May 20th, 2:30 PM

Physical Activity, Sedentary Behavior, and Gestational Diabetes

Lisa Chasan-Taber

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Physical Activity, Sedentary Behavior, and Gestational Diabetes

Lisa Chasan-Taber, Sc.D.
Professor of Epidemiology
University of Massachusetts - Amherst
Gestational Diabetes

Any degree of glucose intolerance with onset or first recognition during pregnancy
How the first nine months shape the rest of your life

The new science of fetal origins

By Annie Murphy Paul
Environmental factors in utero can have profound influences on:

- Lifelong health
- Development of adult diseases
  - Cancer, CVD, diabetes, obesity
  - Asthma, allergies, mental illness
  - Arthritis, osteoporosis, cognitive decline

Critical developmental window of programming

GDM Confers a 7-Fold Risk for Future Type 2 Diabetes

Preventing Diabetes in Women with Gestational Diabetes

Avoiding the slippery slope: preventing the development of diabetes in women with a history of gestational diabetes

Preventing Diabetes in Women with Gestational Diabetes

Through the looking glass: gestational diabetes as a predictor of maternal and offspring long-term health
Pregnancy as a Stress Test for Future Cardiovascular Disease

Adapted from Sattar and Greer; 2002, British Medical Journal.
High Priority Research Needs

High Risk Pregnant Women

Pregnancy

Maternal Outcomes
- gestational diabetes
- hypertension

Maternal Outcomes
- Cesarean delivery

Neonatal Outcomes
- large for gestational age
- NICU admission

Maternal Outcomes
- type 2 diabetes
- postpartum weight retention
- CVD risk factors

Offspring Outcomes
- obesity
- type 2 diabetes
- CVD risk factors

Postpartum and Beyond

Modified from Bennett et al. J Women’s Health 21(9):2012
GDM Risk Factors

- Well documented
  - Prepregnancy overweight/obesity
  - Family history of diabetes
  - Advanced maternal age
  - Ethnicity
  - History of abnormal glucose tolerance/macroscopic infant
  - History of infertility
  - PCOS

Research on possible modifiable risk factors is critical

- Poor diet before or during pregnancy
- Low physical activity before or during pregnancy
- Smoking
- Stress
How Active Are Pregnant Women?
According to national surveys, 2x as many women are sedentary during pregnancy vs. the national average.

- Only 16% meet guidelines.
- Pregnant women who are active, exercise less frequently, for shorter durations, and lower intensity.

Evenson et al. *Paediatric and Perinatal Epidemiology* 2004, **18**, 400–407
Hispanic Americans

- Hispanics are the largest minority group in the U.S
  - highest birth and immigration rates
  - 25% of all US births in 2007

- by 2050
  - Hispanic women will comprise 24% of the female population in the US

- Hispanic children represent the largest minority group of US children
  - 1 of every 6 children
Hispanic Health Disparities

Diabetes Hospital Discharge Rate by Race/Ethnicity
Western Region and Massachusetts: 2003-2005

- White non-Hispanic
- Black non-Hispanic
- Hispanic
- Asian non-Hispanic

<table>
<thead>
<tr>
<th>Region</th>
<th>White non-Hispanic</th>
<th>Black non-Hispanic</th>
<th>Hispanic</th>
<th>Asian non-Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Region</td>
<td>118*</td>
<td>396*</td>
<td>452*</td>
<td></td>
</tr>
<tr>
<td>Massachusetts</td>
<td>114*</td>
<td>242*</td>
<td>368*</td>
<td></td>
</tr>
</tbody>
</table>

State Overall: 133

Division of Health Care Finance and Policy, Calendar Year 2003-2005, Inpatient Hospital Discharge Database.
Probability of Developing Type 2 Diabetes after GDM Among Hispanic Women

