Growing Up in Ireland
National Longitudinal Study of Children

Prenatal Smoking and Childhood Behavioural Problems: A Quasi-Experimental Approach

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Introduction

- Prenatal smoking is associated with a large number of perinatal and neonatal complications.

  (e.g. Cnattinghus, 2004).

- Numerous studies indicate that exposure to prenatal smoking raises the risk of childhood behavioural problems

  (e.g. Brion et al, 2010; Hutchinson et al, 2010; Obel et al, 2009)

- ...And psychopathology in adolescence and adulthood

  (e.g. Rasanen et al, 1999; Weissman et al, 1999; Brennan et al, 2002)

<u>BUT</u>: is the effect direct and causal or due to the association of smoking with other factors?

A Causal Relationship?

Cigarettes contain many harmful compounds:

- Nicotine
- Sulphides
- Cyanide
- Cadmium
- Carcinogenic hydrocarbons

- Can cause cellular damage and alterations in placental biology and placental function (Jauniaux & Burton, 2007)

- Exposure to nicotine has effects on receptor binding and transmission (Shea & Steiner, 2008)

A Causal Relationship?

Direct evidence from human studies of effects of cigarette smoking on foetal development.

- Prenatal exposure linked with increased irritability and hypertonicity at birth and 27 days of age (Stroud et al, 2009).
- Heightened tremors and startles (Fried et al, 1989)
- Lags in the neonate's response to auditory stimuli (Key et al, 2007).

These may serve as early markers of compromised neurodevelopment that may contribute to behavioural problems (both direct and indirect pathways)

Environmental Confounding?

Association may actually result from the correlation of smoking with other characteristics or processes that influence child behaviour

Epidemiological studies

- Hutchinson et al (2010) – significantly higher risks at 3 years of age in MCS controlling for a wide range of confounders (n=13,788).
- Lavigne et al (2011) - no residual effect after controlling for 'critical' confounding factors with 679 US pre-schoolers.
- Roza et al (2009) - compared prenatal to passive smoking and found no effect after adjustment

Genetic Confounding?

Association may actually result from the transmission of genotypes which are associated with a predisposition to smoking and behavioural problems

Twin studies

- Maughan et al (2004) - prenatal smoking not a proxy for genetic risk but may not be a unique cause of childhood behavioural problems.

Sibling Comparison Studies

- D'Onofrio et al (2008) used NLSCY data and differential exposure – smoking accounted for 0.1% difference between siblings in conduct problems.

Quasi-experimental

- Boutwell and Beaver (2010) use ECLS-B and show complete attenuation in externalising problems using Propensity Score Matching

Hypotheses

The present study utilises retrospective cross-sectional data to examine the relationship between prenatal smoking and childhood behavioural problems.

1. Prenatal smoking will be associated with increased risk for behavioural problems.

2. The effect will be resilient to controls for confounding variables.

3. The effect will be dose-dependent.

Sample

- 8,568 nine-year old children participating in the Growing Up in Ireland Project.
- Selected through the school system using a Probability Proportionate to Size (PPS) sampling method with schools serving as the primary sampling units (PSU's).
- 1105 schools from the national total of 3,200 primary schools were selected for inclusion.
- 82% response rate at the school level and 57% at the household level (i.e. eligible child selected within the school)
- The data were weighted to be nationally representative

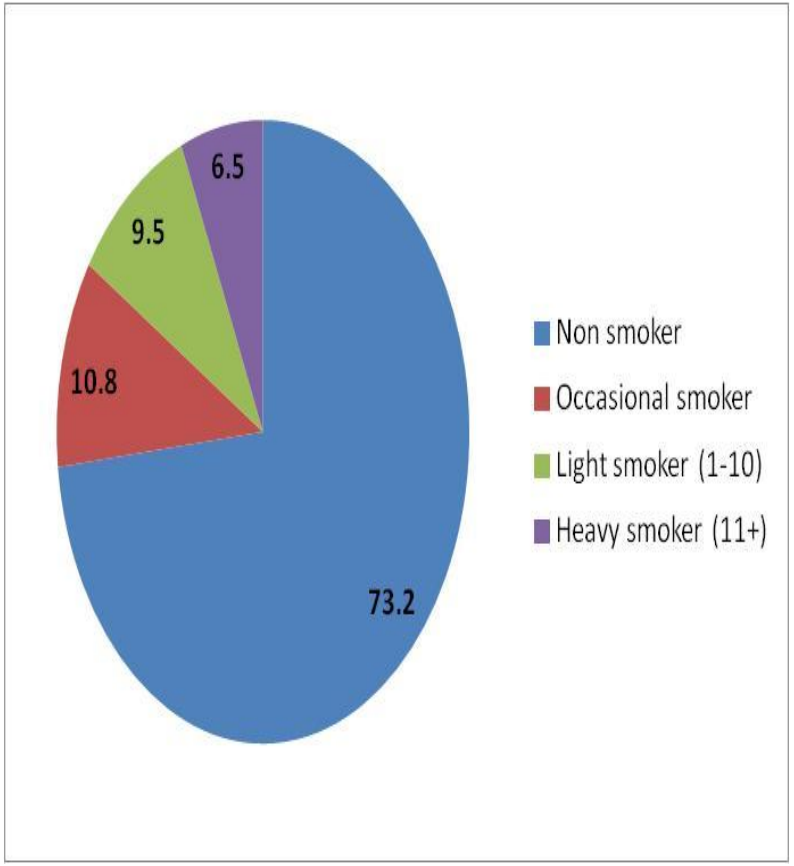
Smoking Measures

Parent self-reported smoking obtained retrospectively
(Never, Occasionally or Daily)

