

# Maternal Physical Activity Before and During Pregnancy and Offspring Adiposity in Mid-childhood

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# BACKGROUND – Impact of Maternal Physical Activity

Maternal Outcomes

## Gestational Weight Gain

Observational:

- Clapp et al., 1995
- Haakstad et al., 2007
- Olson et al., 2003
- Stuebe et al., 2009

RCTs

- Polley et al., 2002
- Barakat et al., 2009
- Mottola et al., 2010
- Haakstad et al., 2011
- Phelan et al., 2011
- Kong et al., 2014

Fetal Outcomes

## Birth Weight

Observational:

- Owe et al., 2009
- Juhl et al., 2010
- Mudd et al., 2012

RCTs:

- Clapp, 2000
- Santos et al., 2005
- Barakat et al., 2009
- Hopkins et al., 2010
- Haakstad et al., 2011
- Kong et al., 2014

Long-term Offspring Outcomes

## Later Obesity

Observational:

- Clapp et al., 1996
- Clapp, 1998
- Mattran et al., 2011

RCTs:

- Kong et al., 2014



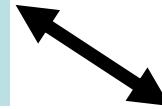
## BACKGROUND – Previous Research on Maternal Physical Activity and Childhood Obesity

- Four known studies (n = 23 – 104)
- Ages:
  - 6 months (Kong et al., 2014)
  - 12 months (Clapp et al., 1998)
  - 18 to 24 months (Mattran et al., 2011)
  - 5 year (Clapp, 1996)
- Overall results:
  - Null to low inverse association (Kong et al., 2014; Clapp et al., 1998; Mattran et al., 2011)
  - Significant inverse association (Clapp, 1996)
- Limitation: Measure of adiposity (i.e. Ponderal Index, skinfold thicknesses )



## AIM 1:

Leisure time physical activity before and during pregnancy



Offspring adiposity outcomes in mid-childhood measured by dual-energy X-ray absorptiometry (DEXA)

