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Maternal Leisure Time Physical Activity and Infant Birth Size

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April 24, 2015

Making Lifelong Connections

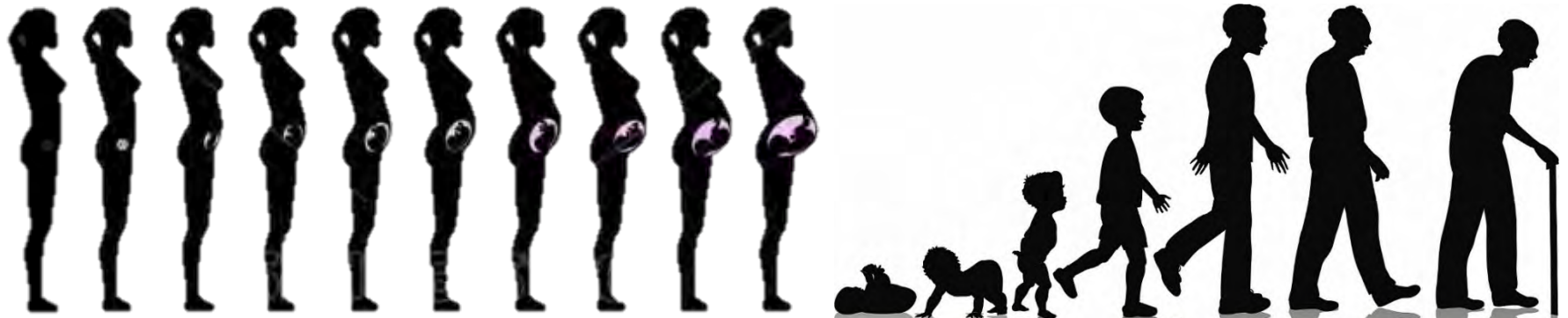
San Antonio, TX

Outline

- Background
- Methods
- Results
- Discussion

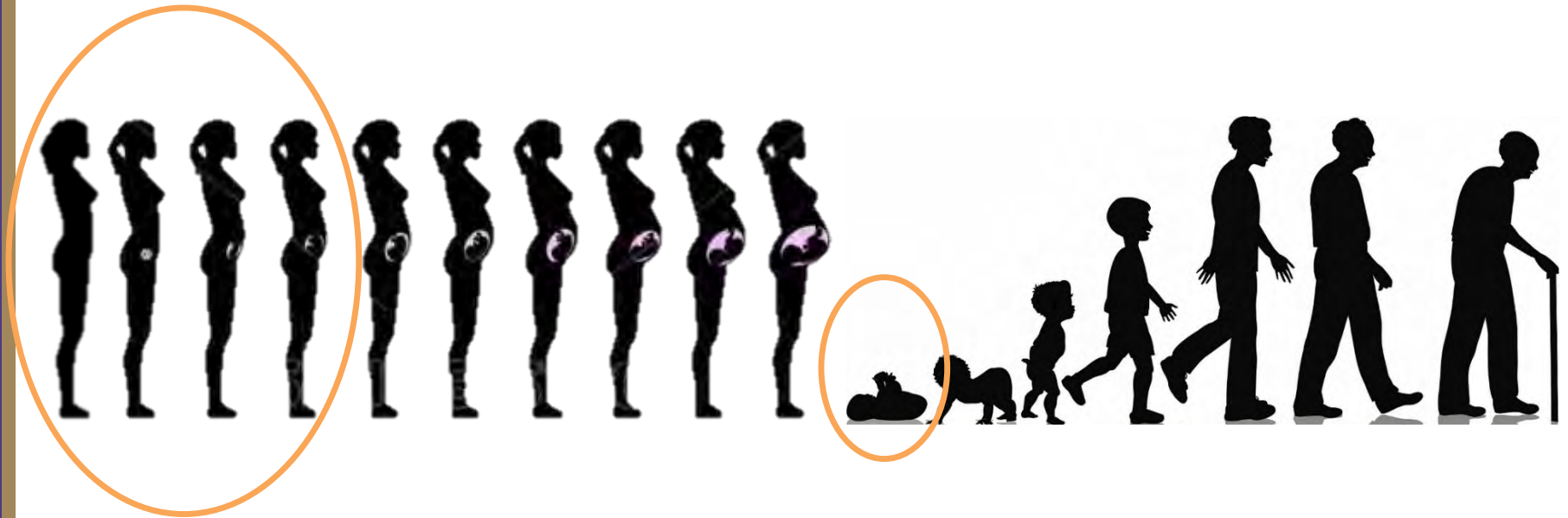


Developmental Origins of Health and Disease



Maternal Behaviors → **Fetal Development** → **Life Course Health**

Developmental Origins of Health and Disease



Maternal Behaviors

- Physical activity



Fetal Development

- Birth size



Life Course Health

- Chronic disease

Leisure Time Physical Activity (LTPA) during Pregnancy



- ACOG* recommends ≥ 30 min/day of moderate to vigorous LTPA before & during pregnancy
