Physical Activity, Sedentary Behavior, and Gestational Diabetes

Lisa Chasan-Taber
University of Massachusetts Amherst, lct@schoolph.umass.edu

Follow this and additional works at: http://escholarship.umassmed.edu/cts_retreat

Part of the Biochemical Phenomena, Metabolism, and Nutrition Commons, Clinical Epidemiology Commons, Endocrinology, Diabetes, and Metabolism Commons, Epidemiology Commons, Exercise Science Commons, Female Urogenital Diseases and Pregnancy Complications Commons, Maternal and Child Health Commons, Nutritional and Metabolic Diseases Commons, Translational Medical Research Commons, and the Women's Health Commons

This work is licensed under a Creative Commons Attribution-Noncommercial-Share Alike 3.0 License.
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

- Population with complicated pregnancy
- Healthy population
- Threshold for vascular or metabolic disease

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

- **High Risk Pregnant Women**
- **Pregnancy**
  - Maternal Outcomes
    - Gestational diabetes
    - Hypertension
  - Neonatal Outcomes
    - Large for gestational age
    - NICU admission
  - Delivery
    - Maternal Outcomes
      - Type 2 diabetes
      - Postpartum weight retention
      - CVD risk factors
  - 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?
Physical Activity During Pregnancy

- 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

State Overall: 133

Western Region
- 452* discharge per 100,000
- 118*
- 396*

Massachusetts
- 368* discharge per 100,000
- 242*
- 114*
- 45*

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
Proyecto Buena Salud

NIH/NIDDK R01 DK064902

N=1,626 pregnant Hispanic Women

Pl: Chasan-Taber, Co-I: Pekow, Markenson, Braun, Buonnaccorsi, Dole
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 answer an Ordinary No. 2 pencil. Fill in the circle best for you. The Quest will be read by at least 3.5 hours per week. 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. 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
   - O 3 or more hours per day

It is very important that you tell us about yourself. Are you going to take the test the first or last day of the trimester?

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

2. Preparing meals (cooking, cleaning, washing 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, brushing, feeding children while you are 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

6. 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

7. Playing with children while you are walking or standing:
   - 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. 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

12. Watching television or a computer:
    - 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. Going places:
    - 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

Going Places:

20. Walking slowly to go places (such as to the bus, work, school, 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

21. Walking very slow (Not 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. Waiting for someone:
    - 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. Going places:
    - 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

For Fun or Exercise...

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

26. Walking very slowly (Not 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

27. Cycling:
    - 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. Stretching:
    - 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. Dancing:
    - 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. Doing other things for fun or exercise? Please tell us what they are:
    - 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. Are you a homemaker, out of work, or unable to work, you do not need to complete this last section.

At Work...

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 at work (heavier than a 1 kilogram milk jug):
    - 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 at work (not carrying anything):
    - 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

35. Walking quickly 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

Page 1

Page 2

Page 4
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>During Pregnancy (n=1,581)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GDM</td>
<td>Abnormal Glucose Tolerance</td>
</tr>
<tr>
<td></td>
<td>Cases (n)</td>
<td>Adjusted OR* (95% CI)</td>
</tr>
<tr>
<td>Sedentary lifestyle (total activity</td>
<td>63 1.0 (Referent)</td>
<td>235 1.0 (Referent)</td>
</tr>
<tr>
<td>2 h/wk or less)</td>
<td>13 1.44 (0.70–2.96)</td>
<td>41 1.22 (0.83–1.81)</td>
</tr>
<tr>
<td>Not sedentary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedentary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television viewing (h/d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2</td>
<td>46 1.0 (Referent)</td>
<td>184 1.0 (Referent)</td>
</tr>
<tr>
<td>2 or more</td>
<td>30 1.28 (0.75–2.18)</td>
<td>92 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>Total</td>
<td>100</td>
<td>1.20 (1.14-1.27)</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

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
Tip Sheets

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

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

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
Change in Total PA from Pre to Post Intervention

### Met-hrs/wk

- **Exercise Arm**: 5.2 Met-hrs/wk (~1 hr 20 min)
- **Health & Wellness Arm**:

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

### Change in Sports/Exercise from Pre to Post Intervention

<table>
<thead>
<tr>
<th>Time Point</th>
<th>MET-hrs/wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>1.3 MET-hrs/wk, ~20 min</td>
</tr>
<tr>
<td>Post</td>
<td>1.3 MET-hrs/wk, ~20 min</td>
</tr>
</tbody>
</table>

**Exercise Arm**

**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 and weeks.](image-url)
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 → Preexisting type 2 diabetes

Acknowledgements

Collaborators:
- Milagros Rosal, UMASS Medical Center
- Tiffany Moore Simas, UMASS
- Caren Solomon MD, Harvard University
- JoAnn Manson MD, Harvard University
- Bess Marcus PhD, UCSD
- Glenn Markenson MD, Baystate Medical Ctr
- Sarah Goff MD, Baystate Medical Center
- Katherine Tucker, PhD UMASS Lowell
- Patty Freedson PhD, UMASS
- Penelope Pekow PhD, UMASS
- Barry Braun PhD, UMASS
- Edward Stanek PhD, UMASS

Post Doctoral Fellows:
- Marquis Hawkins

Doctoral Students:
- Megan Ward Harvey
- Marushka Silveira
- Kathleen Szegda
- Carrie Nobles

Funding Agencies:
- NIH/NIDDK, ASPH/CDC, American Diabetes Association
Thank You