*Diabetes* 1995; 44: 586
Baystate Medical Center
Proyecto Buena Salud

NIH/NIDDK R01 DK064902

N=1,626 pregnant Hispanic Women

PI: Chasan-Taber, Co-I: Pekow, Markenson, Braun, Buonnaccorsi, Dole
Study Design

• *1st Interview*
  1st Prenatal Care Visit

• *2nd Interview*
  Routine Ultrasound

• *3rd Interview*
  Routine GDM screen

Gestational wk: 1 . . 4 . . 8 . . 12 . . 16 . . 20 . . 24 . . 28 . . 32 . . 36 . . 40

1st Trimester  2nd Trimester  3rd Trimester

Birth Outcomes (Medical Record Abstraction)

Pregnancy Physical Activity Questionnaire (PPAQ)

Sports/Exercise

Household/Caregiving

Occupational

Total Physical Activity

NIH/NICHD R03HD39341; PI: Chasan-Taber, Co-I: Freedson, Hosmer, Markenson
Pregnancy Physical Activity Questionnaire

Instructions:
Please use an ordinary No. 2 pencil. Fill in the circle to indicate the answer. Change your answer only where the size of the circle is compact. If you have comments, please write them on the back of the questionnaire.

Example: During this trimester, when you are NOT at work, how much time do you usually spend:

- Taking care of an a:
  - None
  - Less than 1/2 hour per day
  - 1 to almost 3 hours per day
  - 1 to almost 2 hours per day
  - 1 to almost 3 hours per day
  - 3 or more hours per day

It is very important that you tell us about yourself. Honesty is just as important as the things you are doing during this time.

1. Today's Date:

2. What was the first day of your last period?

3. When is your baby due?

4. Preparing meals (sushi, set table, wash dishes)
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

5. Dressing, bathing, feeding children while you are cooking
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

6. Playing with pets
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

7. Watching TV or a
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

8. Play going places (such as to the box, work, shopping)
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

9. Throwing, kicking, hitting, running, jumping
   - None
   - Less than 1/2 hour per day
   - 1/2 to almost 1 hour per day
   - 1 to almost 2 hours per day
   - 2 to almost 3 hours per day
   - 3 or more hours per day

10. Going walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

11. Doing chores (caring for baby, doing laundry, cooking, washing, sweeping, cleaning)
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

12. Doing household chores (laundry, cleaning, cooking, washing, sweeping, cleaning)
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

13. Taking care of an animal
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

14. Playing with plants
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

15. Light cleaning (sweep, dust, wash windows)
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

16. Taking care of an adult
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

17. Playing with children
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

18. Playing with children while you are cooking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

19. Playing with children while you are doing chores
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

20. Doing other things for fun or exercise? Please tell us what they are.

21. We play
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

22. No fun or exercise
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

23. Walking slowly for fun or exercise
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

24. Walking quickly
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

25. Walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

26. Jogging
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

27. Walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

28. Walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

29. Walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

30. No activity
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

31. No activity
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

32. Sitting at work
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

33. Standing or slowly walking
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

34. Standing or slowly walking (weight greater than 40 pounds)
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

Please fill out the next section if you work for wages, as a volunteer, or if you are a student. If you are a homemaker, out of work, or unable to work, you do not need to complete this last section.

At Work...

35. Sitting at work
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

36. Walking at work
    - None
    - Less than 1/2 hour per day
    - 1/2 to almost 1 hour per day
    - 1 to almost 2 hours per day
    - 2 to almost 3 hours per day
    - 3 or more hours per day

Thank You
Type and Intensity of Physical Activity

Sedentary Behavior

- Watching Television
- Using a Computer
- Reading/Talking on the Phone

- <0.5 hours/day
- 0.5-<2 hours/day
- 2-<4 hours/day
- ≥4 hours/day
Meta Analysis: Physical Activity and GDM

**Prepregnancy Activity:**

OR = 0.45  
(95% CI 0.28-0.75)

**Pregnancy Activity:**

OR = 0.76  
(95% CI 0.70-0.83)

