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REDUCING MICRONUTRIENT DEFICIENCIES

# Tiny Start, Lasting Mark:

# The Effect of Low Birthweight on Educational Attainment

Joanne O'Connor – PhD Student, Department of Economics, UCC

Supervisors – Dr Brendan McElroy, Dr Lee-Ann Burke, Dr Ann Kirby

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# Introduction

- Low Birthweight and it's long-term implications
- Research Objective
- Data
- Methodology
- Dependent and Independent Variables
- Results

# Low Birthweight (LBW) and long-term economic implications

- Low birthweight (birthweight less than 2,500g) is widely recognised as an adverse birth outcome (WHO).

- LBW is a major contributor to infant mortality AND has long-term associations with developmental and socioeconomic outcomes (Reichman, 2005)

- The "Foetal Origins Hypothesis" (Barker, 1995)
  - Proposes a connection between early-life conditions, specifically in utero development, and the later emergence of chronic diseases
  - Suggests early biological inputs shape future health and productivity

# Low Birthweight and long -term economic implications

- Almond and Currie (2011) extended and tested Barker's hypothesis using economic models. Found LBW is associated with:
  - Lower test scores
  - Reduced educational attainment
  - Lower income and labour force participation

- This current study utilises the richness of the GUI datasets to extend the previous work
  - Directly links LBW to standardised exam results, not just cognitive ability, and
  - Provides a comprehensive understanding of the long-term implications of LBW within an Irish/ European context
- Future analysis will estimate the of LBW on entry to third-level education as well as the impact on starting salary, following the completion of formal education for the same cohort of Irish children/ young people.

# Research Objective

To explore the relationship between LBW and educational performance

Examine the role of LBW in determining educational achievement, across the time horizon of a child’seducation

# Data – Growing Up in Ireland

Cohort ‘98: recruited at age 9 years, followed up at age 13, 17 and 20 years

Wave 1: Birthweight

Wave 1 and 2: Primary school educational outcomes (Drumcondra Scores)

Wave 3: Junior Certificate

Wave 4: Leaving Certificate

Ethical Approval to access the GUI Child/’98 Cohort datasets has been applied for and was granted by the Social Research Ethics Committee (SREC) in April 2025.

# Dependent Variable – Test scores

- We focus on the Maths and English test scores at the four waves of the study child's educational journey. Two reasons for this:
  - Consistent measures across the 4 waves
  - Watts (2020) examines the association between mathematics and reading skills in 16 year-olds and their earnings in those subjects' careers (between the ages of 33 and 50).
    - The study found a strong correlation between earnings and the standardised average of mathematics and readings test at age 16.
- This approach should ensure that the study captures developmental outcomes and a consistent measure throughout the educational trajectories of children in the GUI datasets.

# Dependent Variable – Test scores Adjustments Made

- To construct the panel test score:
  - The percentage correct measure was selected for all four test scores
- Junior Certificate adjustments:
  - Grades were substituted for the average score for that grade (Department of Education)
- Levels of difficulty were adjusted for JC and LC
    - Higher level – multiplied by 1
    - Ordinary level – multiplied by 0.6
    - Foundational level – multiplied by 0.3
- Bonus point for Higher Level Maths in LC removed

# Dependent Variable: Descriptive Statistics

| Variable | Obs. | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Drumcondra 1: Reading test score (percentage correct) | 8,356 | 70.66 | 20.81 | 0 | 100 |
| Drumcondra 1: Maths test score (percentage correct) | 8,449 | 56.43 | 20.99 | 0 | 100 |
| **"Testscore 1" (avg. of Drumcondra 1test scores)** | **8,459** | **63.46** | **18.86** | **5** | **100** |
| Drumcondra 2: Verbal reasoning test score (percentage correct) | 7,148 | 63.37 | 22.39 | 0 | 100 |
| Drumcondra 2: Numerical ability reasoning test score (percentage correct) | 7,148 | 53.53 | 22.89 | 0 | 100 |
| **"Testscore 2" (avg. of Drumcondra 2 test scores)** | **7,148** | **58.45** | **19.95** | **0** | **100** |
| Junior Certificate English test score (numerical value, adjusted for level of exam completed) | 6,080 | 66.43 | 16.33 | 12 | 92.5 |
| Junior Certificate Maths test score (numerical value, adjusted for level of exam completed) | 6,101 | 60.93 | 19.14 | 6 | 92.5 |
| **"Testscore 3" (avg. of Junior Certificate test scores)** | **6,114** | **63.59** | **15.79** | **6** | **92.5** |
| Leaving Certificate English test score (numerical value, adjusted for level of exam completed) | 4,602 | 65.42 | 23.12 | 0 | 100 |
| Leaving Certificate Maths test score (numerical value, adjusted for level of exam completed and bonus point awarded) | 4,623 | 42.42 | 29.19 | 0 | 100 |
| **"Testscore 4" (avg. of Leaving Certificate test scores)** | **4,704** | **53.76** | **22.28** | **0** | **100** |
| **PANEL (WAVE 1-4) DEPENDENT VARIABLE (combining testscore 1-4)** | **26,425** | **60.41** | **19.54** | **0** | **100** |

