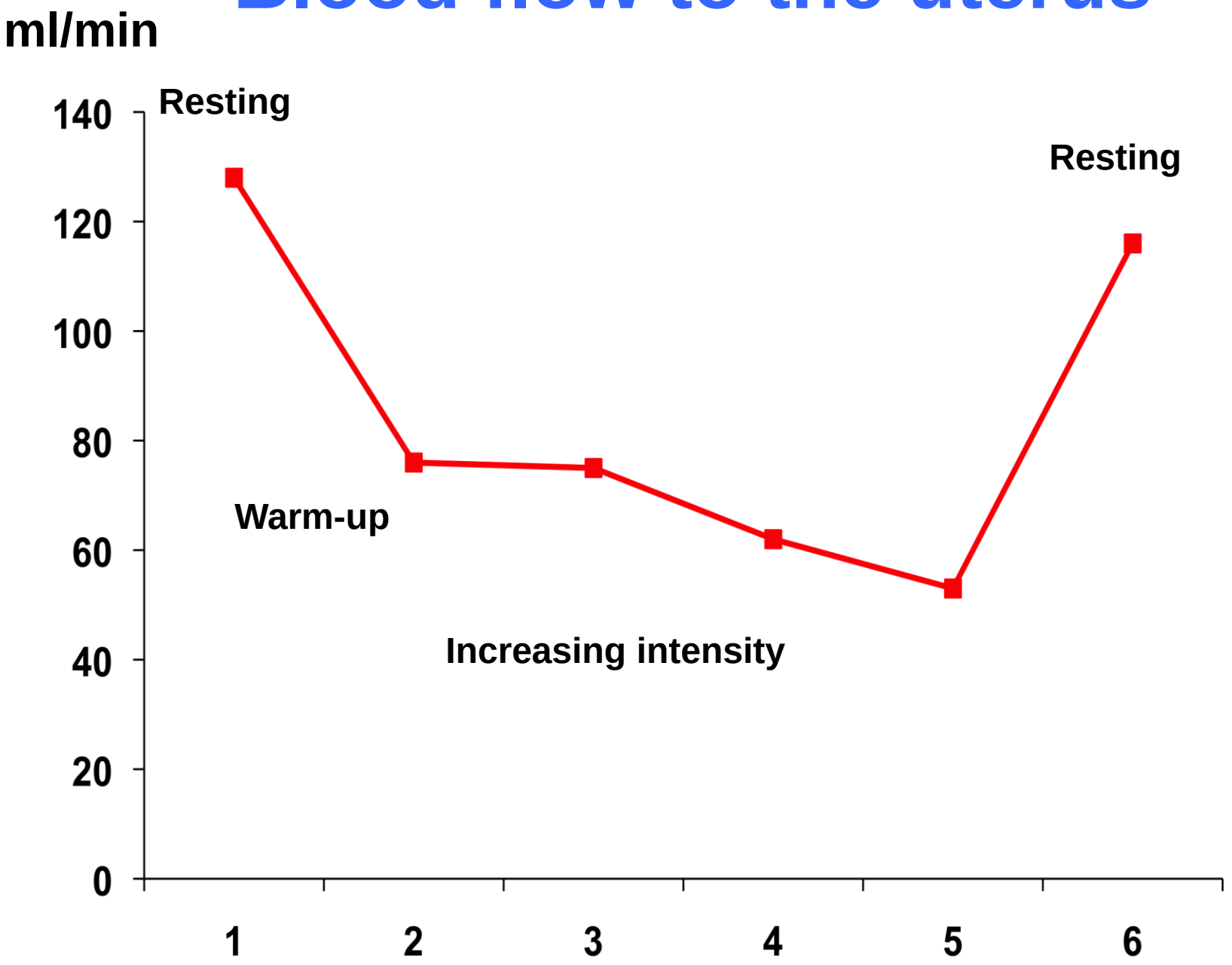
- **6 minutes running**
- **4 minutes resting**