## AIM 2:

**Change** in leisure time physical activity before and during pregnancy

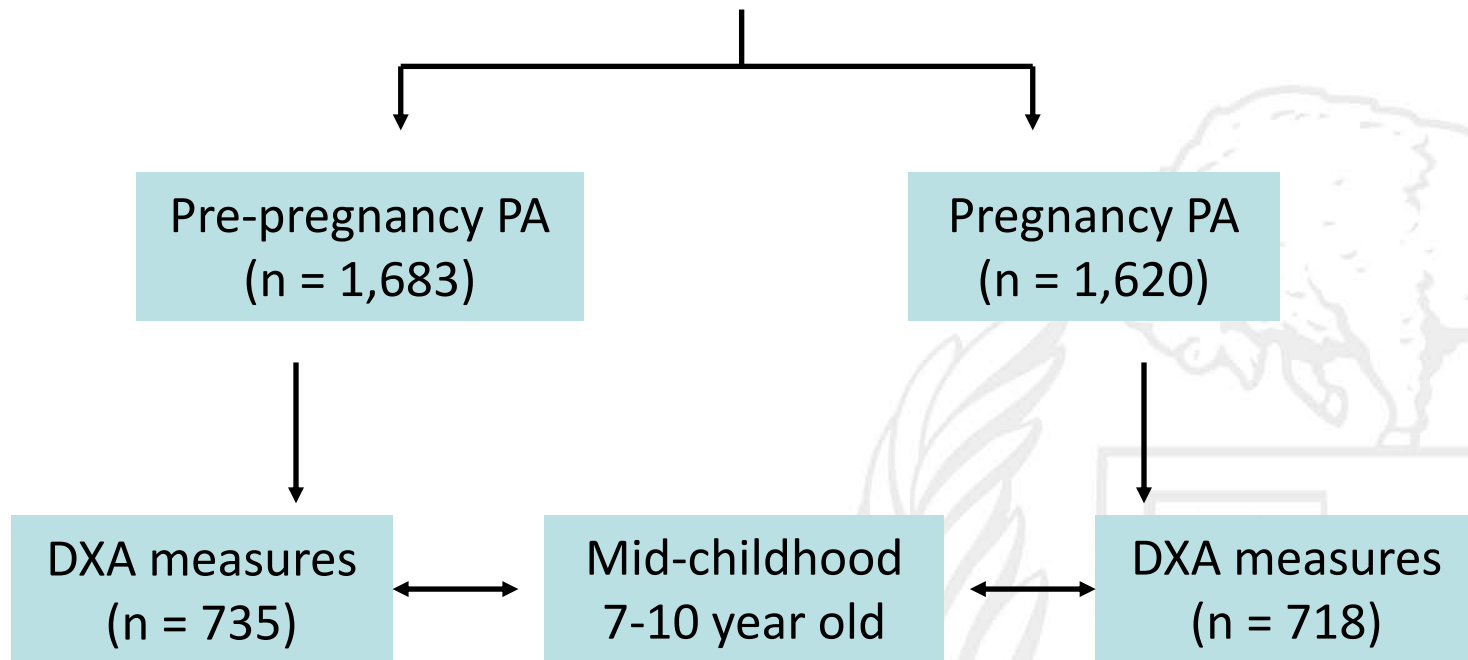


# METHODS



Pre-birth cohort

- n = 2,128
- Established Aug 1999
- Harvard Vanguard Medical Associates
- Massachusetts, USA



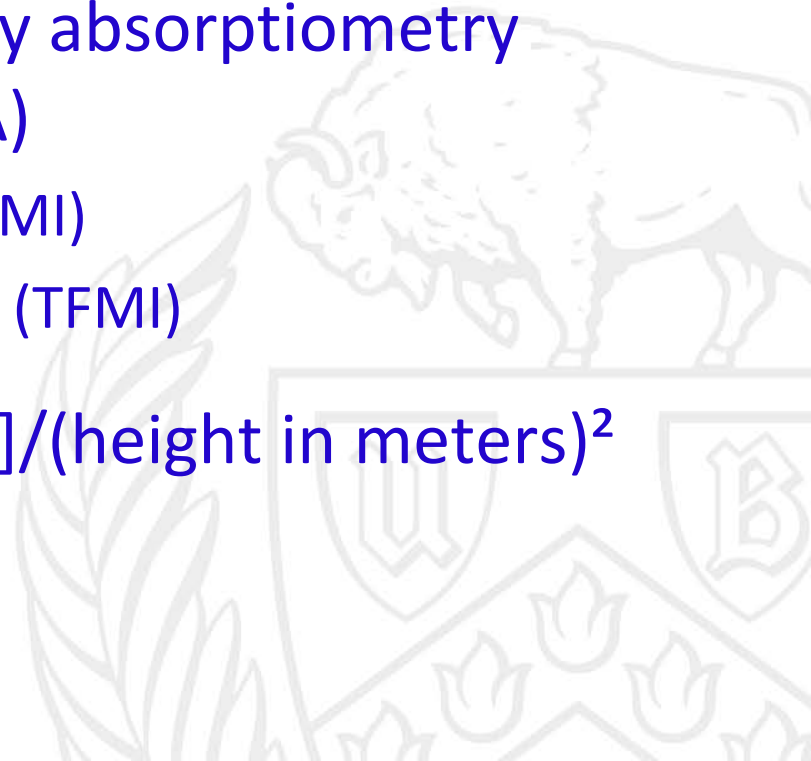
## Exposures: Maternal total leisure time physical activity (LTPA)

- Pregnant women self-reported their activities
  - Pre-pregnancy: initial visit reported 12 months before pregnancy
  - Mid-pregnancy: mid-pregnancy visit reported preceding 3 months
- 3 classes of LTPA: walking, light-to-moderate, and vigorous
- Total LTPA = (walking) + (light-to-moderate) + (2x vigorous)\*
- Change in LTPA = (mid-pregnancy PA) – (pre-pregnancy PA)

