PREGNANCY SMOKING AND CHILD OUTCOMES FROM BIRTH TO 15 MONTHS: FINDINGS FROM NORTHEAST TENNESSEE

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OVERVIEW

- Previous studies linking prenatal cigarette exposure to child outcomes
- Regional rates & birth outcomes
- TIPS – pregnancy smoking intervention program
- TIPS participants: Smoking-related outcomes at birth
- TIPS participants: Smoking-related outcomes at 15 months
WHAT DO WE KNOW?

- Smoking during pregnancy has been definitively indicated as a causal factor in poor birth outcomes.
- Biggest impact has been seen on birth weight:
  - decrements of ~250gm for any level of smoking
  - up to ~400gm for heavier smoking
- Lesser, but significant impact on preterm delivery – up to 10 days early for heavier smoking (indicates growth restriction mechanism)
- Significantly decreased Apgar scores, and increased rates of NICU admissions are seen for babies born to smokers
WHAT DO WE KNOW?

- Smoking during pregnancy has also been linked to growth and health into childhood.
- Multiple studies have shown that effects of prenatal smoke exposure on growth continue into childhood, even after controlling for postnatal smoke exposure.
- By age 7, children with prenatal smoke exposure still have not caught up in stature – an inch or more shorter on average, with significantly decreased head circumferences compared to those without exposure.
WHAT DO WE KNOW?

- Smoking during pregnancy also significantly increases the risk of many health problems into childhood and adolescence including:
  + SIDS
  + Asthma
  + Allergies
  + Respiratory infections
  + Ear infections

- Effects are evident even without, or controlling for, postnatal smoke exposure
WHAT DO WE KNOW?

- Beyond health and growth effects, dozens of studies have linked prenatal smoke exposure to developmental problems.
- Exposure increases the risk for cognitive and language delays, and behavioral and emotional problems in childhood and through to adulthood.
- The magnitude of these effects is as large or larger than effects seen for other prenatal exposures including alcohol, marijuana, illicit drug use, and abuse of prescription drugs; and due to the relative prevalence of cigarette smoking, these effects are much more common.
WHAT DO WE KNOW?

- Several studies have noted a decrease in overall IQ of nearly 10 points due to prenatal smoke exposure.
- Language delays of a year or more have been noted.
- Rates of attention problems, including a 50% increased rate of ADHD diagnosis have been reported in many studies.
WHAT DO WE KNOW?

- Children with prenatal cigarette exposure have elevated levels of depression and anxiety disorders.
- Substantially increased rates of conduct problems, including ODD and encounters with juvenile authorities.
- Greatly increased risk for later smoking and substance use, as well as increased likelihood of addiction.
WHAT DO WE KNOW?

- The mechanisms by which smoking during pregnancy may impact child development have not been fully elucidated.
- We do know that decreased oxygen from the smoke itself plays a role; the nicotine and other chemicals in cigarettes also have been shown to impact the development of neurotransmitters and receptor sites.
- We also know that the amount of cigarette exposure and the timing of the exposure are important.
WHAT DO WE KNOW?

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- Many studies have found a dose response between prenatal smoke exposure and outcomes – especially between 2 and 10 cig/day
- More cigarettes per day = worse outcomes
- No real threshold – have seen effects with as few as 2 cigarettes per day; issue of underreporting means this may not be entirely accurate though
- However, greatest effects seen at a half a pack/day or more
WHAT DO WE KNOW?

- There is not yet a definitive answer on how the timing of pregnancy smoking impacts outcomes.
- For most exposures, early pregnancy exposure is more harmful than later exposure.
- For cigarette exposure, this does not appear to be the case for all outcomes.
- Effects on growth and health appear to occur mostly with late pregnancy exposure; small scale studies and animals models.
- However, some evidence suggests that early exposure may have more subtle effects; but reports are mixed.
WHAT DO WE KNOW?