Daily smokers asked how many they smoked daily:
(1-5, 6-10, 11-25, 26+)

Ordinal variable representing different levels of exposure:

- Never smoked
- Occasional
- Light smoker (1-10)
- Heavy smoker (11+)



Childhood Behavioural Problems

Strengths and Difficulties Questionnaire (Goodman 1997)

It is a 25-item behavioural screening questionnaire which generates 5 scale scores:

- Hyperactivity/inattention
- Emotionality
- Conduct problems
- Peer problems
- Pro-social behaviour

Four deficit-focused scales sum to form a **Total Difficulties** score.

Following Goodman, the 90th percentile is used to define children with an 'abnormal' behavioural profile - at risk for a behavioural/psychiatric problem.

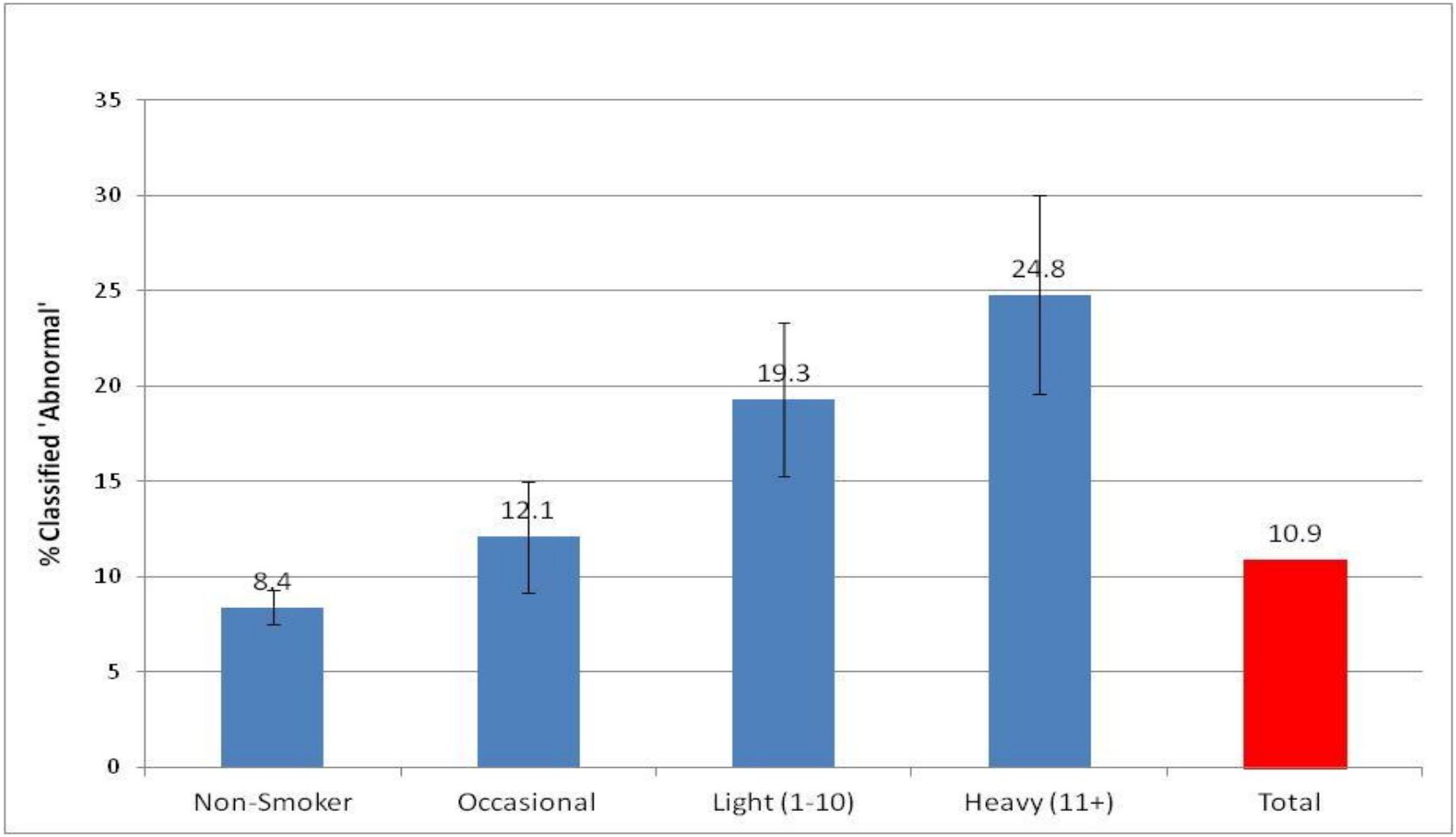
Confounding Variables

- 5 Category CSO Social Class Measure
- Net Household Income using Modified OECD equivalence scale – Income quintiles
- Mother's highest educational level (four groups)
- Maternal age (4 groups) and Ethnicity
- Parent Child Conflict – Pianta scale (12 items)
- Child sex, chronic illness, breastfeeding, birthweight and gestation, ICU at birth
- Negative Life Events: parental divorce/separation, parental drug-use/alcoholism, residential care, mental disorder (summed 0-4)
- Maternal CES-D (8 item)
- Maternal trouble with police