# Independent Variables

## Key Explanatory variable: Birthweight

| Variable | Obs. | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| **Birthweight : Continuous variable** | | | | | |
| **Birthweight (in kg)** | 8,450 | 3.516 | 0.618 | 17 | 6.1 |
| **Birthweight : Two categories** | | | | | |
| **Birthweight <2.5kg** | 373 | 2.076 | 0.277 | 17 | 2.4 |
| **Birthweight = or >2.5kg** | 8,077 | 3.582 | 0.544 | 2.5 | 6.1 |

# Confounding Variables

1. Study Child's Gender
2. Gestational Age of the Study Child
3. Study Child's Ongoing Health
4. Chronic Illness in Study Child
5. Biological Mother's Age at Birth
6. Biological Mother Smoking while Pregnant with Study Child
7. Biological Mother's Highest Level of Educational Attainment
8. Family's Equivalised Income
9. Family/ Study Child's Access to Medical Card
10. Family/ Study Child Access to Health Insurance

# Methodology

- Panel Data Models:
  - Commonly estimated using **Fixed Effects (FE)** or **Random Effects** approaches
  - FE controls for unobserved individual heterogeneity
  - RE allows inclusion of time-invariant variables (do not change across periods)
- Our Challenge:
  - Key explanatory variable is Birthweight – a time invariant variable
  - There is heterogeneity across the GUI study children
- Therefore, we utilise the **Hausman-Taylor** estimator
  - Combines the strengths of FE and RE models
  - Allows estimation of time-invariant effects, through the use of "instrumental" variables

# Hausman Taylor (HT) Estimator

- The HT model categories variables into four groups:

  $x_1$: Time-varying exogenous variables (e.g., parental employment),

  $x_2$: Time-varying endogenous variables (e.g., household income),

  $z_1$: Time-invariant exogenous variables (e.g., maternal education),

  $z_2$: Time-invariant endogenous variables (e.g., birthweight).

- Model is expressed as:

$$y_{it} = x_{1it}\beta_1 + x_{2it}\beta_2 + z_{1i}\gamma_1 + z_{2i}\gamma_{2\ it} + c_i + u_{it}$$

Where $c_i$ represents unobserved individual effect

# Results – Econometric Specification

$$testscore_{it} = \propto + \beta_1 birthweight + \beta_2 birthweight^2 + \beta_3 child's\ gender + \beta_4 mother's\ age\ at\ birth + \beta_5 mother's\ age\ at\ birth^{\ 2} + \beta_6 mother\ smoked + \beta_7 mother's\ education + \beta_6 family\ income + \varepsilon$$

Where:

*testscore* is the test results for child *i* at time *t*

*Equivalised Family Income* is the selected endogenous variable

| Variables | Hausman Taylor Model |
|---|---|
| Time-Varying Exogenous Variables | |
| Mother's Highest Level of Education | 1.429***<br>(0.137) |
| Child's Ongoing Health | 1.025***<br>(0.212) |
| Child has a Chronic Illness | -3.139***<br>(0.363) |
| Child is covered by a Medical Card | 0.043*<br>(0.355) |
| Child is covered by Medical Insurance | 5.601***<br>(0.328) |
| Time-varying Endogenous Variable | |
| Equivalised Family Income (quintiles €) | 0.587***<br>(0.113) |
| Time-Invariant Exogenous Variables | |
| Child's Birthweight | 19.363***<br>(3.55) |
| Child's Birthweight squared | -2.455***<br>(0.458) |
| Child's gender | -0.499<br>(0.413) |
| Mother's age at Child's birth | 5.575***<br>(0.854) |
| Mother's age at Child's birth squared | -0.084***<br>(0.139) |
| Child born early | 0.427<br>(0.776) |
| Mother smoked during pregnancy | -1.335***<br>(0.201) |
| Constant | -57.91***<br>(18.965) |
| Sample size = 22,481 | |
| Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 | |

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# Conclusion

- We find that higher birthweight improves test scores, although with diminishing returns at higher levels
- Investing in early child and maternal health could generate meaningful improvements in children's educational outcomes and, in turn, national productivity
- Further research will explore how LBW influences higher education attainment and initial labour market outcomes

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# Thank you !

Questions?

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# Additional Information

# Systematic Review Results : Low birthweight due to Iron Deficiency

| | Outcome | Event rate | Confidence Interval |
|---|---|---|---|
| Finkelstein et al. (2024) | Iron supplementation's effect on LBW | RR = 0.84 | 95% CI: 0.72 to 0.99 |
| Safarzadeh et al (2023) | Odds of LBW in iron deficient mother | aOR = 1.04 | 95% CI: 0.78 to 2.01 |
| Young et al (2023) | Odds of LBW in iron deficient mother | OR = 1.28 | 95% CI: 1.22 to 1.35 |
| | Odds of very LBW in iron deficient mother | OR = 2.15 | 95% CI: 1.47 to 3.13 |
| Yuan et al (2019) | Decreased risk of LBW due to iron supplementation | OR = 0.61 | 95% CI: 0.44 to 0.84 |
| Drukker et al (2015) | LBW odds in iron deficient patients | OR = 1.14 | 95% CI: 0.99 to 1.30 |
| Haider et al (2013) | LBW reduction in non-iron deficient patients | RR = 0.81 | 95% CI: 0.71 to 0.93 |