- What we know about the effects of prenatal smoke exposure, as well as dose and timing are important for intervention efforts.
- Suggests that quitting smoking by 20-27 weeks may lead to significant health benefits.
- Also suggests that even cutting down on the number of cigarettes/day can be beneficial.
- Further research is needed.
PRELIMINARY WORK

- Nationally, 12% of pregnant women smoke
- In Tennessee, rate is 17%
- Suspected the rate in NE TN was much higher, but in 2007 no published data; small scale practice-based studies suggested 25% or more
- Undertook a delivery chart review at local hospitals to find out regional rates
Local Pregnancy Smoking Rates by Delivery Hospital and Year

<table>
<thead>
<tr>
<th>Hospital</th>
<th>2006</th>
<th>2007</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCMC</td>
<td>31.4%</td>
<td>33.0%</td>
<td>↑1.6%</td>
</tr>
<tr>
<td>JCSH</td>
<td>14.5%</td>
<td>17.1%</td>
<td>↑2.6%</td>
</tr>
<tr>
<td>Indian Path</td>
<td>29.7%</td>
<td>37.5%</td>
<td>↑7.8%</td>
</tr>
<tr>
<td>Sycamore Shoals</td>
<td>42.5%</td>
<td>37.6%</td>
<td>↓4.9%</td>
</tr>
</tbody>
</table>
PRELIMINARY WORK

- Is smoking a significant predictor of child outcomes in the region?
- Looked all women who gave birth to live-born singletons at JCMC & JCSH in 2006 & 2007
- Sample contained 4144 women and their newborns, representative of regional demographics (largely Caucasian, and disadvantaged (50% plus on Medicaid))
- Data were extracted from electronic delivery logs at each facility
## PRELIMINARY WORK

- 25% of the women self-reported as smokers at delivery
- The rates of low birth weight and preterm deliveries were much higher than national averages

<table>
<thead>
<tr>
<th>Birth Outcome</th>
<th>Non-Smokers</th>
<th>Smokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight (gm)</td>
<td>3299</td>
<td>2965</td>
</tr>
<tr>
<td>LBW (%)</td>
<td>8.6%</td>
<td>18.4%</td>
</tr>
<tr>
<td>Birth Length (in)</td>
<td>19.8</td>
<td>19.2</td>
</tr>
<tr>
<td>Gestational Age (wks)</td>
<td>38.4</td>
<td>37.7</td>
</tr>
<tr>
<td>PTB (%)</td>
<td>11.1%</td>
<td>18.8%</td>
</tr>
<tr>
<td>NICU Admission (%)</td>
<td>7.5%</td>
<td>14.6%</td>
</tr>
</tbody>
</table>

All differences significant at p<.05 after control for background factors

In January of 2007, the Tennessee Governor’s office strengthened efforts to improve birth outcomes in the region and funded the Tennessee Intervention for Pregnant Smokers (TIPS) program for four years; recently refunded through June 2012.

TIPS is a multi-faceted approach that aims to reduce pregnancy smoking rates and improve birth outcomes in the 6 counties of NE TN.

[www.etsu.edu/tips](http://www.etsu.edu/tips)
THE INTERVENTION

The program involves:

1) **Physician training** in providing smoking cessation counseling as a routine part of prenatal care

2) **Nurse training** in providing smoking cessation counseling as part of inpatient & outpatient services

3) Provision of prenatal counseling and case management services

4) Provision of a **hospital-based counselor/case manager** for admitted high-risk women and those post-partum

5) **Education and training programs** for nursing, public health, respiratory therapy, and medical students

6) Community-based education and cessation workshops

7) Development of **self-help materials**

6 FT staff, 2 PT staff; 2 FTE+ in students each term
THE INTERVENTION

All TIPS services are available to prenatal patients in NE TN who:

- Are Current smokers
- Are Exposed to significant secondhand smoke
- Are Former smokers ≤ 2 years smoke-free

Trained prenatal care providers offer:

- Brief smoking cessation advice and assistance (5 A’s)
- Referrals to TIPS Case Managers

Case Managers provide:

- Smoking cessation counseling & support
- TIPS self-help materials
- Support for the reduction of life stressors including domestic violence
- Referrals to other needed services
THE INTERVENTION

- Substantial research component – to evaluate project AND to permit long term study of effects of prenatal smoke exposure

- Phase I (1st 3.5 years)
  - In depth interviews in 1st and 3rd trimesters: detailed demographics and smoking history, alcohol and substance abuse, depression, IPV, social support, stress, self-esteem, smoking effects knowledge, ADD screen, temperament, religiosity; biochem verification
  - Briefer interviews at 6 wks and 6 mo post-partum; medical chart reviews

- Phase I (Years 3.5 on)
  - Briefer interviews 4 times during pregnancy; 6 wk, 6 mo PP; medical chart reviews