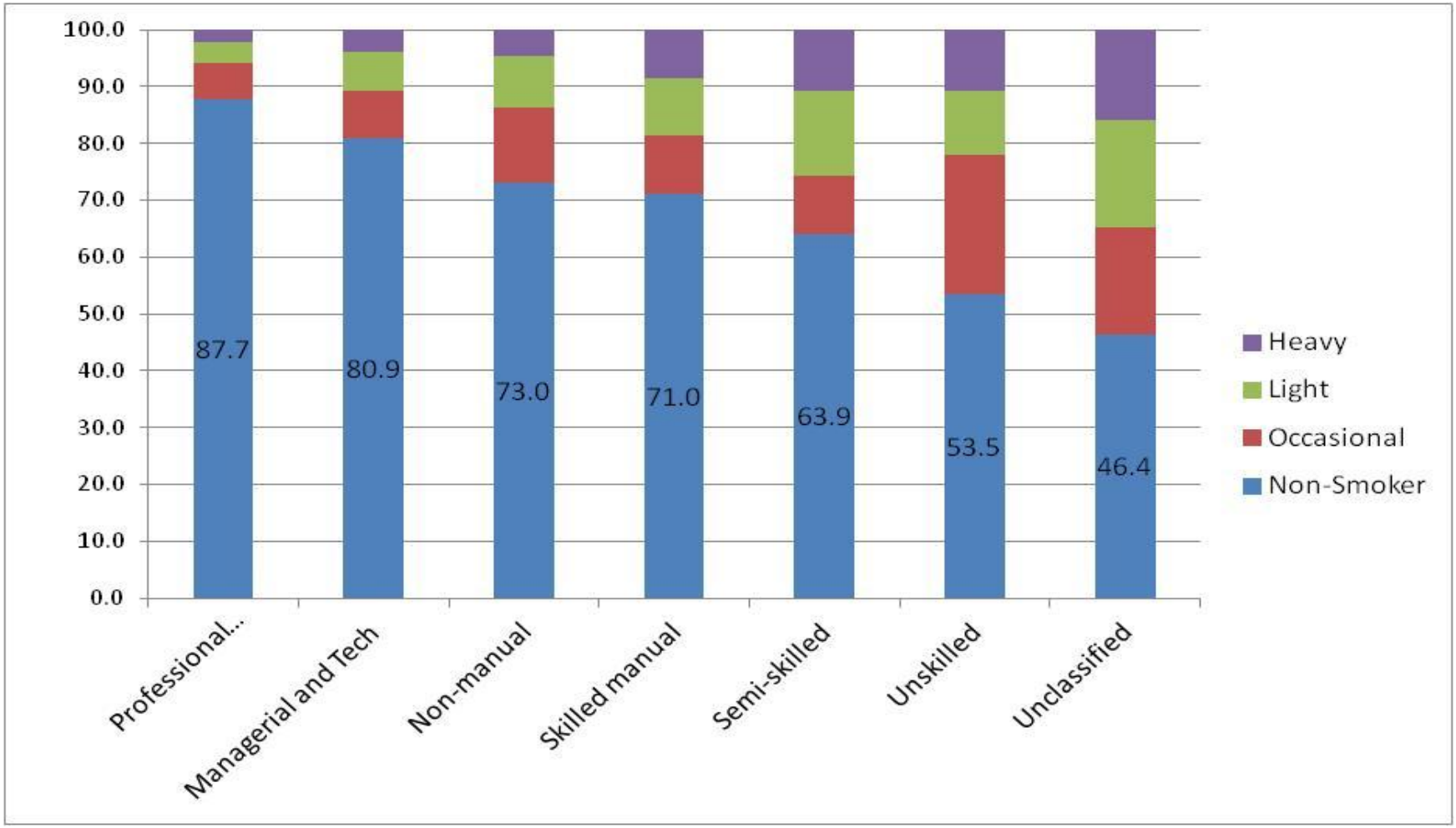
Missing Cases Analysis

- Non-Biological parents not asked smoking questions (n=108)
- A further 142 wouldn't or couldn't answer
- Depression scores missing for 697 cases
- HH income missing for 626 cases
- Multiple imputation by chained regression (Royston) used
- **Final case base (n = 7502)**