- Among US pregnant women in 1999-2006
 - 57% reported moderate to vigorous LTPA during pregnancy
 - 23% met the ACOG recommendation

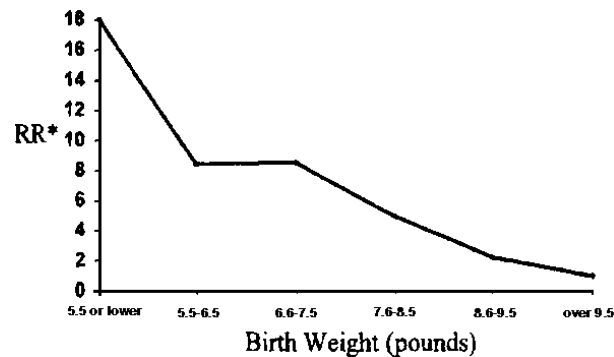
*ACOG: American Congress of Obstetricians and Gynecologists

ACOG committee opinion. Number 267. Int J Gynaecol Obstet 2002;77(1):79-81.
Evenson et al. 2010. Prev Med; 50(3):123-128.

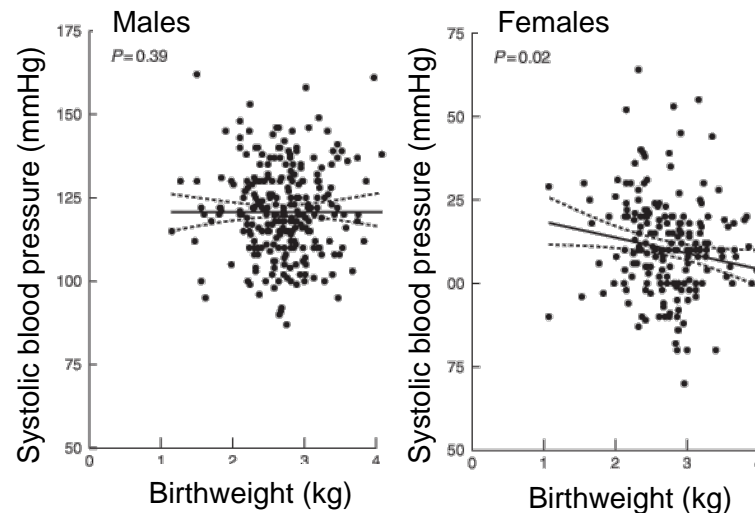
Newborn Birth Size



- Indicator of fetal growth
- Associated with life course health



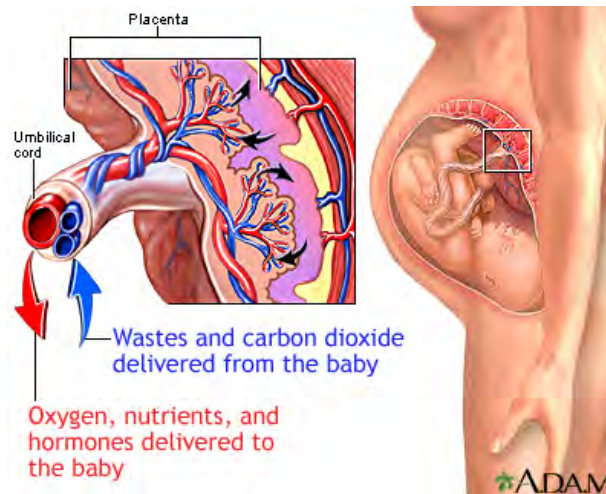
*of metabolic syndrome



- Differs by fetal sex and pre-pregnancy weight

Biological Mechanisms

- LTPA influences maternal metabolism and placental development
- Differences in response to changes in the intrauterine environment by infant sex