- All singleton children eligible for developmental assessment at 15 months: health and environment, cognitive, language, behavioral, motor, assessments; maternal assessment of verbal IQ and psychosocial factors including parenting
THE INTERVENTION

- **Phase I (1st 3.5 years)**
  - Over 1200 women received case manager services; 5000+ received care from trained providers
  - 405 TIPS-eligible women (plus 176 non-smoker controls) participated in the research
  - Of the 581 research participants, maintained over 400 to 6 mo PP

- **Phase II**
  - To date nearly 800 received case manager services
  - 232 have participated in the research
  - Developmental assessment: 150+ tested to date; finding about 65%, of those over 90% are participating
A recent meta-analysis of pregnancy smoking cessation interventions revealed a 15.1% quit rate by delivery for interventions comparable to or more intense than the TIPS equivalent of 4 or more Case Manager sessions (Lumley et al., 2008).
INTERVENTION SUCCESS

- In 3 years, pregnancy smoking rates by delivery dropped 18% across all practices with case management services, 10% in practices with trained providers and no case management.
- Working with a case manager over multiple sessions proved particularly effective for smoking cessation, quit attempts, and reduction, as did provision of stress management assistance, mental health referrals, and family smoking cessation efforts.
Since the beginning of the TIPS project in mid-2007, pregnancy smoking rates in the region have decreased 20.2%, compared to a statewide decrease of only 2.1% during that time.

Also during that time, preterm birth rates have dropped 24.6%, and low birth weight rates have dropped 19.4%. Statewide, rates on low birth weight births have only dropped only 4.2%.
## INTERVENTION SUCCESS

### Birth Outcomes by Quit Status

<table>
<thead>
<tr>
<th>Birth Variables</th>
<th>Quit Smoking (n=307)</th>
<th>Kept Smoking (n=801)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low birth weight (%)</td>
<td>11.0%</td>
<td>17.3%</td>
<td>.009</td>
</tr>
<tr>
<td>Preterm birth (%)</td>
<td>14.5%</td>
<td>16.0%</td>
<td>.075</td>
</tr>
</tbody>
</table>
What is the impact of pregnancy smoking relative to the use of other substances?

Intervention resources have necessarily been devoted to helping substance using pregnant women become drug free.

Unfortunately, the vast majority of pregnant women who successfully quit using illicit drugs continue to smoke.

Health providers often fail to adequately address smoking during pregnancy with these women, citing the belief that illicit drug use is much more harmful to the fetus than smoke exposure, and the need to save limited time available to focus on that drug use and other negative health behaviors.
Due to the magnitude of effects of prenatal cigarette exposure and the relative prevalence, a recent population-based study found that the elimination of smoking would have a much greater impact on decreasing poor birth outcomes than elimination of any other substance.

However, few studies have quantified the relative impact on birth outcomes of different prenatal exposures.

Such information in the regional population is essential.
Looked at the data from research participants who had delivered.

Not wanting to rely on self-report for illicit drug use (may be substantial under-reporting), restricted the sample to infants who had biological testing for substances at delivery (meconium) [oversampled substance users].

Final sample contained 265 infants:
- No cigarette/no drug use (n=46)
- Cigarette use only (n=75)
- Illicit drug use only (n=21)
- Cigarette & illicit drug use (n=123)

Drugs examined included amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, and opioids.
### BIRTH OUTCOMES

Substance Use Group Differences on Primary Birth Outcomes

<table>
<thead>
<tr>
<th>Substance Use Group</th>
<th>Birth Weight (gm)</th>
<th>Gestational Age (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Cig/No Drug</td>
<td>3232</td>
<td>38.9</td>
</tr>
<tr>
<td>Cigarette Only</td>
<td>3068</td>
<td>38.7</td>
</tr>
<tr>
<td>Illicit Drug Only</td>
<td>3054</td>
<td>38.1</td>
</tr>
<tr>
<td>Cig AND Drug</td>
<td>2954</td>
<td>38.5</td>
</tr>
<tr>
<td>F, p</td>
<td>3.70, p=.012</td>
<td>.89, p=.447</td>
</tr>
</tbody>
</table>

Effect for birth weight controlled for significant confounders (education, preeclampsia, race): F=4.55, p=.004
Adjusted Birth Weights for the 198 Smokers:

- Smoked Only (n=75) 3065 gm
- Smoked AND Used Marijuana (n=39) 3068 gm
- Smoked AND Hard Illicit Drug Use (n=84) 2902 gm