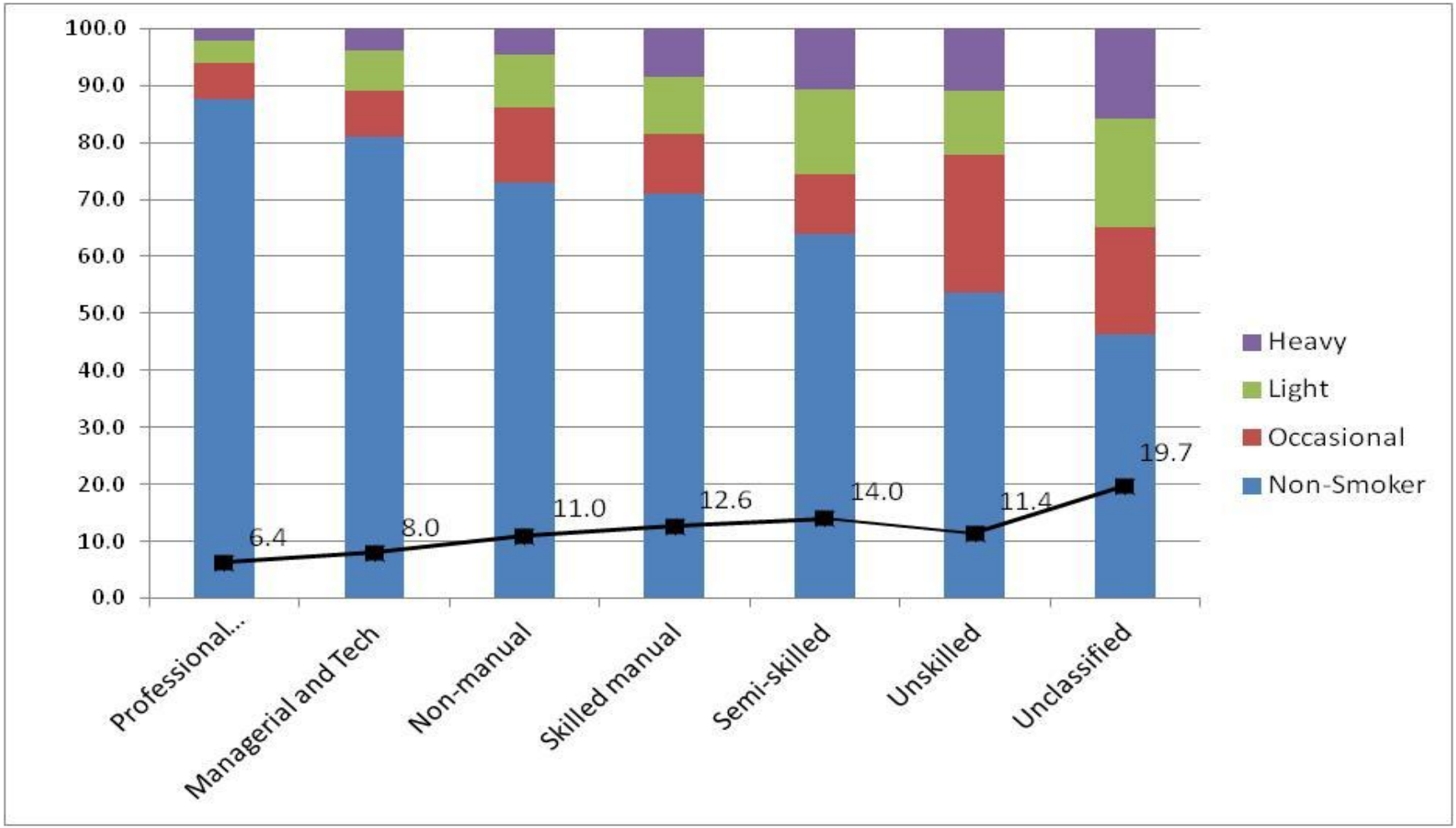
Childhood Behavioural Problems by Prenatal Smoking Status