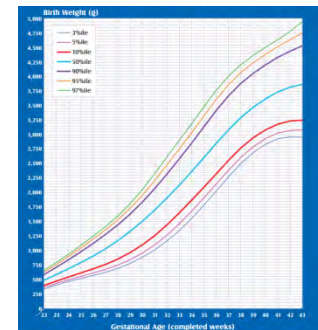
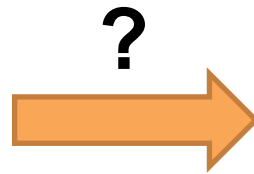
Research Gaps

- ACOG* LTPA recommendation only for reduced risk of pregnancy complications, not birth size
- Inconsistent associations of LTPA and birthweight in previous studies
- Few studies looked at other measures of birth size
- No studies examining differences by infant sex or pre-pregnancy BMI

*ACOG: American Congress of Obstetricians and Gynecologists

Research Questions

- Is maternal moderate to vigorous LTPA before or during pregnancy associated with newborn birth size?
- Does this association differ by infant sex or pre-pregnancy overweight/obesity?



Study Population: Omega Study

- Prospective pregnancy cohort (1996-2008)
- Perinatal clinics associated with Swedish Medical Center and Tacoma General Hospital in Washington state
- Eligibility criteria: <20 weeks, age>18 yrs,
- 5,063 eligible; 4,000 participated (79%)
- In-person interview, medical record abstraction, maternal blood samples, placental samples



Data Collection

- In person interview at 4-29 weeks
 - Pre-pregnancy and early pregnancy LTPA
 - Socio-demographic characteristics
 - Reproductive and medical history
 - Biological samples
- Medical record review after delivery
 - Pregnancy complications
 - Newborn birth size



8-20 weeks



Birth

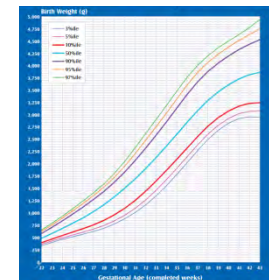


Exposure and Outcomes

- Exposure: quartiles of moderate to vigorous pre-pregnancy (ppLTPA) or early pregnancy (epLTPA) LTPA
 - Average duration (hours/week)
 - Average energy expenditure (MET-hours/week)

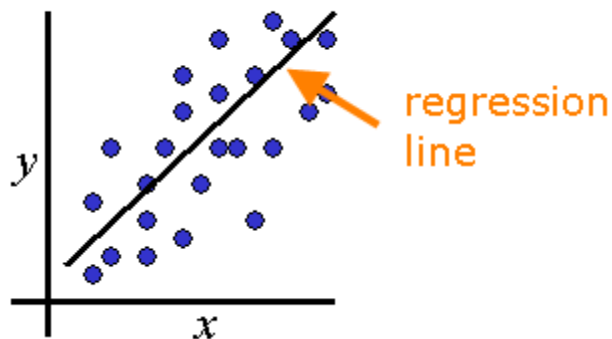


- Outcomes
 - Birthweight (grams)
 - Head circumference (cm)
 - Ponderal index (birthweight/birth length³)



Statistical Analysis: Linear Regression

- Mean difference in birth size per quartile of maternal LTPA
- Adjustment: gestational age, infant sex, maternal age, race, education, marital status, severe hyperemesis, parity, pre-pregnancy BMI, smoking during pregnancy



Statistical Analysis: Linear Regression

- Stratified analyses by
 - Infant sex
 - Pre-pregnancy overweight/obese (BMI ≥ 25 kg/m²)
- Sensitivity analysis: Additional adjustment for gestational diabetes, preeclampsia, and total caloric intake