\*2008 U.S. Physical Activity Guidelines for Americans

# Outcomes: Mid-childhood overall and central adiposity

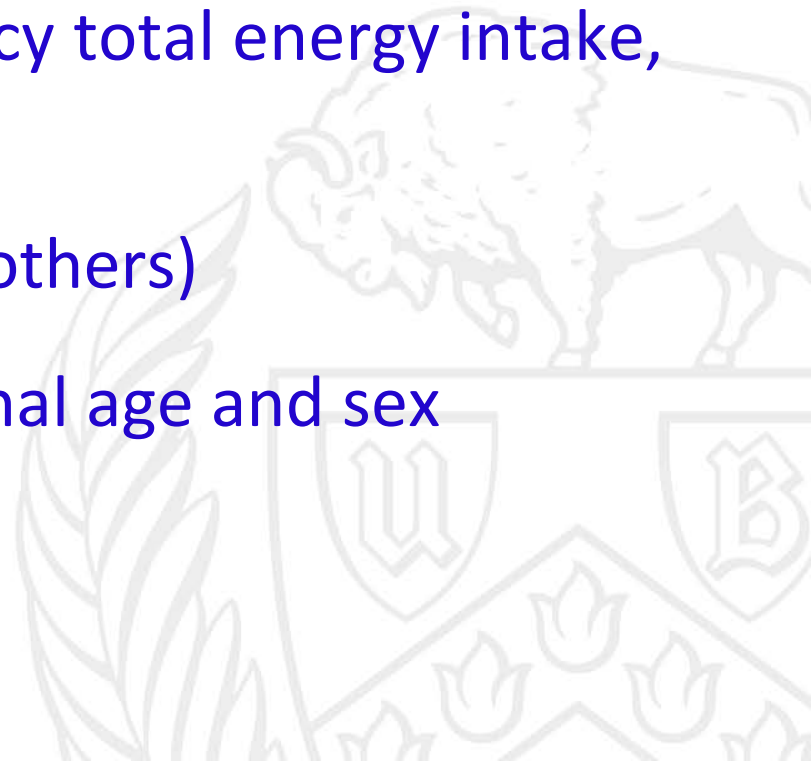
- Height and weight measurements
- Whole body dual-energy X-ray absorptiometry (DEXA) (Hologic, Bedford, MA)
  - Overall- Total fat mass index (FMI)
  - Central- Truncal fat mass index (TFMI)
- Formula:  $[FMI \text{ (or TFMI) in kg}] / (\text{height in meters})^2$





## Potential confounders

- Maternal race/ethnicity, education, age at enrollment, pre-pregnancy BMI, marital status, smoking status, mid-pregnancy total energy intake, annual household income
- Paternal BMI (reported by mothers)
- Child's birth weight, gestational age and sex



# Data analysis

- LTPA reported as categorical and continuous variables in hours/week
- Multivariable linear regression models to examine associations, adjusting for confounders
- Confounders selection- based on  $>10\%$  change in beta after adding a confounder



# RESULTS



## Table 1. Sample characteristics

Table 1: Characteristics of eligible pairs of Viva mothers and children

	Pre-pregnancy (n = 735)		Pregnancy (n = 718)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
<b>Maternal characteristic</b>				
Pre-pregnancy BMI, kg/m <sup>2</sup>		24.7 (5.0)		24.5 (4.9)
Normal	470 (63.9)		468 (65.3)	
Overweight	166 (22.6)		155 (21.6)	
Obese	99 (13.5)		94 (13.1)	
Age at enrollment, y		32.3 (5.2)		32.4 (5.0)
Gestational age at early pregnancy visit, week		10.5 (2.7)		10.4 (2.7)
Gestational age at mid-pregnancy visit, week		27.8 (1.9)		27.9 (2.0)
Education				
Less than college	221 (30.1)		207 (28.8)	
College	256 (34.9)		250 (34.8)	
Graduate	257 (35.0)		261 (36.4)	
Marital status				
Single, divorced, widowed or other	55 (7.5)		51 (7.1)	
Married or partner	679 (92.5)		667 (92.9)	
Race/ethnicity				
White	526 (71.7)		515 (71.7)	
Black	92 (12.5)		96 (13.4)	
Other	116 (15.8)		107 (14.9)	