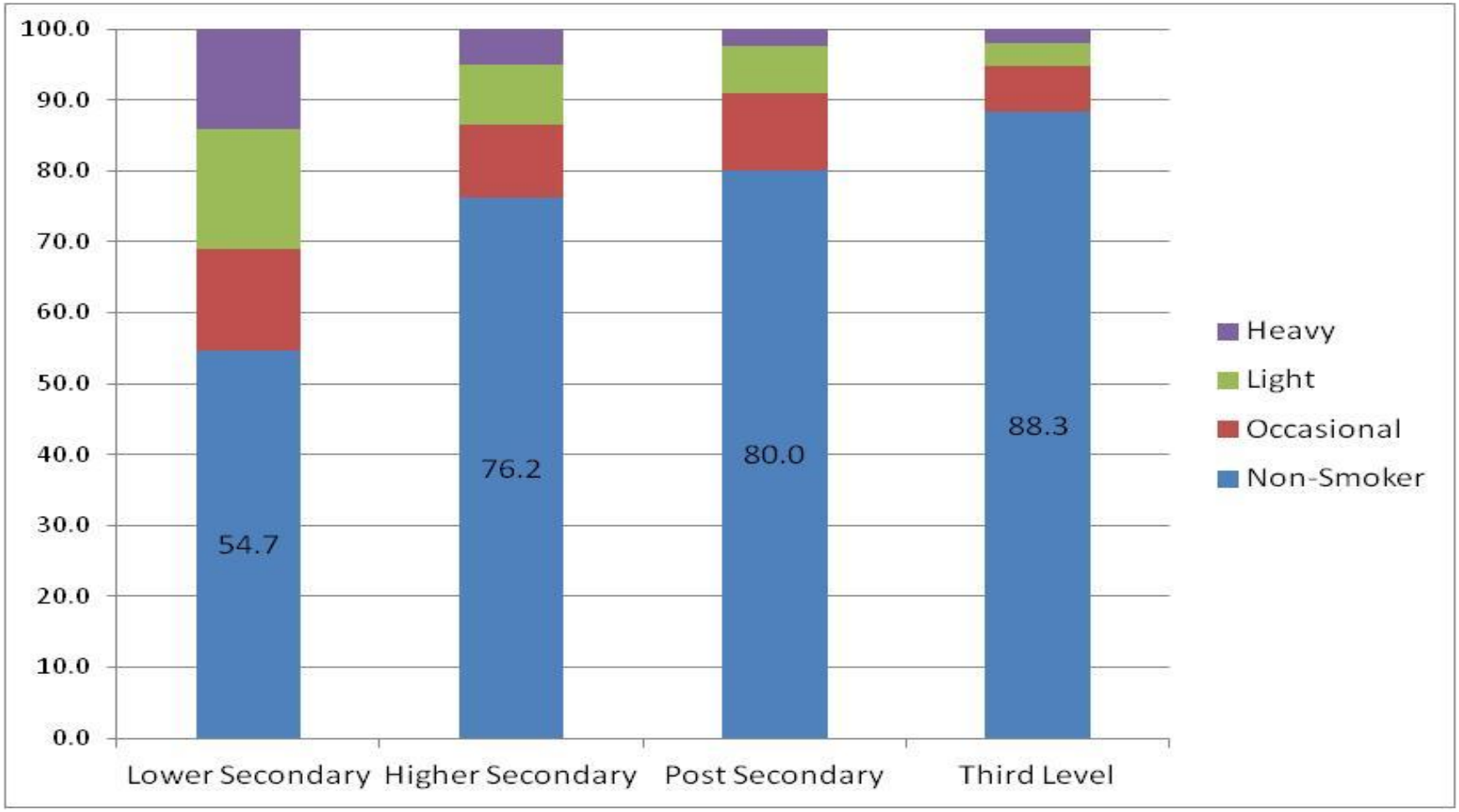
Prenatal Smoking by Household Social Class



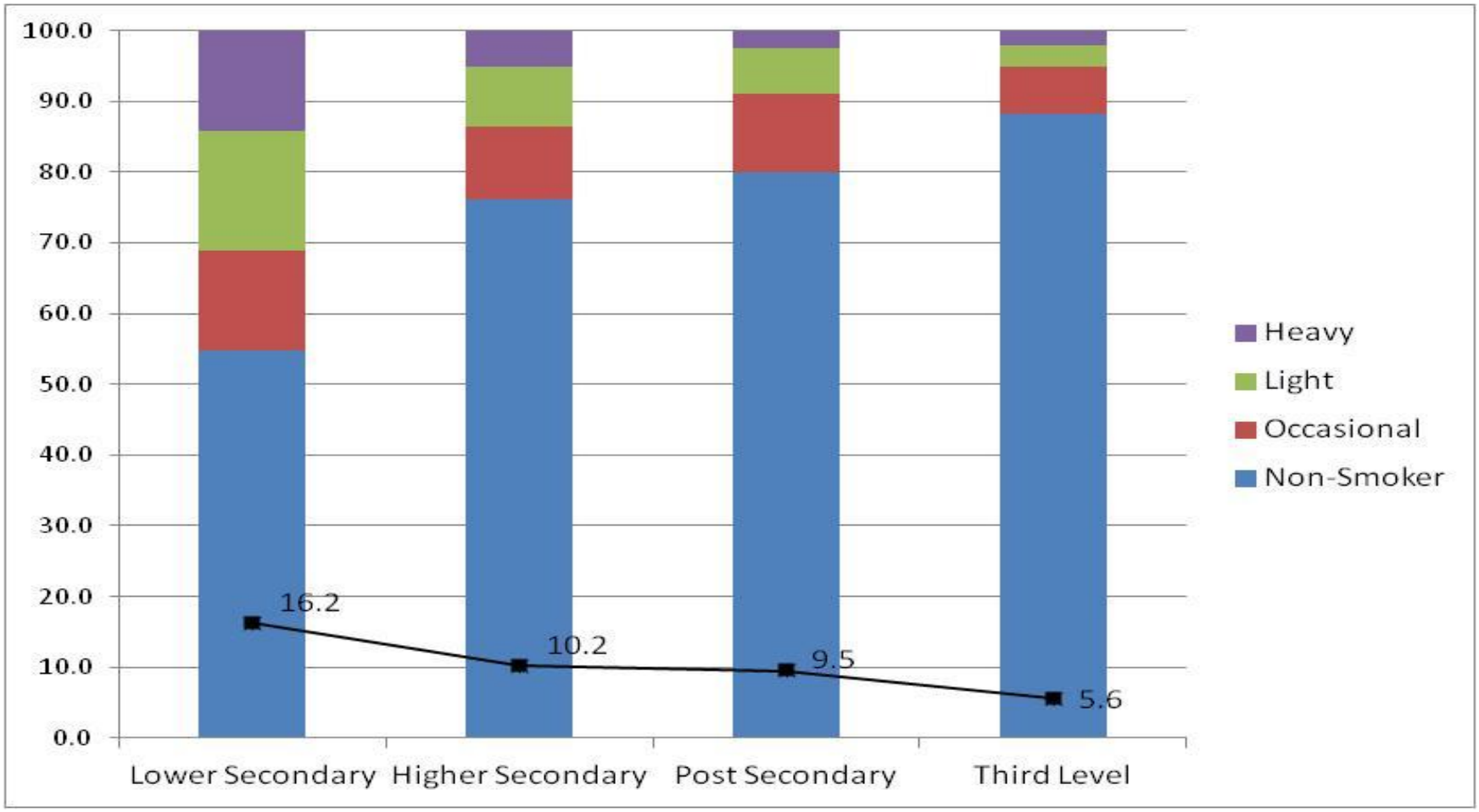
Childhood Behavioural Problems by Household Social Class



