

Serum Hormone levels at the time of ACL Injury

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Background and significance

- Incidence of ACL Tears is 2 to 9.7 times higher in females compared to males
 - Lindenfeld American J Sport Med 1994
 - Myklebust Scan J Sport Med 1998
 - Messina American J Sport Med 1999
 - Beynnon ISSS 1999
 - Ireland J Ath Training 1999
 - Gwinn American J Sport Med 2000

Background and significance

- One in five female alpine ski racers suffer an ACL disruption
- Female racers are 3.2 times more likely to sustain an ACL disruption than male counterparts
 - Stevenson H et al. The Iowa Ortho J 1998.

Extrinsic Factors for ACL injury (skiing)

- Equipment
 - Boot-binding interface
 - Release values
 - Ski design
- Skill level/conditioning
- Ski Conditions/slope

Intrinsic Factors

■ Anatomical

- Femoral notch dimensions
- Alignment of lower extremity
- Joint laxity
- Ligament size

■ Neuromuscular

- Muscle firing patterns
- Reaction time
- Strength

■ Hormonal factors

- **Serum levels of estradiol (E_2) and progesterone (P_4)**

Previous work

- Wojtys EM. 1998. Reported higher number of ACL injuries during ovulatory phase of menstrual cycle. (N=28)
- Wojtys EM. 2002. Using urine analysis found higher number of ACL injuries during ovulatory phase (N=65)

Previous work

- Slauterbeck J, 2002. Reported a higher than expected number of ACL injuries during days 1 and 2 of the menstrual cycle. (n=37)
- Moller-Nielson J. 1989. Female soccer players were more susceptible to injury during premenstrual and menstrual phase

Previous work

- Myklebust G. 1998. Reported higher number of injuries during the late luteal phase. (N=28)
- Arendt EA. 2002. Females at higher risk during follicular phase when compared to luteal phase. (N=83)

Relationship between phase of menstrual cycle and ACL injury patterns is unclear

- Different study designs (control group)
- Different methods used to document cycle (urine, serum, saliva, self report)
- Different techniques to categorize cycle (2, 3 or 5 phases)
- Different sports with different baseline risk have been studied

Hypothesis

- The phase of menstrual cycle has no effect on the risk of suffering an ACL injury

Specific Aims

- To identify female skiers at the time of ACL disruption and matched uninjured controls
- To obtain serum at the time of injury and analyze E_2 and P_4 concentrations.
- To use serum E_2 and P_4 concentrations to identify phase of menstrual cycle at the time of injury (pre-ovulatory, postovulatory)
- To determine if incidence of ACL injury is affected by phase of menstrual cycle

Study Design

- Case- control study
- Performed at a Vermont ski area during the 2000-2004 ski seasons

Outcome measures

- ACL Disruption was diagnosed by physician at ski clinic and verified by follow up with orthopedic surgeon
- Serum Estradiol (E_2) and Progesterone (P_4)
- Injury History
- Menstrual history and use of oral contraceptives

Statistical Analysis

- Pearson Chi-Square test used to compare proportions of skiers in (follicular) pre-ovulatory and (luteal) post-ovulatory phase between ACL injured and control groups.

Subjects

- 82 injured subjects enrolled.
 - 7 excluded.
 - 29 on birth control
 - **46 not on birth control.**
- 78 control subjects enrolled.
 - 7 excluded.
 - 26 on birth control.
 - **45 not on birth control**

Chi-Square distribution of ACL injuries grouped by menstrual cycle phase based on serum levels of P₄

PHASE	GROUP	
	Injured	Uninjured
Follicular	34 (74%)	25 (56%)
Luteal	12 (26%)	20 (44%)

P = 0.067

Conclusion

- We were able to identify female skiers at the time of ACL rupture, obtain serum, analyze serum for E_2 and P_4 levels, and use this information to stage the menstrual cycle at the time of injury
- There was a strong trend for increased incidence of ACL injuries during follicular phase of the menstrual cycle