**Table 1. Sample characteristics cont.**

	Pre-pregnancy (n = 735)		Pregnancy (n = 718)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
Smoking status				
Never smoked	516 (70.2)		516 (72.1)	
Former smoker	148 (20.1)		139 (19.4)	
Smoked during pregnancy	71 (9.7)		61 (8.5)	
Household income, \$/y				
<\$40000	96 (13.9)		92 (13.5)	
\$40000 to \$70000	144 (20.8)		142 (20.8)	
>\$70000	453 (65.4)		449 (65.7)	
Mid-pregnancy energy intake, kcal/day		2150 (646)		2162 (651)
<b>Paternal characteristic</b>				
Father BMI, kg/m <sup>2</sup>		26.5 (3.9)		26.4 (3.9)
<b>Offspring characteristic</b>				
Birth weight, g		3,504 (543)		3,505 (545)
Gestational age, week		39.6 (1.8)		39.6 (1.7)
Gender				
Male	348 (47.3)		340 (47.4)	
Female	387 (52.7)		378 (52.6)	

\* Leisure time physical activity (LTPA) derived by adding self-reported walking, light/moderate physical activity and doubled of vigorous physical activity

‡ Change in total LTPA = pre-pregnancy total LTPA - mid-pregnancy total LTPA

SD = standard deviation

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Other	116 (15.8)		107 (14.9)	

## Maternal physical activity and offspring FAT mass index

	Fat mass index (kg/m <sup>2</sup> )	
	Model 1	Model 2
	Mean Difference (95% CI)	
Pre-pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.11 (-0.27, 0.49)	0.21 (-0.17, 0.58)
11+ h/week	0.02 (-0.36, 0.40)	0.13 (-0.24, 0.50)
Pre-pregnancy LTPA, 2 h/week	-0.02 (-0.04, 0.01)	-0.01 (-0.04, 0.01)
Pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.11 (-0.20, 0.42)	0.22 (-0.08, 0.53)
11+ h/week	0.11 (-0.26, 0.48)	0.22 (-0.14, 0.59)
Pregnancy LTPA, 2 h/week	0.00 (-0.03, 0.04)	0.01 (-0.02, 0.04)

Model 1: child age of DXA measures, gender

status, and smoking status

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

## Maternal physical activity and offspring FAT mass index

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11+ h/week	0.02 (-0.36, 0.40)	0.13 (-0.24, 0.50)
Pre-pregnancy LTPA, 2 h/week	-0.02 (-0.04, 0.01)	-0.01 (-0.04, 0.01)
Pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.11 (-0.20, 0.42)	0.22 (-0.08, 0.53)
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Model 1: child age of DXA measures, gender

status, and smoking status

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status



## Maternal physical activity and offspring TRUNCAL fat mass index

	Truncal fat mass index (kg/m <sup>2</sup> )	
	Model 1	Model 2
	Mean Difference (95% CI)	
Pre-pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.07 (-0.10, 0.24)	0.11 (-0.06, 0.27)
11+ h/week	0.06 (-0.11, 0.23)	0.10 (-0.07, 0.27)
Pre-pregnancy LTPA, 2 h/week	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)
Pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.05 (-0.09, 0.19)	0.11 (-0.03, 0.24)
11+ h/week	0.06 (-0.10, 0.23)	0.11 (-0.05, 0.28)
Pregnancy LTPA, 2 h/week	0.00 (-0.01, 0.02)	0.01 (-0.01, 0.02)