Prenatal Smoking by Maternal Education



Childhood Behavioural Problems by Maternal Education



Analysis Strategy

Ideally, RCT methods used to control for confounding

- Not practical or ethical

Could use regression but parametric assumptions around distribution of predictors.

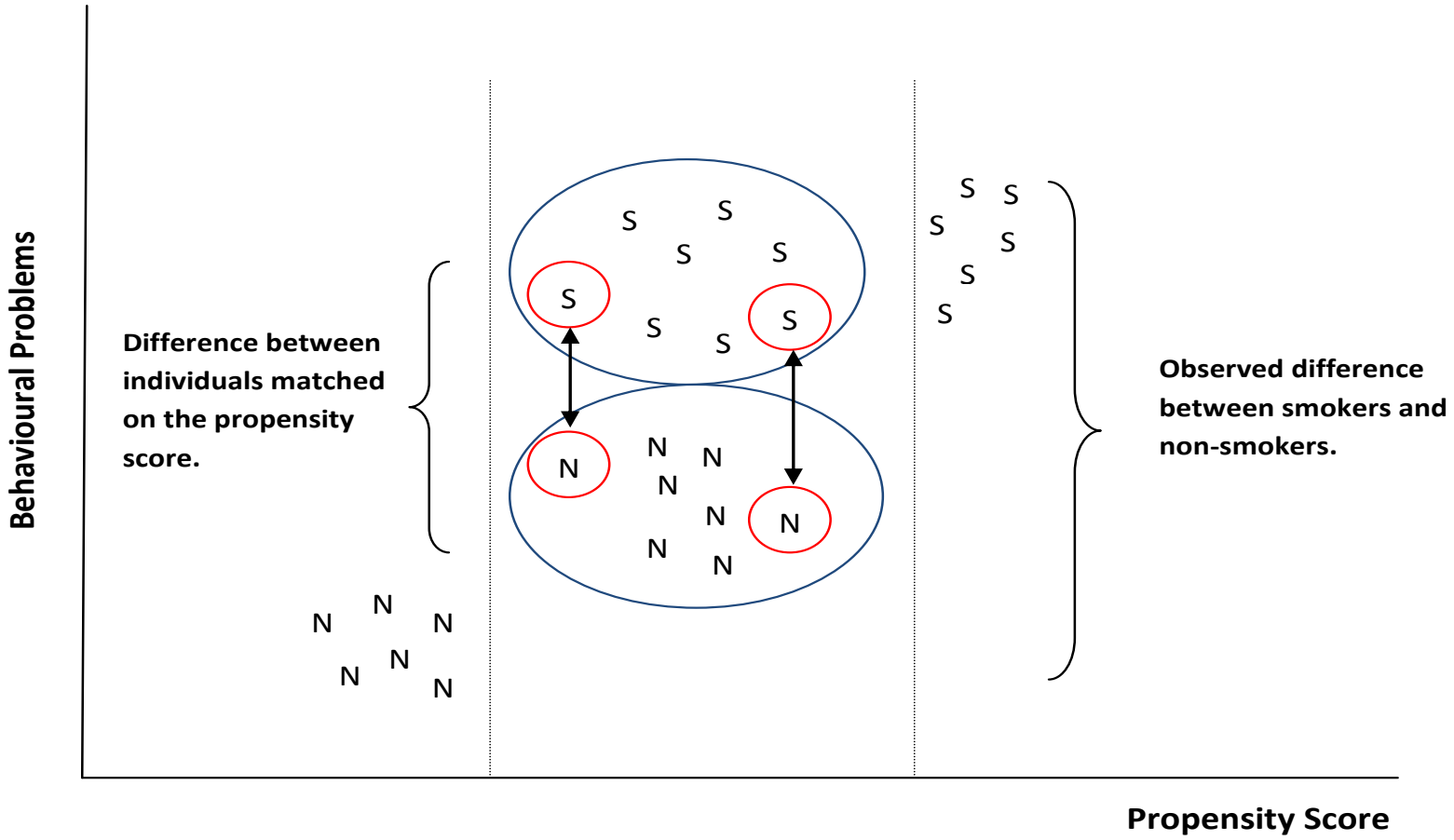
Use Propensity Score Matching

Propensity Score Matching

What would the treatment effect have looked like if we could have randomly assigned individuals to smoking conditions?