Participant Characteristics



| | Total (N=3310) | Active* pre-pregnancy N=3028 (91.5%) | Not active pre-pregnancy N=282 (8.5%) |
|---|-------------------|---|--|
| | % | % | % |
| Active* in early pregnancy | 74.6 | 78.5 | 33.3 |
| Maternal age (years, mean) | 32.6 | 32.7 | 31.5 |
| Non-Hispanic white race | 86.4 | 87.7 | 72.0 |
| At least high school education | 96.4 | 97.3 | 86.5 |
| Married | 91.4 | 92.1 | 83.3 |
| Nulliparous | 62.8 | 64.2 | 47.2 |
| Pre-pregnancy BMI category | | | |
| Normal weight (18.5-24.9 kg/m²) | 70.9 | 72.0 | 59.2 |
| Overweight/obese (≥25 kg/m²) | 24.9 | 24.0 | 35.9 |

*Reporting any LTPA

Maternal LTPA and Birthweight

| | Overall | Infant sex | Pre-pregnancy BMI |
|--|---------|------------|-------------------|
|--|---------|------------|-------------------|

| | β (95% CI) |
|--|--------------------|
| Pre-pregnancy | |
| Duration (hrs/wk) | -8.4 (-22, 4.8) |
| <i>Interaction P value</i> | |
| Energy expenditure (MET-hrs/wk) | -9.2 (-23, 4.0) |
| <i>Interaction P value</i> | |

| | |
|--|--------------------|
| Early pregnancy | |
| Duration (hrs/wk) | -11 (-23, 2.7) |
| <i>Interaction P value</i> | |
| Energy expenditure (MET-hrs/wk) | -12 (-24, 0.90) |
| <i>Interaction P value</i> | |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Birthweight

| | Overall | Infant sex | | Pre-pregnancy BMI |
|--|--------------------|-------------------|--------------------|-------------------|
| | | Males | Females | |
| | β (95% CI) | β (95% CI) | β (95% CI) | |
| Pre-pregnancy | | | | |
| Duration (hrs/wk) | -8.4 (-22, 4.8) | 5.4 (-13, 24) | -23 (-42, -4.5) | |
| Interaction P value | | | 0.03 | |
| Energy expenditure (MET-hrs/wk) | -9.2 (-23, 4.0) | 1.9 (-17, 21) | -22 (-40, -2.8) | |
| Interaction P value | | | 0.08 | |
| Early pregnancy | | | | |
| Duration (hrs/wk) | -11 (-23, 2.7) | -1.7 (-20, 17) | -21 (-39, -2.1) | |
| Interaction P value | | | 0.10 | |
| Energy expenditure (MET-hrs/wk) | -12 (-24, 0.90) | -3.4 (-22, 15) | -23 (-42, -3.8) | |
| Interaction P value | | | 0.09 | |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Birthweight

| | Overall | Infant sex | | Pre-pregnancy BMI | |
|--|--------------------|-------------------|--------------------|--------------------|------------------|
| | | Males | Females | Normal Weight | Overweight/obese |
| | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) |
| Pre-pregnancy | | | | | |
| Duration (hrs/wk) | -8.4 (-22, 4.8) | 5.4 (-13, 24) | -23 (-42, -4.5) | -17 (-32, -1.7) | 7.4 (-22, 37) |
| Interaction P value | | | 0.03 | | 0.12 |
| Energy expenditure (MET-hrs/wk) | -9.2 (-23, 4.0) | 1.9 (-17, 21) | -22 (-40, -2.8) | -18 (-33, -3.1) | 7.6 (-23, 38) |
| Interaction P value | | | 0.08 | | 0.09 |
| Early pregnancy | | | | | |
| Duration (hrs/wk) | -11 (-23, 2.7) | -1.7 (-20, 17) | -21 (-39, -2.1) | -18 (-33, -2.9) | 13 (-17, 42) |
| Interaction P value | | | 0.10 | | 0.03 |
| Energy expenditure (MET-hrs/wk) | -12 (-24, 0.90) | -3.4 (-22, 15) | -23 (-42, -3.8) | -21 (-36, -5.9) | 14 (-16, 43) |
| Interaction P value | | | 0.09 | | 0.01 |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Newborn Head Circumference