Test for group difference: F=3.39, p=.036

Adjusted Birth Weight Difference = 163 gm

Interpretation: Compared with those who both smoked and used hard illicit drugs, those who smoked but DID NOT USE HARD ILLICIT DRUGS had a 163gm gain in adjusted birth weight – a 5.6% difference.
Adjusted Birth Weights for the 105 Hard Illicit Drug Users:

- Hard Drug Use Only (n=21) 3207 gm
- Hard Drug Use AND Smoked (n=84) 2890 gm

Test for group difference: F=6.28, p=.014

Adjusted Birth Weight Difference = 317gm

Interpretation: Compared with those who both smoked and used hard illicit drugs, those who used hard illicit drugs BUT DID NOT SMOKE had a 317 gm gain in adjusted birth weight – an 11.0% difference.
BIRTH OUTCOMES

Effect of BOTH Smoking AND Hard Illicit Drug Use on Birth Weight

Adjusted Birth Weights:

- No smoking/No Drug Use (n=46) 3248 gm
- Smoked AND Hard Drug Use (n=84) 2896 gm

Test for group difference: F=17.42, p<.001

Adjusted Birth Weight Difference = 352 gm

Interpretation: Compared with those who both smoked and used hard illicit drugs, those who USED NEITHER SUBSTANCE had a 352 gm gain in adjusted birth weight – a 12.2% difference.
Pregnancy substance use was NOT associated with early delivery in the current sample.

Pregnancy marijuana use did not adversely impact birth weight BEYOND the effects of cigarette smoking.

This finding suggests that for pregnant women who both smoke and use marijuana, quitting marijuana use while continuing to smoke will not lead to improved birth outcomes.
Pregnancy smoking had twice the impact on birth weight as illicit drug use.

Findings support the assertions of those who have suggested that pregnancy smoking may be at least as detrimental to the developing fetus as the use of many illicit drugs.

Findings also support the need to direct more attention toward increasing pregnancy smoking cessation efforts.

Pregnant women should be strongly advised of the risks of continued smoking, and should be assisted in their efforts to eliminate the use of ALL substances, including tobacco.

DEVELOPMENTAL TESTING

- Project participants are invited to participate in our developmental follow-up study when the children are 15 months of age.
- Assessment takes about 2.5 hours, in addition to the questionnaires the mothers are asked to complete prior to the appointment.

- Child lab assessments include:
  - Battelle
  - REEL-3
  - Test of Sensory Function

- Maternal report of child development:
  - Infant Toddler Sensory Profile
  - CSBS DP Infant-Toddler Checklist
  - Toddler Behavior Assessment Questionnaire
DEVELOPMENTAL TESTING

- Approximately 65% of eligible participants have been located at 15 months; over 90% have participated.
- To date, have tested over 150 children.
- Data from first 142 on select outcomes presented here (85 smoking at conception).
- Findings preliminary until all 200+ are tested and data finalized.
<table>
<thead>
<tr>
<th>Background Factor</th>
<th>Quit Smoking (n=35)</th>
<th>Kept Smoking (n=50)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age</td>
<td>23.1</td>
<td>23.8</td>
<td>NS</td>
</tr>
<tr>
<td>Maternal education</td>
<td>12.6</td>
<td>11.8</td>
<td>.019</td>
</tr>
<tr>
<td>Maternal marital status (% married)</td>
<td>40%</td>
<td>28%</td>
<td>.089</td>
</tr>
<tr>
<td>Parity</td>
<td>1.8</td>
<td>1.9</td>
<td>NS</td>
</tr>
<tr>
<td>Prenatal alcohol exposure</td>
<td>26%</td>
<td>22%</td>
<td>NS</td>
</tr>
<tr>
<td>Prenatal marijuana exposure</td>
<td>26%</td>
<td>44%</td>
<td>.067</td>
</tr>
<tr>
<td>Prenatal hard illicit drug exposure</td>
<td>10%</td>
<td>12%</td>
<td>NS</td>
</tr>
<tr>
<td>Postnatal smoke exposure</td>
<td>23%</td>
<td>52%</td>
<td>.006</td>
</tr>
<tr>
<td>Maternal IQ</td>
<td>96.3</td>
<td>94.5</td>
<td>NS</td>
</tr>
</tbody>
</table>
# GROWTH & HEALTH DIFFERENCES