Tobias DK et al. Diabetes Care 2011;34:223-229
Table 3. Sedentary Behavior and GDM: Project Viva

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>Before Pregnancy (n=1,638)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GDM</td>
<td>Abnormal Glucose Tolerance</td>
<td>GDM</td>
<td>Abnormal Glucose Tolerance</td>
<td>GDM</td>
<td>Abnormal Glucose Tolerance</td>
</tr>
<tr>
<td></td>
<td>Cases (n)</td>
<td>Adjusted OR* (95% CI)</td>
<td>Cases (n)</td>
<td>Adjusted OR* (95% CI)</td>
<td>Cases (n)</td>
<td>Adjusted OR* (95% CI)</td>
</tr>
<tr>
<td>Sedentary lifestyle (total activity 2 h/wk or less)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not sedentary</td>
<td>63</td>
<td>1.0 (Referent)</td>
<td>235</td>
<td>1.0 (Referent)</td>
<td>55</td>
<td>1.0 (Referent)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>13</td>
<td>1.44 (0.70–2.96)</td>
<td>41</td>
<td>1.22 (0.83–1.81)</td>
<td>22</td>
<td>1.43 (0.79–2.59)</td>
</tr>
<tr>
<td>Television viewing (h/d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2</td>
<td>46</td>
<td>1.0 (Referent)</td>
<td>184</td>
<td>1.0 (Referent)</td>
<td>47</td>
<td>1.0 (Referent)</td>
</tr>
<tr>
<td>2 or more</td>
<td>30</td>
<td>1.28 (0.75–2.18)</td>
<td>92</td>
<td>0.99 (0.74–1.32)</td>
<td>29</td>
<td>1.03 (0.59–1.78)</td>
</tr>
</tbody>
</table>

# Meta Analysis: Television Viewing and Risk of Type 2 Diabetes

<table>
<thead>
<tr>
<th>Type 2 diabetes</th>
<th>Weight, %</th>
<th>RR (95% CI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hu et al, 2001</td>
<td>18.9</td>
<td>1.20 (1.08-1.32)</td>
<td></td>
</tr>
<tr>
<td>Hu et al, 2003</td>
<td>29.8</td>
<td>1.16 (1.09-1.24)</td>
<td></td>
</tr>
<tr>
<td>Krishnan et al, 2009</td>
<td>36.6</td>
<td>1.17 (1.12-1.23)</td>
<td></td>
</tr>
<tr>
<td>Ford et al, 2010</td>
<td>14.7</td>
<td>1.37 (1.21-1.55)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>1.20 (1.14-1.27)</td>
<td></td>
</tr>
</tbody>
</table>

Test for heterogeneity: $P = .11; I^2 = 50.4\%$

![Graph showing the relationship between television viewing and risk of Type 2 Diabetes]
Meta Analysis: Television Viewing and Risk of Type 2 Diabetes

![Graph showing the relationship between television viewing and risk of type 2 diabetes. The x-axis represents television viewing hours per day (0-8 h/d), and the y-axis represents the risk ratio (RR). The graph shows an increasing risk ratio as television viewing increases.]
Interventions to Reduce the Incidence of Type 2 Diabetes

Diabetes Prevention Program Research Group *NEJM* 2002; 346: 393
Interventions to Reduce the Incidence of GDM