- Use the covariates to derive a ‘propensity to smoke’ score.
- Match each participant who smoked with a participant who had a similar propensity to smoke but was not exposed
- Measure the average difference in the outcome variable across groups (treatment and control)
- Dose response tested by matching non-smokers to levels of smoking

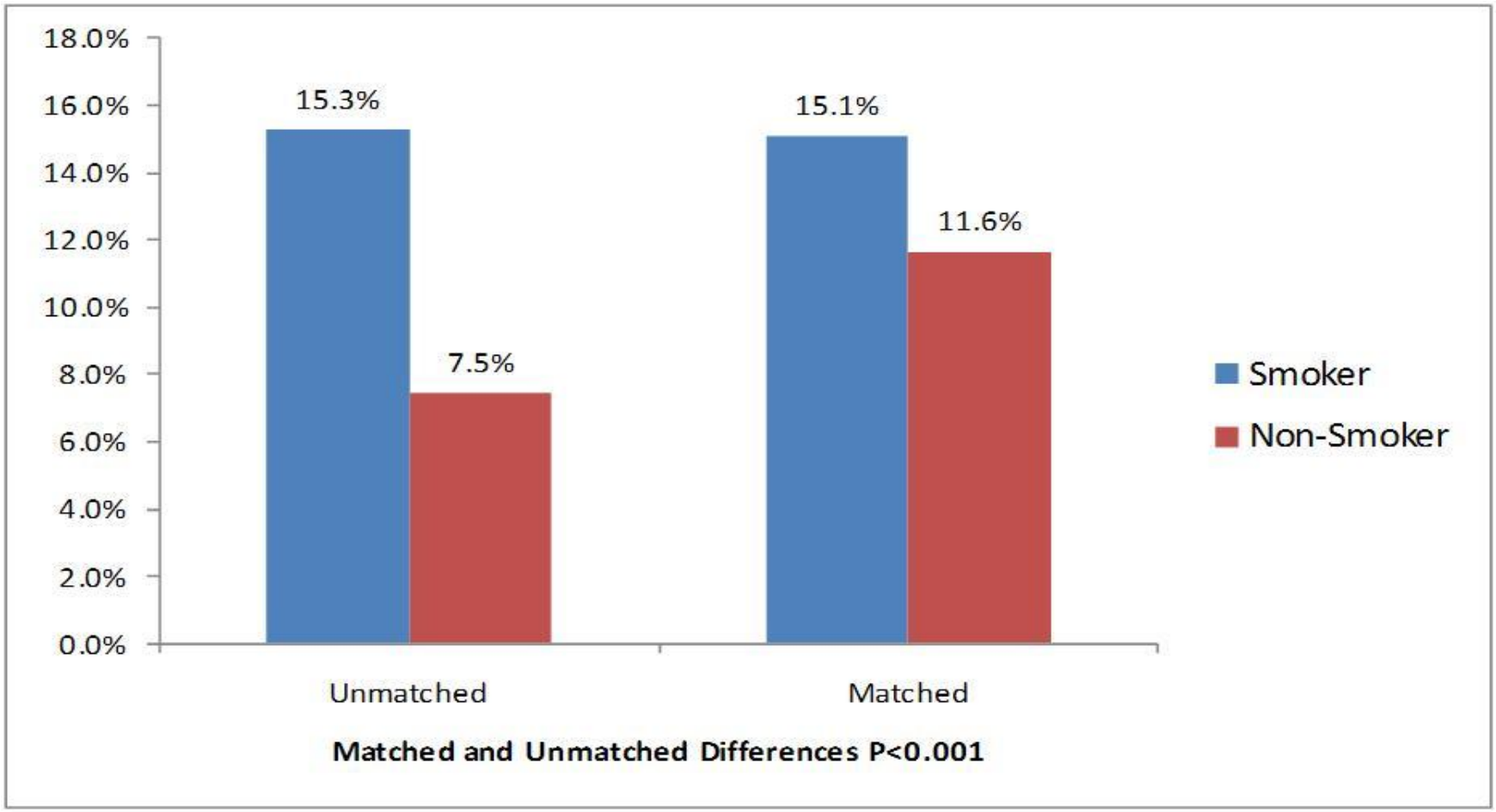
Graphical Representation of Matching on the Propensity Score