| | Overall | Infant sex | Pre-pregnancy BMI |
|---------------------------------|----------------------------|------------|-------------------|
| | β (95% CI) | | |
| Pre-pregnancy | | | |
| Duration (hrs/wk) | 0.076 (0.011, 0.14) | | |
| <i>Interaction P value</i> | | | |
| Energy expenditure (MET-hrs/wk) | 0.055 (-0.011, 0.12) | | |
| <i>Interaction P value</i> | | | |
| Early pregnancy | | | |
| Duration (hrs/wk) | -0.0066 (-0.071, 0.058) | | |
| <i>Interaction P value</i> | | | |
| Energy expenditure (MET-hrs/wk) | -0.012 (-0.076, 0.053) | | |
| <i>Interaction P value</i> | | | |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Newborn Head Circumference

| | Overall | Infant sex | | Pre-pregnancy BMI |
|--|-------------------------------|------------------------------|----------------------------|-------------------|
| | | Males | Females | |
| | β (95% CI) | β (95% CI) | β (95% CI) | |
| Pre-pregnancy | | | | |
| Duration (hrs/wk) | 0.076 (0.011, 0.14) | 0.14 (0.046, 0.24) | 0.0017 (-0.082, 0.086) | |
| Interaction P value | | | 0.02 | |
| Energy expenditure (MET-hrs/wk) | 0.055 (-0.011, 0.12) | 0.12 (0.02, 0.22) | -0.015 (-0.10, 0.069) | |
| Interaction P value | | | 0.03 | |
| Early pregnancy | | | | |
| Duration (hrs/wk) | -0.0066 (-0.071, 0.058) | -0.0064 (-0.10, 0.091) | -0.0088 (-0.092, 0.074) | |
| Interaction P value | | | 0.78 | |
| Energy expenditure (MET-hrs/wk) | -0.012 (-0.076, 0.053) | 0.0057 (-0.092, 0.10) | -0.033 (-0.12, 0.050) | |
| Interaction P value | | | 0.39 | |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Newborn Head Circumference

| | Overall | Infant sex | | Pre-pregnancy BMI | |
|--|-------------------------------|------------------------------|----------------------------|----------------------------|--------------------------|
| | | Males | Females | Normal Weight | Overweight/obese |
| | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) |
| Pre-pregnancy | | | | | |
| Duration (hrs/wk) | 0.076 (0.011, 0.14) | 0.14 (0.046, 0.24) | 0.0017 (-0.082, 0.086) | 0.079 (-0.00035, 0.16) | 0.072 (-0.053, 0.20) |
| Interaction P value | | | 0.02 | | 0.79 |
| Energy expenditure (MET-hrs/wk) | 0.055 (-0.011, 0.12) | 0.12 (0.02, 0.22) | -0.015 (-0.10, 0.069) | 0.036 (-0.043, 0.12) | 0.096 (-0.032, 0.22) |
| Interaction P value | | | 0.03 | | 0.62 |
| Early pregnancy | | | | | |
| Duration (hrs/wk) | -0.0066 (-0.071, 0.058) | -0.0064 (-0.10, 0.091) | -0.0088 (-0.092, 0.074) | -0.0073 (-0.085, 0.070) | -0.0077 (-0.13, 0.12) |
| Interaction P value | | | 0.78 | | 0.90 |
| Energy expenditure (MET-hrs/wk) | -0.012 (-0.076, 0.053) | 0.0057 (-0.092, 0.10) | -0.033 (-0.12, 0.050) | -0.018 (-0.095, 0.060) | -0.0028 (-0.13, 0.12) |
| Interaction P value | | | 0.39 | | 0.79 |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Newborn Ponderal Index

| | Overall | Infant sex | Pre-pregnancy BMI |
|---------------------------------|-----------------------|------------|-------------------|
| | β (95% CI) | | |
| Pre-pregnancy | | | |
| Duration (hrs/wk) | 0.14 (-0.24, 0.51) | | |
| <i>Interaction P value</i> | | | |
| Energy expenditure (MET-hrs/wk) | 0.14 (-0.24, 0.52) | | |
| <i>Interaction P value</i> | | | |
| Early pregnancy | | | |
| Duration (hrs/wk) | 0.19 (-0.23, 0.60) | | |
| <i>Interaction P value</i> | | | |
| Energy expenditure (MET-hrs/wk) | 0.14 (-0.27, 0.56) | | |
| <i>Interaction P value</i> | | | |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