# Junior Certificate Grade Values

| Junior Certificate Grades | Percentage range | Value used in analysis |
|---|---|---|
| A | ≥ 85 to 100 | 92.5 |
| B | ≥ 70 and < 85 | 77.5 |
| C | ≥ 55 and < 70 | 62.5 |
| D | ≥ 40 and < 55 | 47.5 |
| E | ≥ 25 and < 40 | 20 |
| F | ≥ 10and < 25 | 20 |
| NG | ≥ 0 and < 10 | 20 |

# Leaving Certificate Higher Level Maths, Bonus Point Adjustment

| Before Adjustment | | |
|---|---|---|
| Grade | Frequency | Percentage |
| 0 | 26 | 1.27 |
| 37 | 26 | 1.27 |
| 70 | 43 | 2.10 |
| 71 | 58 | 2.83 |
| 75 | 50 | 2.44 |
| 80 | 98 | 4.78 |
| 81 | 123 | 6.00 |
| 85 | 105 | 5.12 |
| 90 | 95 | 4.63 |
| 91 | 232 | 11.31 |
| 95 | 171 | 8.34 |
| 100 | 130 | 6.34 |
| 102 | 221 | 10.78 |
| 105 | 117 | 5.70 |
| 110 | 143 | 6.97 |
| 113 | 163 | 7.95 |
| 115 | 95 | 4.63 |
| 125 | 155 | 7.56 |

| After Adjustment | | |
|---|---|---|
| Grade | Frequency | Percentage |
| 0 | 26 | 1.27 |
| 37 | 26 | 1.27 |
| 45 | 43 | 2.10 |
| 46 | 58 | 2.83 |
| 50 | 50 | 2.44 |
| 55 | 98 | 4.78 |
| 56 | 123 | 6.00 |
| 60 | 105 | 5.12 |
| 65 | 95 | 4.63 |
| 66 | 232 | 11.31 |
| 70 | 171 | 8.34 |
| 75 | 130 | 6.34 |
| 77 | 221 | 10.78 |
| 80 | 117 | 5.70 |
| 85 | 143 | 6.97 |
| 88 | 163 | 7.95 |
| 90 | 95 | 4.63 |
| 100 | 155 | 7.56 |

# Summary Statistics: Test scores and Child

| VARIABLE | MEAN | SD |
|---|---|---|
| TEST SCORES | 60.66 | 19.39 |
| Birthweight | 3.53 | 0.60 |
| Child's gender | | |
| Male | 0.482 | 0.49 |
| Female | 0.518 | 0.49 |
| Child Born Early (36 weeks' gestation or earlier) | | |
| No | 0.879 | 0.33 |
| Yes | 0.121 | 0.33 |
| Child's health | | |
| Healthy | 0.731 | 0.44 |
| Some health problems | 0.246 | 0.43 |
| Often unwell/ poor health | 0.023 | 0.15 |
| Child has a Chronic Illness | | |
| No | 0.904 | 0.29 |
| Yes | 0.096 | 0.29 |
| Observations = 22,481 | | |

# Summary Statistics: Mother

| Variable | Mean | SD |
|---|---|---|
| MOTHER CHARACTERISTICS | | |
| Age of mother at Child's birth | 30.95 | 5.15 |
| Mother smoked in Pregnancy | | |
| Never smoked | 0.788 | 0.41 |
| Occasionally smoked | 0.094 | 0.29 |
| Smoked 1-5 cigarettes per day | 0.019 | 0.14 |
| Smoked 6-10 cigarettes per day | 0.053 | 0.22 |
| Smoked 11-25 cigarettes per day | 0.043 | 0.20 |
| Smoked 26 or more cigarettes per day | 0.003 | 0.56 |
| Mother's highest Level of Education | | |
| None or primary education | 0.021 | 0.14 |
| Lower secondary education | 0.104 | 0.30 |
| Higher Secondary/Vocational course | 0.331 | 0.47 |
| Non-degree course | 0.236 | 0.42 |
| Primary degree | 0.174 | 0.38 |
| Postgraduate degree | 0.134 | 0.34 |
| Observations = 22,481 | | |

# Summary Statistics: Family

| Variable | Mean | SD |
|---|---|---|
| Test scores | 60.66 | 19.39 |
| Family's Equivalised Income (Quintile €) | | |
| Lowest Quintile | 0.133 | 0.34 |
| 2nd | 0.167 | 0.37 |
| 3rd | 0.197 | 0.39 |
| 4th | 0.231 | 0.42 |
| Highest Quintile | 0.272 | 0.45 |
| Child has a Medical Card | | |
| No | 0.779 | 0.42 |
| Yes | 0.221 | 0.42 |
| Child has Medical Insurance | | |
| No | 0.382 | 0.49 |
| Yes | 0.618 | 0.49 |
| Observations = 22,481 | | |