Measurements

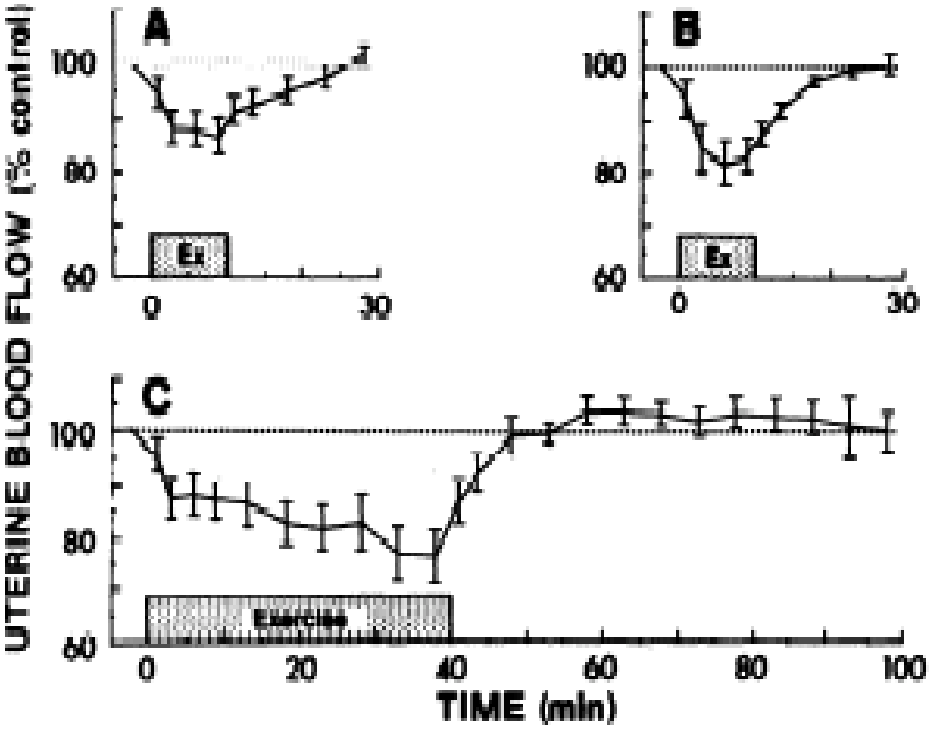
- **VO_2 max**
- **Maternal blood lactate**
- **Fetal heart rate**
- **A. umbilicalis - PI**
- **Uterine artery volume blood flow**