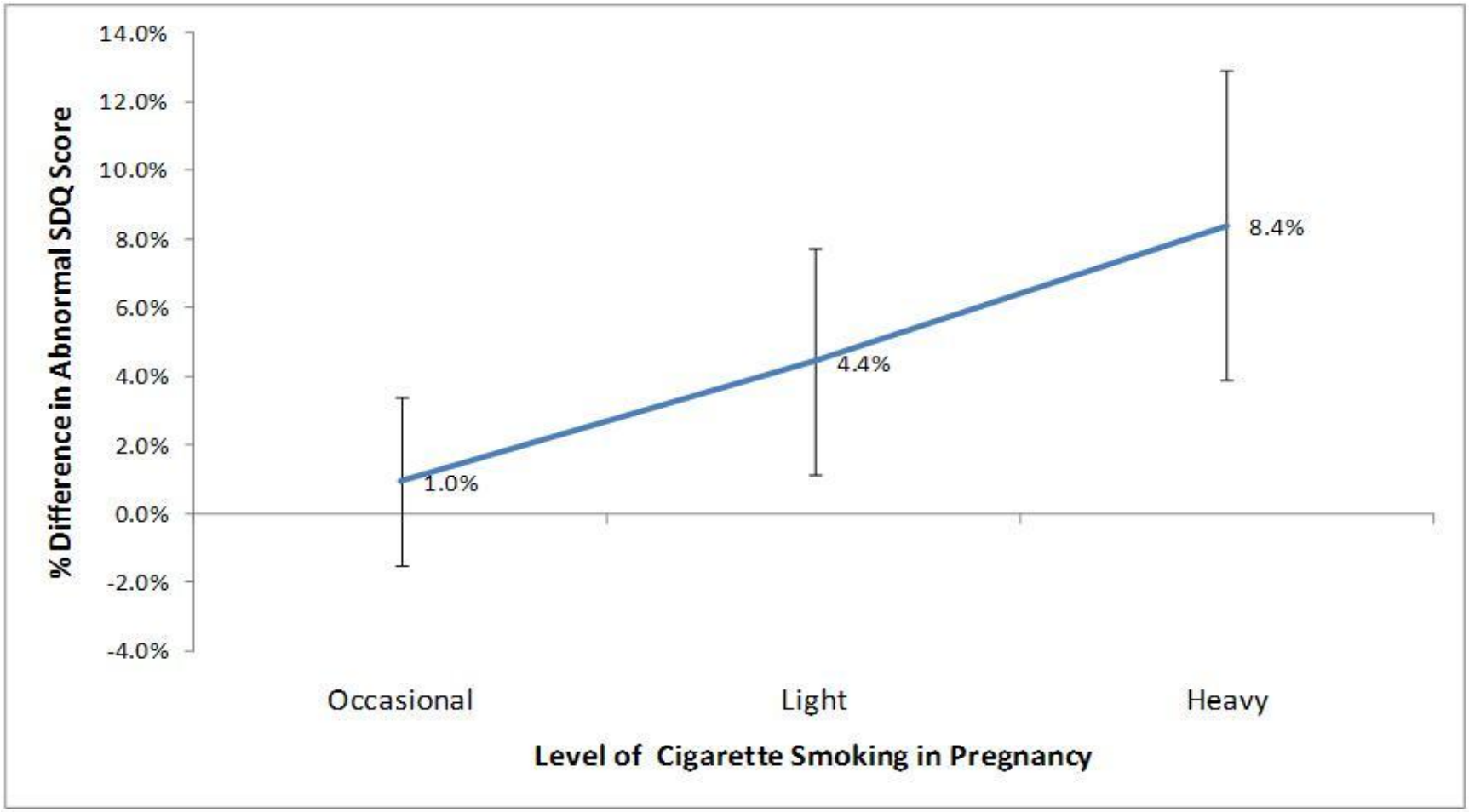
Distribution of Selection Variables in Unmatched and Matched Samples

	Unmatched Sample			Matched Sample		
	Smokers	Non-Smokers	Sig.	Smoker **(treatment)**	Non-Smokers **(control)**	Sig.
HH Professional Class	7%	16%	***	7%	8%	Not Sig.
HH Unskilled Manual	10%	3%	***	9%	9%	Not Sig.
Mother Lwr 2nd Educ.	31%	11%	***	31%	31%	Not Sig.
Mother 3rd Level Ed,	13%	31%	***	13%	14%	Not Sig.
HH 1st Income Group	27%	16%	***	27%	26%	Not Sig.
HH 5th Income Group	12%	23%	***	12%	13%	Not Sig.
Child BW <2500g	7%	4%	***	7%	7%	Not Sig.
Child Breastfed	35%	57%	***	35%	36%	Not Sig.

% With Abnormal SDQ Score Before and After Matching for Confounders by Prenatal Smoking Status



% Difference in Probability of Abnormal SDQ Score for Children Whose Mother's Smoked in Pregnancy Compared to Children in the Matched Control Groups



Discussion

Smoking during pregnancy associated with increased risk for behavioural problems in childhood.

- Exposed children 1.3 times more likely to be in the ‘abnormal’ range.
- Clear dose-response relationship evident
- Adds to our confidence in a causal relationship

Why difference from Boutwell & Beaver?

- Heavy sample attrition in ECLS study

Limitations and Future Directions?

Possible reporting bias?

- Self-reports of smoking have been found to be accurate (Patrick et al, 1994)
- ...as have retrospective reports (Kenkel et al, 2003)
- Patterns found using Teacher SDQ as well

Other possible confounders?

Gene-environment Interactions?

- e.g. Kahn et al, (2003)

Conclusions

Prenatal smoking casts a long shadow. The effects of which can still be seen in middle childhood.

- Childhood behavioural problems associated with lower educational achievement (Palloni et al 2008; Jonsson et al 2011)

- Prenatal smoking may serve to widen existing socio-economic inequalities in child health outcomes.

- Policy implications as prenatal smoking modifiable in principle