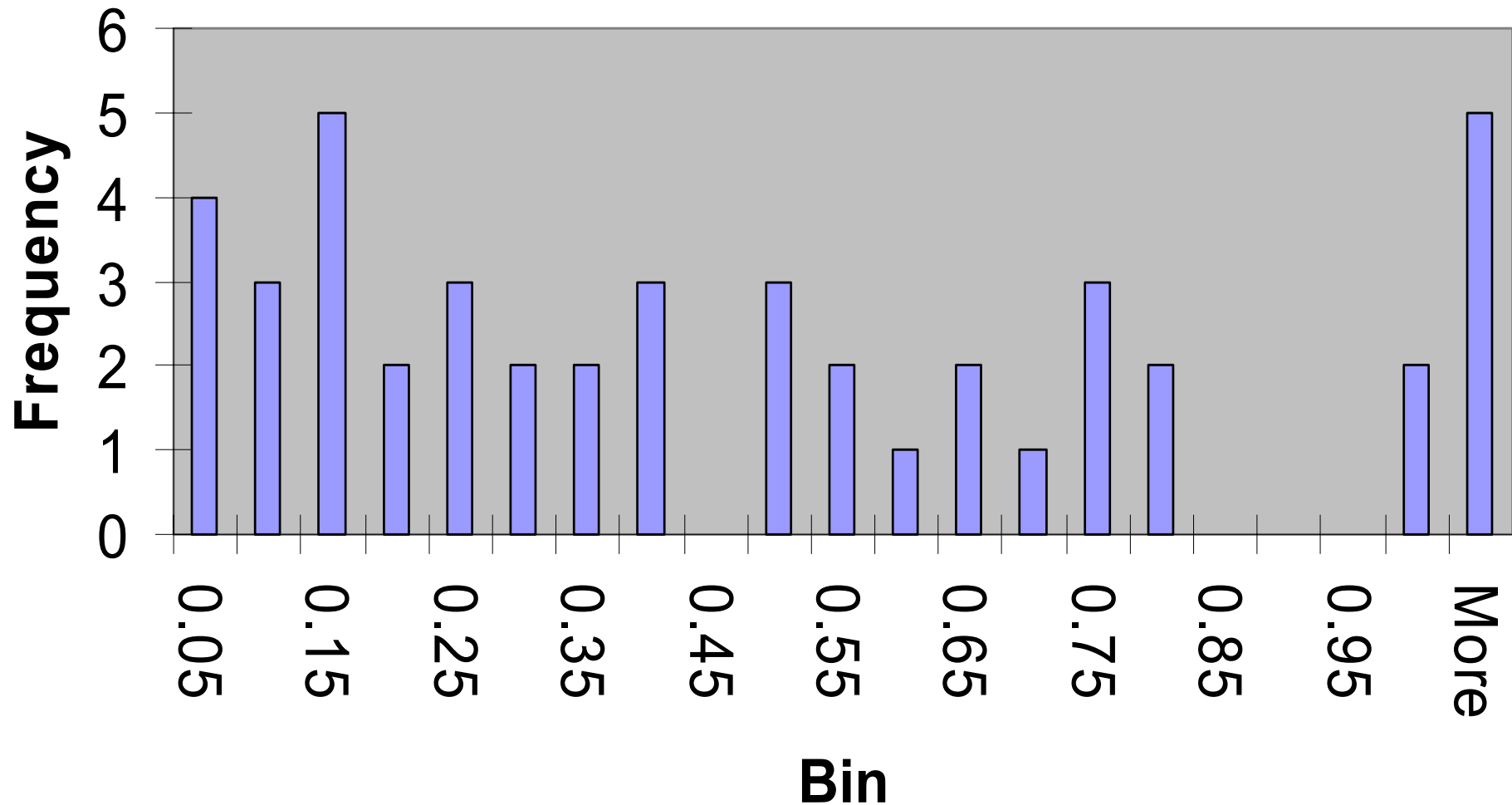
Thank You

- We would like to thank the ACL Study group for funding this research

Sugarbush Mountain, VT



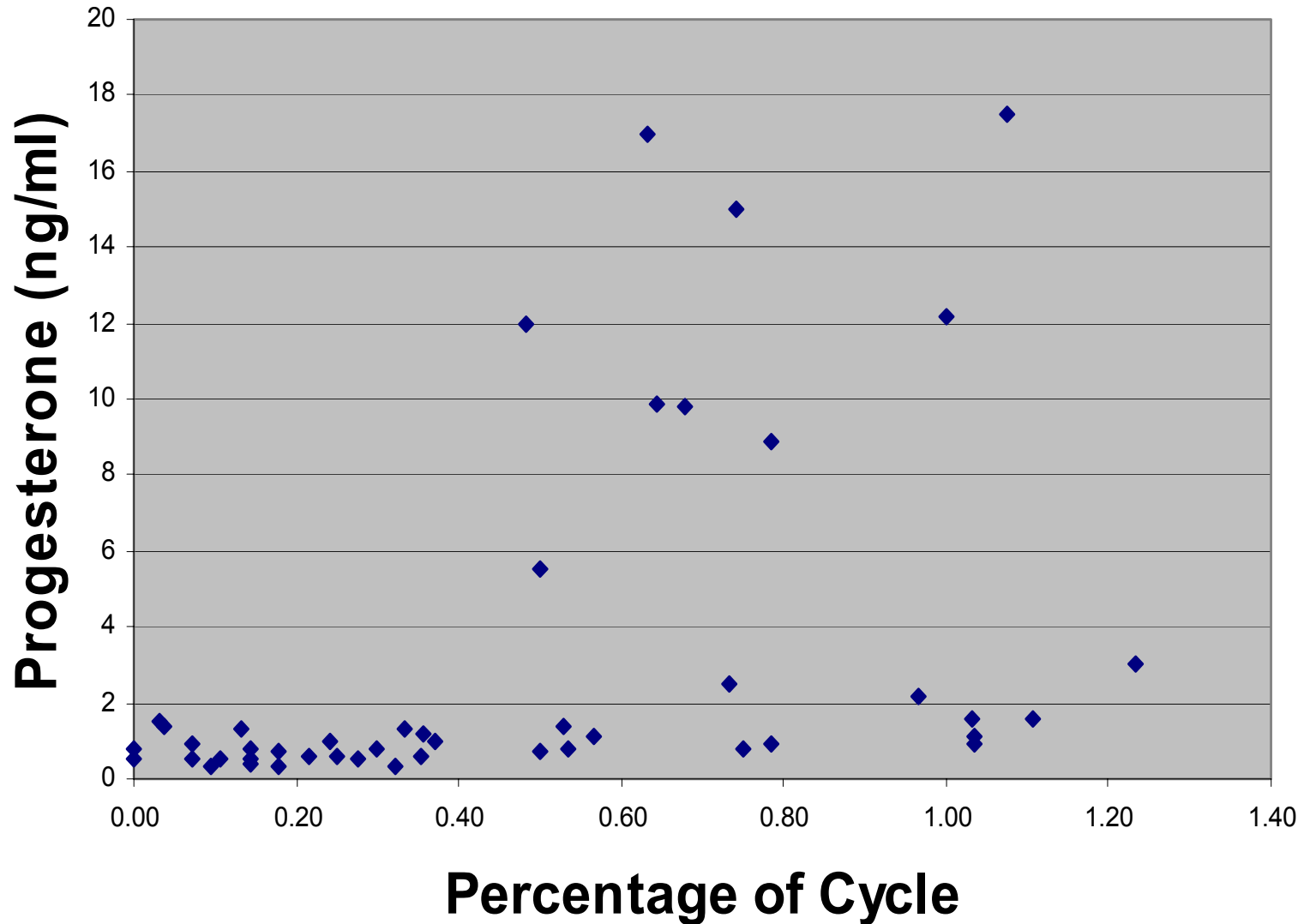
Percentage of cycle for injured (no birth control)



Phase based on P₄ below/above 2ng/ml * Self-reported phase using pct of cycle

Phase based on progesterone level below/above 2ng/ml	Self-reported phase using pct of cyc	
		< than 50%
Follicular	37 (65%)	20 (35%)
Luteal	3 (10%)	26 (90%)

Progesterone Concentration vs percentage of Cycle



Chi-Square distribution of ACL injuries grouped by menstrual cycle based on self-report

PHASE	GROUP	
	injured	uninjured
Less than 50%	25 (57%)	15 (36%)
Greater than 50%	19 (43%)	27 (64%)