Model 1: child age of DXA measures, gender

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

## CHANGE in physical activity and offspring **FAT** mass index

	n (%)	Fat mass index (kg/m <sup>2</sup> )		
		Model 1	Model 2	Model 3
		Mean Difference (95% CI)		
Change in total LTPA (categorical)				
Decrease (-2+ h/week)	377 (57.9)	0.0 (ref)	0.0 (ref)	0.0 (ref)
Maintenance (0 ± 1 h/week)	160 (24.6)	0.09 (-0.21, 0.40)	0.07 (-0.22, 0.37)	-0.02 (-0.34, 0.30)
Increase (2+ h/week)	114 (17.5)	0.21 (-0.14, 0.56)	0.17 (-0.17, 0.50)	0.09 (-0.25, 0.44)
Change in total LTPA, 2 h/week	651 (100)	0.01 (-0.02, 0.04)	0.02 (-0.01, 0.05)	0.01 (-0.02, 0.05)

Model 1: child age of DXA measures, gender

Model 2: Additionally adjusted for pre-pregnancy LTPA

LTPA = leisure time physical activity; SD = standard deviation; CI = confident interval

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

Model 3: pre-pregnancy leisure time physical activity

## CHANGE in physical activity and offspring **FAT** mass index

	n (%)	Fat mass index (kg/m <sup>2</sup> )		
		Model 1	Model 2	Model 3
		Mean Difference (95% CI)		
Change in total LTPA (categorical)				
Decrease (-2+ h/week)	377 (57.9)	0.0 (ref)	0.0 (ref)	0.0 (ref)
Maintenance (0 ± 1 h/week)	160 (24.6)	0.09 (-0.21, 0.40)	0.07 (-0.22, 0.37)	-0.02 (-0.34, 0.30)
Increase (2+ h/week)	114 (17.5)	0.21 (-0.14, 0.56)	0.17 (-0.17, 0.50)	0.09 (-0.25, 0.44)
Change in total LTPA, 2 h/week	651 (100)	0.01 (-0.02, 0.04)	0.02 (-0.01, 0.05)	0.01 (-0.02, 0.05)

Model 1: child age of DXA measures, gender

Model 2: Additionally adjusted for pre-pregnancy LTPA

LTPA = leisure time physical activity; SD = standard deviation; CI = confident interval

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

Model 3: pre-pregnancy leisure time physical activity

## CHANGE in physical activity and offspring **TRUNCAL** fat mass index

	n (%)	Truncal fat mass index (kg/m <sup>2</sup> )		
		Model 1	Model 2	Model 3
		Mean Difference (95% CI)		
Change in total LTPA (categorical)				
Decrease (-2+ h/week)	377 (57.9)	0.0 (ref)	0.0 (ref)	0.0 (ref)
Maintenance (0 ± 1 h/week)	160 (24.6)	0.01 (-0.13, 0.15)	0.01 (-0.12, 0.14)	-0.02 (-0.17, 0.12)
Increase (2+ h/week)	114 (17.5)	0.07 (-0.08, 0.23)	0.06 (-0.09, 0.21)	0.03 (-0.12, 0.19)
Change in total LTPA, 2 h/week	651 (100)	0.00 (-0.01, 0.02)	0.01 (0.00, 0.02)	0.00 (-0.01, 0.02)