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Study population</th>
<th>Intervention</th>
<th>GDM Criteria</th>
<th>Association</th>
</tr>
</thead>
</table>
| Barakat, 2013 | Spain n=510 | **Group exercise**: 50-55 min, 3x week  
**Duration**: 10-12 to 38-39 weeks | WHO  
IADPSG | OR 0.62 (95% CI 0.40-0.98)  
OR 0.90 (95% CI 0.52-1.57) |
| Stafne, 2012 | Norway n=855 | **Group exercise**: 60 min, 1x week  
**Individual exercise**: 45 min, 2x week  
**Duration**: 18-22 to 32-26 weeks | WHO | PA 7%; C 6%  
p=0.37 |
| Luoto, 2011 | Finland n=399 | **Individual exercise**: 800 MET-hrs/wk  
**Duration**: 8-12 to 37 weeks | ADA | PA 15.8%, C 12.4%  
p=0.31 |
| Phelan, 2011 | Providence, RI n=401 | **Individual exercise**: 30 min on most days of the week  
**Duration**: 10-16 weeks to 6 months post-partum | Not reported | PA 13.6%, C 8.1%  
p=n.s. |
An Exercise Intervention to Prevent GDM

The B.A.B.Y. Study

Behaviors Affecting Baby and You

NIH/NIDDK
R01 DK074876

N=290 pregnant ethnically diverse women

Pl: Chasan-Taber, Co-Pl Braun, Stanek, Marcus, Markenson
Eligible participants

Baseline Assessment
PPAQ, actigraph, 24 hr recall

Exercise Arm
12 Week Intervention
In person education on exercise followed by mail & telephone follow-up

Health & Wellness Arm
12 Week Intervention
In person education on health & wellness followed by mail & telephone follow-up

Follow-up Assessment
PPAQ, actigraph, 24 hr recall

Gestational Diabetes Screen

B.A.B.Y. Study Intervention Content

- Face-to-Face Visit
  - Tailoring Questionnaire
  - Stage-Matched Manual
  - Pedometer and Activity Log
  - Goal Setting
- Booster Telephone Calls
  - Problem Solving
  - Progress Toward Goals
- Mailings
  - Individually Tailored Report
  - Tip Sheets
  - Stage-Matched Manual
Tip Sheets

The B.A.B.Y. Study
Behaviors Affecting Baby and You

10 minutes as easy as 1,2,3....
Look at the tips and see!

10 Minute Physical Activities from A-Z

Accumulate 30 minutes a day of activity.
(Try exercising in 10-15 minute bouts)

Invigorate yourself with fresh air. Park farther away from your destination and

Rake the leaves. Get outdoors and do your chores

How Do People Find Time to Get 10 Minutes of Exercise?

- Markie has mapped out a path through her house. While dinner cooks, she walks up and down the stairs, through the bedrooms, and across the hall. Her final stop is the kitchen so she can march in place and stir dinner every once in a while.
Pedometer

- Omron Pedometer HJ112
Health & Wellness Materials

  - Information You Can Trust from the Leading Experts in Women's Health Care
- *Easing Back Pain During Pregnancy*
- *Travel During Pregnancy*
- *Morning Sickness*
Change in Total PA from Pre to Post Intervention

Chasan-Taber et al., Journal of Physical Activity and Public Health 2011: 8(Suppl 2)
Change in Sports/Exercise from Pre to Post Intervention

Chasan-Taber et al., Journal of Physical Activity and Public Health 2011: 8(Suppl 2)
Impact of Exercise Intervention on Gestational Diabetes
Estudio Parto

Randomized Trial of a Postpartum Diabetes Prevention Program for Hispanic Women

NIH/NIDDK
2R01 DK064902

N=300 Postpartum Hispanic Women

PI: Chasan-Taber, Co-PI Braun, Pekow, Marcus, Rosal, Markenson
Proyecto Mamá

Randomized Lifestyle Intervention in Overweight and Obese Pregnant Hispanic Women

NIH/NIDDK
R01 DK097011

N=300 pregnant Hispanic Women

PI: Chasan-Taber, Co-PI Braun, Pekow, Stanek, Marcus, Rosal, Markenson
Inter-Generational Cycle: Diabetes Begets Diabetes

- Preexisting type 2 diabetes
- Gestational diabetes
- Impaired adult glucose tolerance
- Fetal hyperinsulinism
- Childhood obesity
- Adolescent impaired glucose tolerance

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