P = 0.05

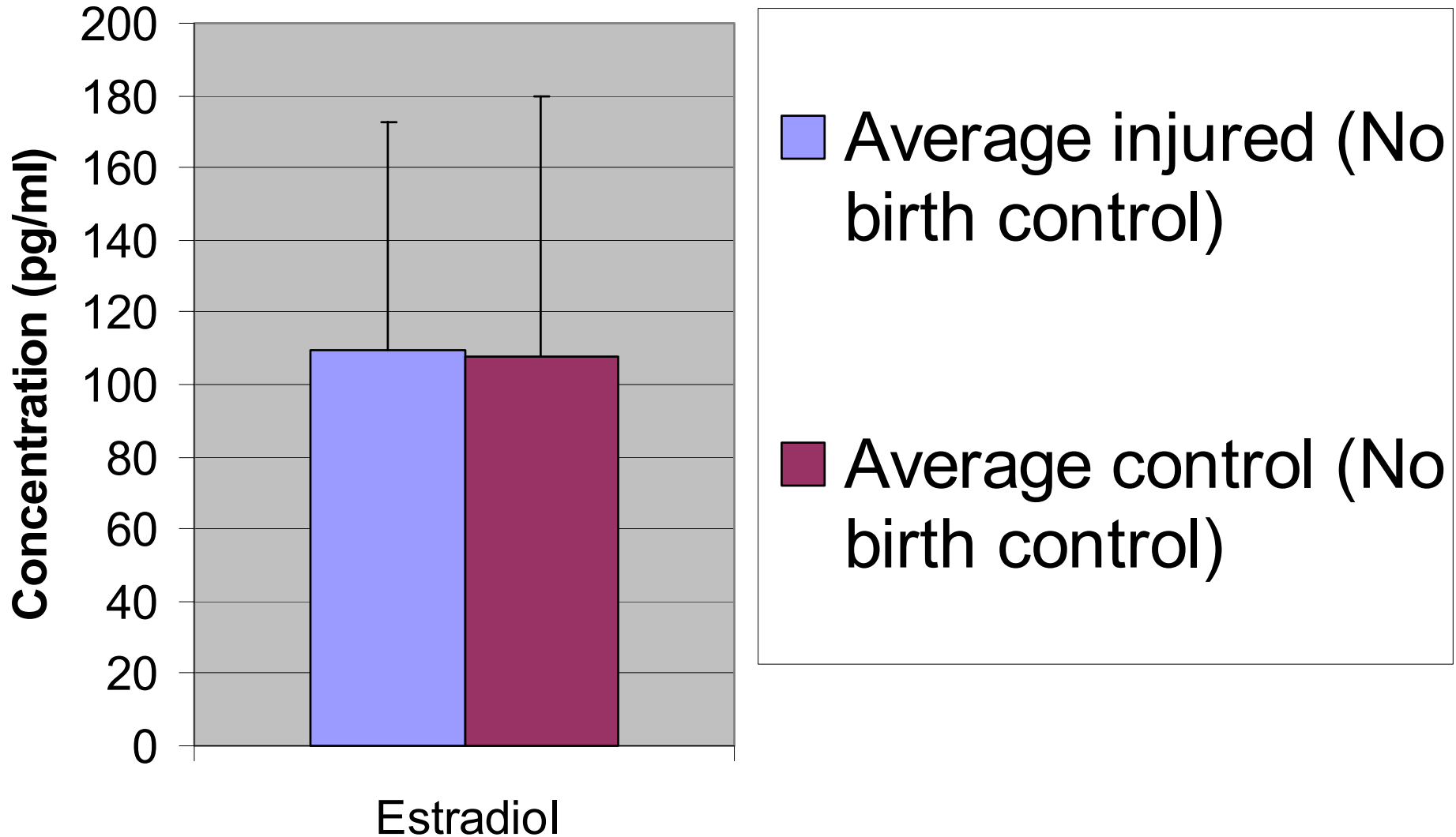
Self Reported phase using pct of cycle * group

PHASE	GROUP	
	injured	uninjured
follicular	21 (47%)	13 (30%)
ovulatory	6 (13%)	6 (14%)
luteal	18 (40%)	25 (57%)