Model 1: child age of DXA measures, gender

Model 2: maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

Model 3: pre-pregnancy leisure time physical activity

## CONCLUSIONS

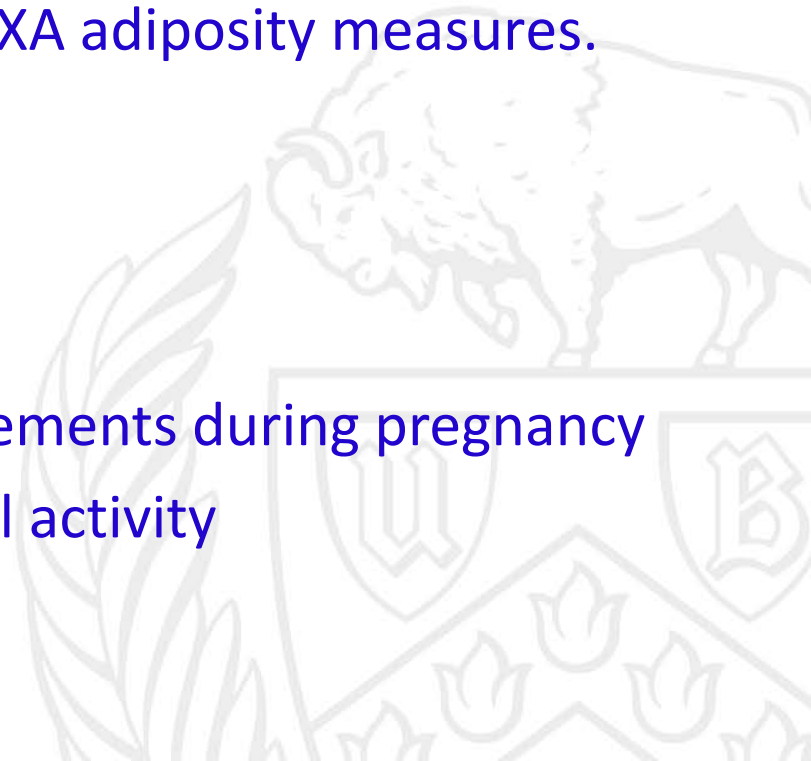
- U.S. pre-birth cohort- White, married and high socio-economic status pregnant women
- Maternal physical activity were not associated with offspring overall and central adiposity in mid-childhood.
- Maintained or increased physical activity during pregnancy was not associated with lower mid-childhood adiposity.
- Other benefits of maternal physical activity (i.e. pre-eclampsia, gestational diabetes, low back pain)

## Strengths

- Relatively large sample size (n = 700+) with long-term follow-up
- Included pre-pregnancy physical activity → change from pre-pregnancy to pregnancy
- Research-quality of measures → DXA adiposity measures.

## Limitations

- Self-reported physical activity.
- Only one time point of PA measurements during pregnancy
- No report on occupational physical activity

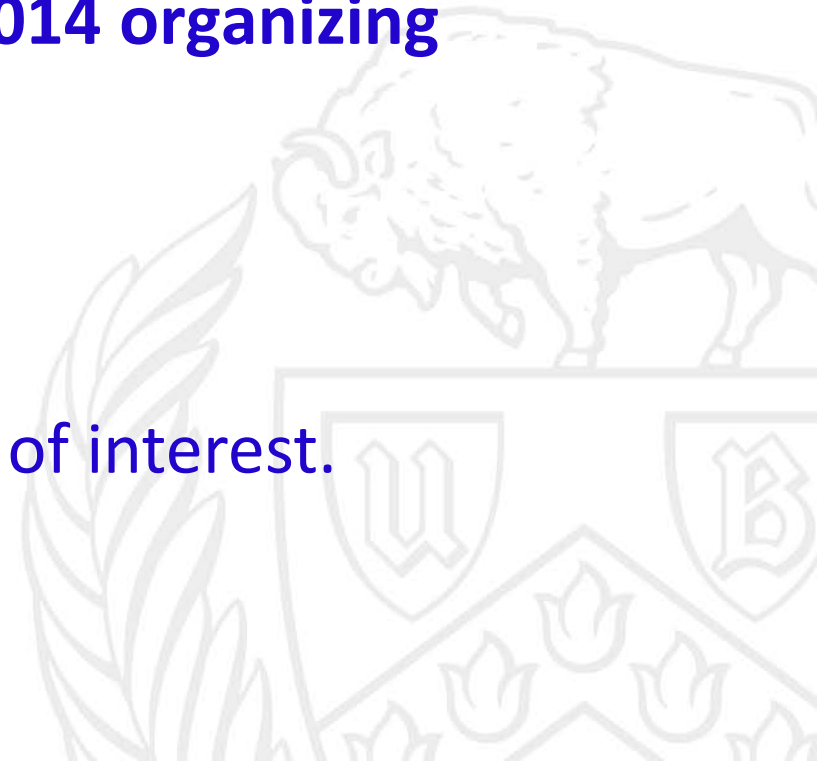


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- **Co-authors**
  - Matthew Gillman, Sheryl Rifas-Shiman and Xiaozhong Wen
- **Project Viva research team and participants**
- **The Power of Programming 2014 organizing committee**