Maternal LTPA and Newborn Ponderal Index

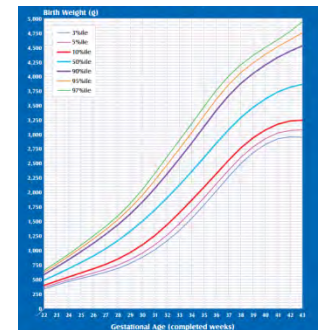
| | Overall | Infant sex | | Pre-pregnancy BMI | |
|--|-----------------------|---------------------------|----------------------------|---------------------------|----------------------------|
| | | Males | Females | Normal Weight | Overweight/obese |
| | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) |
| Pre-pregnancy | | | | | |
| Duration (hrs/wk) | 0.14 (-0.24, 0.51) | 0.056 (-0.006, 0.12) | 0.024 (-0.16, 0.20) | 0.039 (-0.084, 0.16) | 0.054 (-0.032, 0.14) |
| Interaction P value | | | 0.67 | | 0.95 |
| Energy expenditure (MET-hrs/wk) | 0.14 (-0.24, 0.52) | 0.011 (-0.0007, 0.022) | -0.0032 (-0.034, 0.028) | 0.0028 (-0.019, 0.024) | 0.0091 (-0.008, 0.026) |
| Interaction P value | | | 0.15 | | 0.91 |
| Early pregnancy | | | | | |
| Duration (hrs/wk) | 0.19 (-0.23, 0.60) | 0.041 (-0.06, 0.14) | -0.020 (-0.18, 0.14) | 0.0045 (-0.12, 0.13) | 0.051 (-0.031, 0.13) |
| Interaction P value | | | 0.98 | | 0.75 |
| Energy expenditure (MET-hrs/wk) | 0.14 (-0.27, 0.56) | 0.013 (-0.009, 0.034) | -0.0059 (-0.040, 0.028) | 0.0029 (-0.023, 0.029) | 0.0097 (-0.0078, 0.027) |
| Interaction P value | | | 0.84 | | 0.78 |

Model is adjusted for gestational age at delivery, infant sex, severe hyperemesis gravidarum (Y/N), parity (0/1+), maternal age, pre-pregnancy BMI category, race (white/non-white), education (HS or more/less than HS), smoking during pregnancy (Y/N), and marital status (married/not married).

Mean differences for quartiles of measures of physical activity are presented.

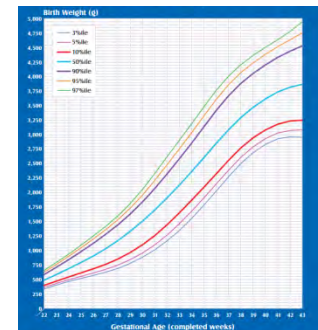
Conclusion: Head Circumference

- Pre-pregnancy moderate to vigorous LTPA was associated with greater head circumference among male infants. ♂



Conclusion: Birthweight

- Pre-pregnancy and early pregnancy moderate to vigorous LTPA was inversely associated with birthweight
 - among female infants and
 - among women with normal pre-pregnancy BMI



Discussion

- Previous studies
 - Inverse association of epLTPA and head circumference (Hopkins et al 2010, Juhl et al 2010)
 - Similar but non-significant associations of epLTPA and birthweight (Hopkins et al 2010, Haakstad et al 2011)
- Timing of LTPA assessment, type of PA assessed, and limited study power may explain differences in findings

Strengths and Limitations

- Strengths

- Large, prospective study
- LTPA assessed at two time points
- Multiple objective measures of birth size



- Limitations

- Self-reported physical activity
- No intrauterine growth measures
- Limited generalizability to less active populations



Future Directions & Implications

- Evaluate clinical importance of observed differences and mechanisms underlying observed associations
- Results may guide identification and promotion of preventive targets for optimal fetal growth



Acknowledgements

- Omega study participants
- Collaborators
 - Daniel Enquobahrie, PhD MPH MD
 - Pandora Wander, MD MS
 - Chunfang Qiu, MD
 - Ray Miller
 - Michelle Williams, ScD
- Support
 - UW Reproductive, Perinatal, and Pediatric Training Grant (T32 HD052462)
 - National Institutes of Health (R01HD-32562, K01HL103174)
 - UW Maternal and Child Health Leadership Program (T76 MC 00011)

Thank you!

Questions?