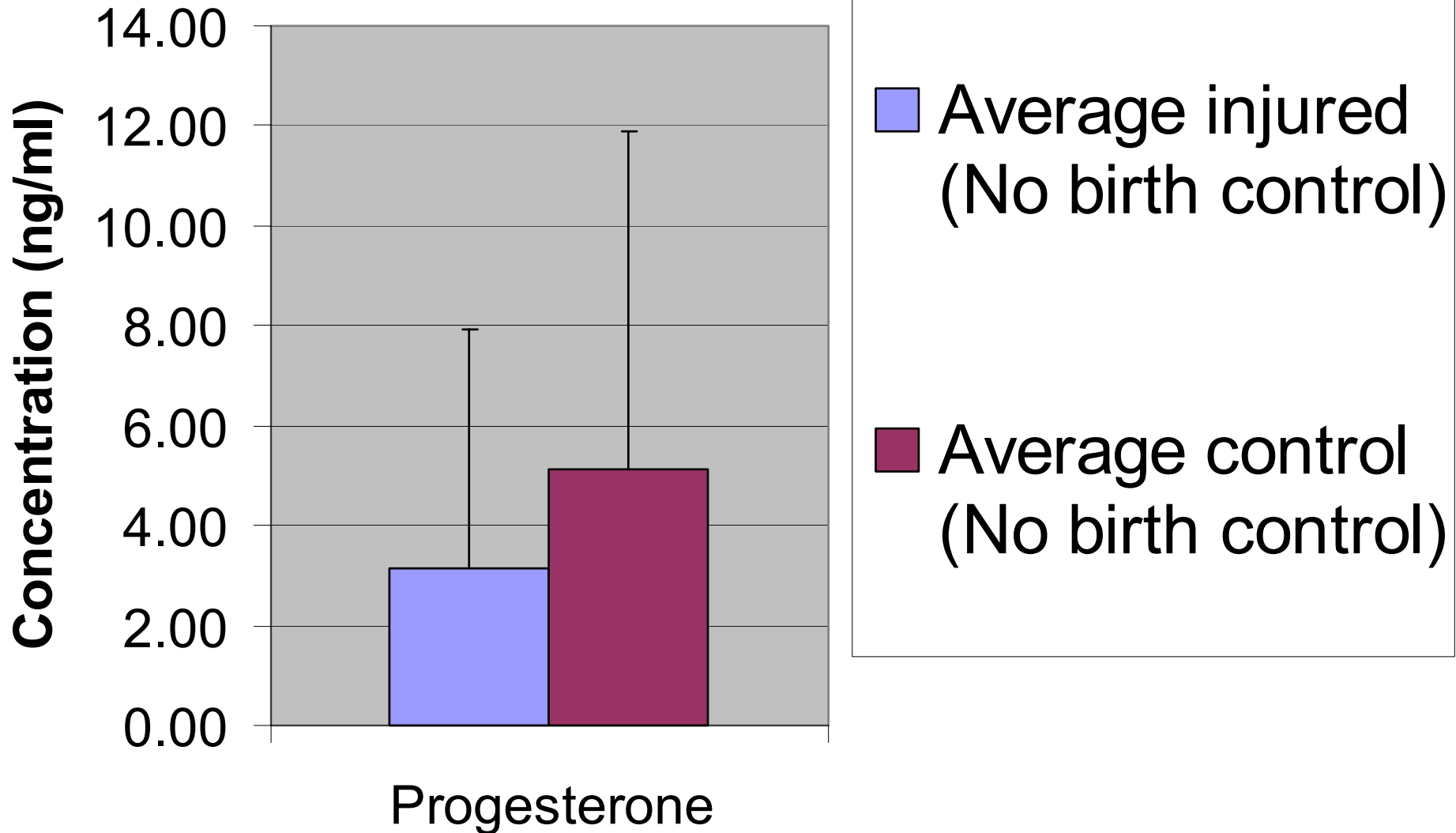
Exclusion Criteria

- Subjects were excluded if they had
 - History of grade II/III knee sprain
 - Previous surgical procedures
 - History of metabolic disease
 - Degenerative joint disease
 - Currently pregnant

Estradiol Concentrations



Progesterone



Results (power)

- Our Chi square test with Alpha= 0.05 has 44% power
- To have 80% power we need 109 subjects in each group