# CONFLICT OF INTEREST

All authors declare no conflicts of interest.



Questions or  
comments?



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# SUPPLEMENTAL MATERIALS



## Maternal physical activity and offspring LEAN mass index

	Lean mass index (kg/m <sup>2</sup> )	
	Model 1	Model 2
	Mean Difference (95% CI)	
Pre-pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	-0.07 (-0.35, 0.21)	0.10 (-0.17, 0.38)
11+ h/week	0.08 (-0.20, 0.36)	0.26 (-0.02, 0.53)
Pre-pregnancy LTPA, 2 h/week	0.00 (-0.02, 0.02)	0.00 (-0.02, 0.02)
Pregnancy LTPA (categorical)		
0-2 h/week	0.0 (ref)	0.0 (ref)
3-10 h/week	0.03 (-0.20, 0.26)	0.18 (-0.04, 0.40)
11+ h/week	0.03 (-0.24, 0.31)	0.14 (-0.13, 0.40)
Pregnancy LTPA, 2 h/week	0.00 (-0.02, 0.02)	0.00 (-0.02, 0.02)

Model 1: Adjusted for child age of DXA measures and gender

Model 2: Additionally adjusted for maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status, and smoking status

LTPA = leisure time physical activity; SD = standard deviation; CI = confident interval

## CHANGE in physical activity and offspring LEAN mass index

	n (%)	Lean mass index (kg/m <sup>2</sup> )		
		Model 1	Model 2	Model 3
		Mean Difference (95% CI)		
<b>Change in total LTPA (categorical)</b>				
Decrease (-2+ h/week)	377 (57.9)	0.0 (ref)	0.0 (ref)	0.0 (ref)
Maintenance (0 ± 1 h/week)	160 (24.6)	-0.09 (-0.31, 0.14)	-0.07 (-0.28, 0.15)	-0.05 (-0.29, 0.18)
Increase (2+ h/week)	114 (17.5)	0.21 (-0.05, 0.47)	0.13 (-0.12, 0.38)	0.14 (-0.12, 0.39)
<b>Change in total LTPA, 2 h/week</b>	<b>651 (100)</b>	<b>-0.01 (-0.03, 0.01)</b>	<b>0.00 (-0.02, 0.01)</b>	<b>-0.01 (-0.03, 0.02)</b>

Model 1: Adjusted for child age of DXA measures and gender

Model 2: Additionally adjusted for maternal race/ethnicity, education, age, pre-pregnancy BMI, marital status and smoking status

Model 3: Additionally adjusted for pre-pregnancy LTPA

LTPA = leisure time physical activity; SD = standard deviation; CI = confident interval

Change in total LTPA = pre-pregnancy total LTPA - mid-pregnancy total LTPA

## Compared to excluded women:

slightly older [mean, 32.2 (SD, 5.3) y vs. 31.6 (5.2) y],

slightly longer gestational age at delivery [39.6 (1.7) weeks vs. 39.3 (2.1) weeks]

heavier at birth [3505 (547) g vs. 3434 (617) g]

more educated (% graduate, 34.5 % vs. 26.2 %),

higher in white race (69.8% vs. 64.5%),

higher in household income (% > \$70000, 64.8% vs. 58.7%),

higher in female infants (51.3% vs. 46.8%)

lesser in women who smoked during pregnancy (9.4% vs. 14.6%).