<table>
<thead>
<tr>
<th>Birth Variables</th>
<th>Quit Smoking (n=35)</th>
<th>Kept Smoking (n=50)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (gm)</td>
<td>3334</td>
<td>3071</td>
<td>.045</td>
</tr>
<tr>
<td>Low birth weight (%)</td>
<td>5.7%</td>
<td>12.2%</td>
<td>.096</td>
</tr>
<tr>
<td>Preterm birth (%)</td>
<td>5.7%</td>
<td>10.2%</td>
<td>NS</td>
</tr>
<tr>
<td>NICU admission (%)</td>
<td>6.1%</td>
<td>11.4%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note: Means and percentages adjusted for maternal education and marital status, and for prenatal marijuana exposure
# GROWTH & HEALTH DIFFERENCES

<table>
<thead>
<tr>
<th>15 Month Variables</th>
<th>Quit Smoking (n=35)</th>
<th>Kept Smoking (n=50)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (lb)</td>
<td>23.9</td>
<td>22.1</td>
<td>.076</td>
</tr>
<tr>
<td>Height (in)</td>
<td>30.6</td>
<td>28.9</td>
<td>.049</td>
</tr>
<tr>
<td>Hospitalization (% 1x+ since birth)</td>
<td>12.0%</td>
<td>25.7%</td>
<td>.009</td>
</tr>
<tr>
<td>Sick child visits (% 4x+ since birth)</td>
<td>20.0%</td>
<td>37.1%</td>
<td>.040</td>
</tr>
<tr>
<td>Respiratory infection (% 1+)</td>
<td>24.0%</td>
<td>48.6%</td>
<td>.017</td>
</tr>
<tr>
<td>Ear infection (% 1+)</td>
<td>51.4%</td>
<td>54.0%</td>
<td>NS</td>
</tr>
<tr>
<td>Diagnosed with allergies (%)</td>
<td>12.0%</td>
<td>22.9%</td>
<td>.091</td>
</tr>
<tr>
<td>Diagnosed with asthma (%)</td>
<td>11.4%</td>
<td>16.0%</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note: Means and percentages adjusted for maternal education and marital status, and for prenatal marijuana exposure, and postnatal smoke exposure.
### DEVELOPMENTAL OUTCOME DIFFERENCES

<table>
<thead>
<tr>
<th>15 Month Outcomes</th>
<th>Quit Smoking (n=35)</th>
<th>Kept Smoking (n=50)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Motor (%ile)</td>
<td>53.1</td>
<td>47.1</td>
<td>NS</td>
</tr>
<tr>
<td>Fine Motor (%ile)</td>
<td>63.0</td>
<td>55.3</td>
<td>.086</td>
</tr>
<tr>
<td>Receptive Language (%ile)</td>
<td>56.4</td>
<td>50.5</td>
<td>.079</td>
</tr>
<tr>
<td>Expressive Language (%ile)</td>
<td>51.4</td>
<td>44.8</td>
<td>.054</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>103.8</td>
<td>94.0</td>
<td>.032</td>
</tr>
<tr>
<td>Attention and Memory (%ile)</td>
<td>54.7</td>
<td>42.1</td>
<td>.025</td>
</tr>
<tr>
<td>Social-Adult Interaction (%ile)</td>
<td>78.3</td>
<td>71.9</td>
<td>.070</td>
</tr>
<tr>
<td>Social-Communication (%ile)*</td>
<td>48.2</td>
<td>34.9</td>
<td>.034</td>
</tr>
</tbody>
</table>

**Note:** Means and percentages adjusted for maternal education and marital status, and for prenatal marijuana exposure, and postnatal smoke exposure.

* - All assessments were laboratory assessments with the exception of Social-Communication which was from the parent-report CSBS.
CONCLUSIONS

- Smoking during pregnancy is highly prevalent in NE TN and contributes to poor birth outcomes
- Pregnancy smoking interventions can be highly effective at reducing smoking rates and improving outcomes
- Quitting smoking by the third trimester can lead to an improvement in birth outcomes, and better developmental outcomes at 15 months
- Even if a woman smokes early in pregnancy, quitting by the third trimester can significantly reduce the risk for poor outcomes and should be encouraged
ACKNOWLEDGEMENTS

- Jessica Scott, MA – Infant Tester
- Erin Chambers, MBA – Developmental Study Coordinator
- Lana McGrady, MS – TIPS project Study Manager
- All of the TIPS participants and their children
- Reference list is available on request
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