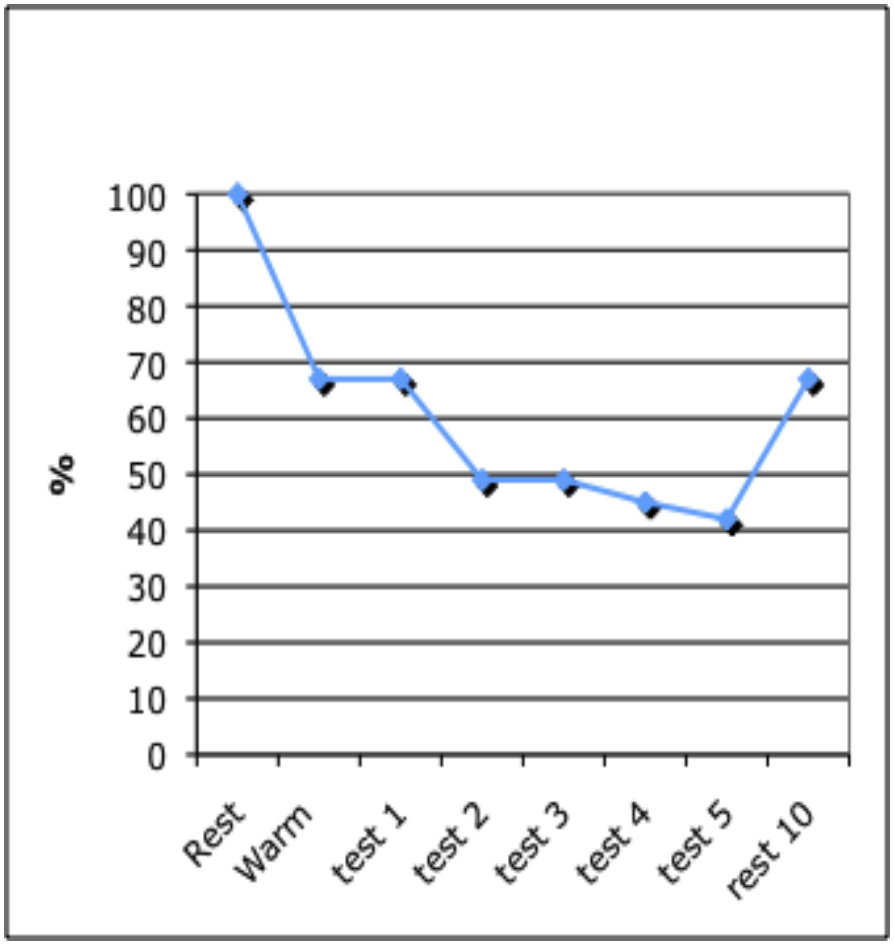

Copyright: Kjersti Platzer

Blood flow to the uterus



Volume blood flow to the uterus





Lothgering - 1983

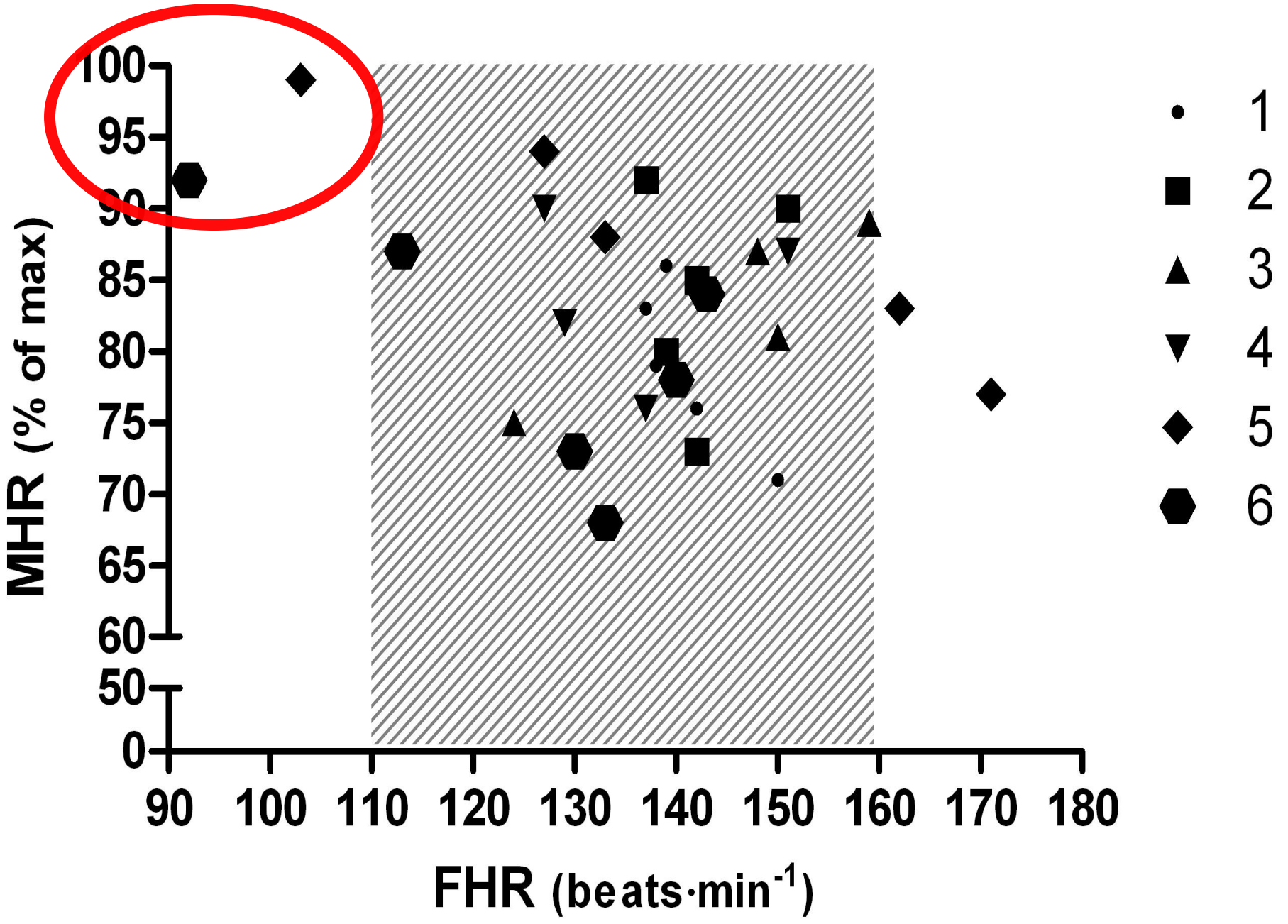
Direct measurements of uterine art

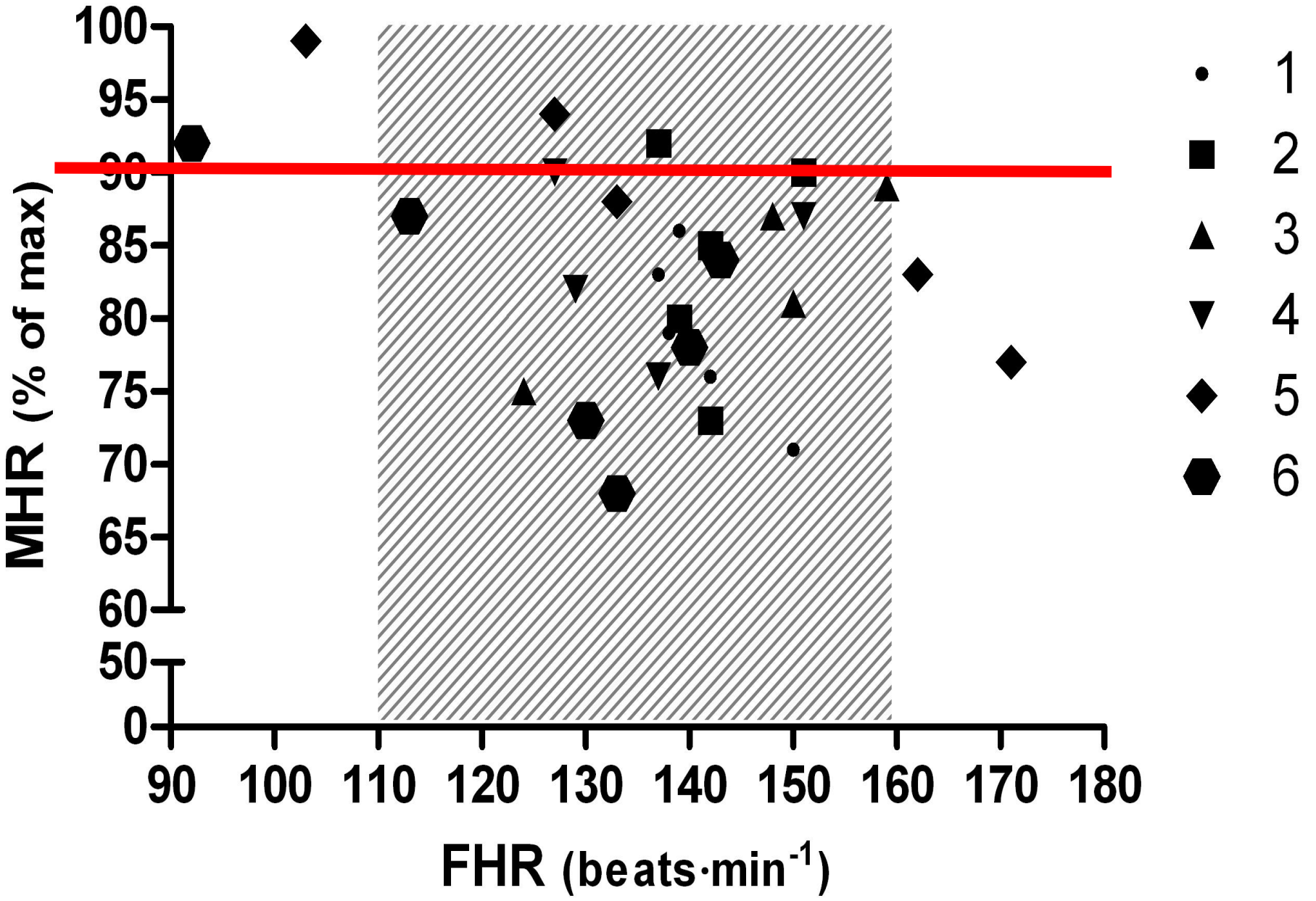
8 pregnant sheep on treadmill

Salvesen - 2012

Indirect measurements of uterine art

6 pregnant top athletes on treadmill


100
95
90
85
80
75
70
65
60
50
0
MHR (% of max)
90
100
110
120
130
140
150
160
170
180
FHR (beats·min-1)
1
2
3
4
5
6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Conclusions

Fetal bradycardia & umbilical artery PI > 2SD can occur at high training intensities

Fetal distress may occur at MHR > 90%

Reduced volume blood flow to the uterus

- **15-25% after warming-up**
- **< 50% may induce fetal distress (if in combination with MHR max > 90%)**

Advice for pregnant elite athletes:

Don’t go above 90% MHR max!