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Physical Activity, Sedentary Behavior, and Gestational Diabetes

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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
Maternal Morbidities According to Age

Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System, 2005
How the first nine months shape the rest of your life

The new science of fetal origins

By Annie Murphy Paul
Fetal Basis of Adult Disease

- 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

Avoiding the slippery slope: preventing the development of diabetes in women with a history of 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
  - Maternal Outcomes: *gestational diabetes* *hypertension*
  - Maternal Outcomes: *Cesarean delivery*
  - Neonatal Outcomes: *large for gestational age* *NICU admission*
  - Offspring Outcomes: *obesity* *type 2 diabetes* *CVD risk factors*

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/macrosomic 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.

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

Western Region:
- 452* (White non-Hispanic)
- 396* (Black non-Hispanic)
- 118* (Hispanic)
- 36* (Asian non-Hispanic)

Massachusetts:
- 368* (White non-Hispanic)
- 242* (Black non-Hispanic)
- 114* (Hispanic)
- 45* (Asian non-Hispanic)

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
Study Design

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

1st Interview
1st Prenatal Care Visit

2nd Interview
Routine Ultrasound

3rd Interview
Routine GDM screen

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 circles completely. The Questionnaire will be read by a machine, so if you need to change your answer, erase the incorrect circle completely. If you have comments, please write them on the back of the questionnaire.

**Example:** During this trimester, when you are NOT at work, usually spend:

1. **C1. Taking care of an adult:**
   - [ ] None
   - [ ] Less than 1/2 hour per day
   - [ ] 1 to almost 3 hours per day
   - [ ] 3 or more hours per day

It is very important you tell us about yourself honestly. There are just a few things you are doing during this trimester.

**During this trimester, when you are NOT at work, usually spend:**

6. **Dressing, bathing, feeding children while you are sitting:**
   - [ ] None
   - [ ] Less than 1/2 hour per day
   - [ ] 1 to almost 2 hours per day
   - [ ] 2 to almost 3 hours per day
   - [ ] 3 or more hours per day

7. **Playing with children while you are sitting or standing:**
   - [ ] None
   - [ ] Less than 1/2 hour per day
   - [ ] 1 to almost 2 hours per day
   - [ ] 2 to almost 3 hours per day
   - [ ] 3 or more hours per day

8. **Playing with children while you are walking:**
   - [ ] None
   - [ ] Less than 1/2 hour per day
   - [ ] 1 to almost 2 hours per day
   - [ ] 2 to almost 3 hours per day
   - [ ] 3 or more hours per day

9. **Camping children:**
   - [ ] None
   - [ ] Less than 1/2 hour per day
   - [ ] 1 to almost 2 hours per day
   - [ ] 2 to almost 3 hours per day
   - [ ] 3 or more hours per day

10. **Taking care of an adult:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

11. **Watching TV or a video:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

12. **Light cleaning or laundry, vacuuming, cleaning windows:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

13. **Playing with pets:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

14. **Light cleaning or laundry, vacuuming, cleaning windows:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

15. **For Fun or Exercise...**

16. **Walking slowly for fun or exercise:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

17. **Riding a bike:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

18. **Swimming:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

19. **For Fun or Exercise...**

20. **Walking slowly for fun or exercise:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

21. **Walking slowly for fun or exercise:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

**Going Places...**

22. **Walking slowly to go places (such as to the bus, work, shopping, etc.):**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

23. **Double Stroller Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

24. **Double Stroller Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

25. **Double Stroller Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

26. **Double Stroller Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

27. **Other Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

28. **Other Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

29. **Other Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

30. **Other Walking:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1 to almost 2 hours per day
    - [ ] 2 to almost 3 hours per day
    - [ ] 3 or more hours per day

31. **Other Walking:**
    - [ ] None
    - [ ] Less than 1/2 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 self-employed, out of work, or unable to work, you do not need to complete this last section.

**At Work...**

32. **Sitting at work or in class:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1/2 to almost 2 hours per day
    - [ ] 2 to almost 4 hours per day
    - [ ] 4 or more hours per day

33. **Sitting at work or in class:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1/2 to almost 2 hours per day
    - [ ] 2 to almost 4 hours per day
    - [ ] 4 or more hours per day

34. **Sitting at work or in class:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1/2 to almost 2 hours per day
    - [ ] 2 to almost 4 hours per day
    - [ ] 4 or more hours per day

35. **Sitting at work or in class:**
    - [ ] None
    - [ ] Less than 1/2 hour per day
    - [ ] 1/2 to almost 2 hours per day
    - [ ] 2 to almost 4 hours per day
    - [ ] 4 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>During Pregnancy (n=1,581)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GDM</td>
<td>Cases (n)</td>
<td>Adjusted OR* (95% CI)</td>
<td>GDM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedentary lifestyle (total activity 2 h/wk or less)</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>
</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>
</tr>
<tr>
<td>Television viewing (h/d)</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>
</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>
</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>
</tr>
</thead>
<tbody>
<tr>
<td>Hu et al, 2001</td>
<td>18.9</td>
<td>1.20 (1.08-1.32)</td>
</tr>
<tr>
<td>Hu et al, 2003</td>
<td>29.8</td>
<td>1.16 (1.09-1.24)</td>
</tr>
<tr>
<td>Krishnan et al, 2009</td>
<td>36.6</td>
<td>1.17 (1.12-1.23)</td>
</tr>
<tr>
<td>Ford et al, 2010</td>
<td>14.7</td>
<td>1.37 (1.21-1.55)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>1.20 (1.14-1.27)</strong></td>
</tr>
</tbody>
</table>

Test for heterogeneity: $P = .11$; $I^2 = 50.4\%$
Meta Analysis: Television Viewing and Risk of Type 2 Diabetes
Interventions to Reduce the Incidence of Type 2 Diabetes

![Graph showing cumulative incidence of diabetes over years for different interventions: Placebo, Metformin, Lifestyle.]

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

PI: Chasan-Taber, Co-PI 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
Stage Matched Manuals

¿NECESITO ESTO?

JumpStart to Health

TRY IT, YOU’LL LIKE IT...

Seamos Saludables

Libro 2

Siga Adelante...

Seamos Activas

Libro 4
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

- Your Pregnancy & Birth
- Easing Back Pain During Pregnancy
- Travel During Pregnancy
- Morning Sickness
Change in Total PA from Pre to Post Intervention

- Pre: 5.2 Met-hrs/wk (~1 hr 20 min)
- Post: ~5.0 Met-hrs/wk

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

- Exercise Arm: 1.3 MET-hrs/wk, ~20 min
- Health & Wellness Arm:

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

![Graph showing the impact of exercise intervention on gestational diabetes across different doses of intervention. The x-axis represents the dose of intervention in weeks (0-12, 2-12, 4-12, 6-12, 8-12), and the y-axis represents the number of subjects receiving key GDM screen. The graph compares Exercise, GDM, No GDM, and Health and Wellness categories.]
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
  - In-utero exposure to gestational diabetes
  - Fetal hyperinsulinism
  - Childhood obesity
  - Adolescent impaired glucose tolerance
- Impaired adult glucose tolerance

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- Marushka Silveira
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