# Online Appendix

# The effects of sun intensity during pregnancy and in the first 12 months of life on childhood obesity

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## Appendix A: District Mobility from Pregnancy to the Child's Six Birthday

Our data record information on district only at age 6, not at birth. If families are mobile across districts between birth and age 6, this will lead to measurement error in our sunshine measures. Overall, mobility in Germany is low. For the state of Lower Saxony, parents were asked in the school entry examinations whether they changed address over the past 2 years. Less than 2% of parents did so.
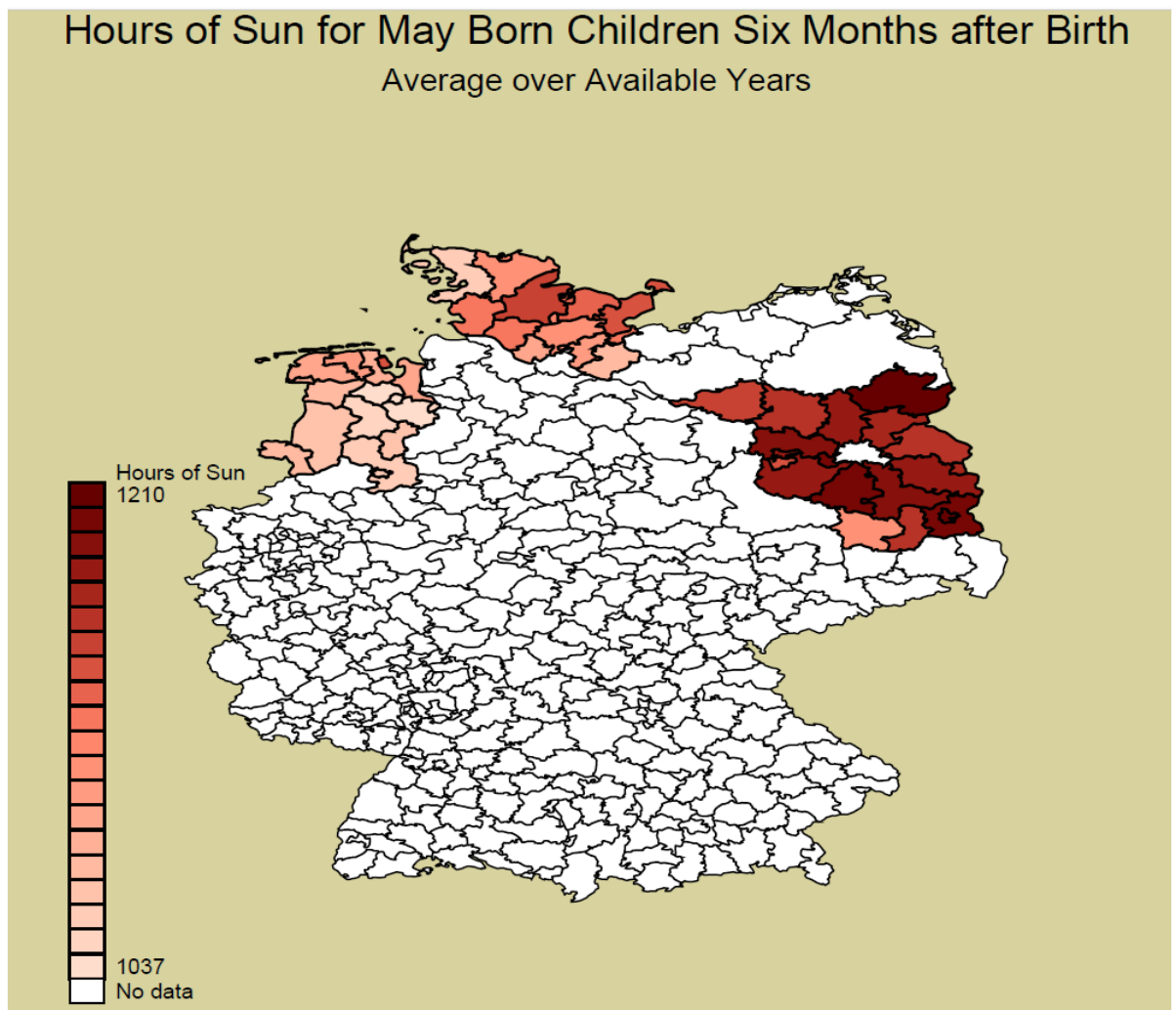
To investigate district mobility more widely, we draw on two external data sources, the German Socio Economic Panel (GSOEP), a longitudinal survey of up to 14,000 households available for the years 1985 to 2017, and the Sample of Integrated Labor Market Biographies (SIAB), a 2% random sample of employees covered by the social security system available for the years 1975 to 2017.While an important advantage of the SIAB over the GSOEP is the much larger sample size, important drawbacks are that it is possible to identify district moves only for mothers who took parental leave and returned to work by age 6. Moreover, only the place of work, not the place of residence, is observed. A drawback of the GSOEP, on the other hand, is that residence at birth is available at a more aggregated district level than districts; in our main sample, the 44 districts are aggregated into 7 "areas".

According to the SIAB, in a sample of mothers who signed up for parental leave between 1986 and 2001 (22,335 mothers), 72.8% returned to work by age 6. Of those, 15.7% worked in a district at their child's sixth birthday (or, if not working at their child's sixth birthday, at the time they were last observed working) that is different from the district they were employed at before giving birth. When additionally restricting the sample to mothers who give birth in our sample districts (3,821 mothers), 73.1% returned to work by age 6 and 15.1% of those work in a different district than they were employed at before giving birth. In the GSOEP, there are 2,947 mothers who gave birth between 1986 and 2001. Of those, 8.6% moved between "areas". Focusing only on the "areas" included in our sample (388 mothers), 8.5% moved. Overall, these numbers confirm that district mobility in Germany is low.

Importantly, it is highly unlikely that families base their mobility decisions on expected sunshine hours in the destination district. After all, future sunshine hours in a specific district, conditional on district-by-year of birth and month of birth fixed effects—the key control variables in our regressions—are impossible to predict. District mobility therefore creates unsystematic measurement error in sunshine hours in our specification, leading to an attenuation bias toward zero in our estimates. Our estimates may therefore be best understood as a lower bound for the effects of sunshine hours in pregnancy and infancy on adiposity risk at age 6.

## Appendix B: Additional Results

**Figure B1: Average Sunshine Hours in the first Six Months after Birth**



*Notes:* The figure plots average sunshine hours in the first six months after birth for May born children by region of birth. Darker colors denote more sunshine hours.
*Data source* : 21 weather stations.

## Table B1: Effects of Average Temperature and Cumulative Rainfall During Pregnancy and First years of Life on Adiposity Risk at Age 6

| | (1) temperature | (2) rainfall |
|---|---|---|
| | | |
| average temperature/rainfall in pregnancy | 0.001 (0.003) | 0.001 (0.001) |
| average temperature/rainfall first 6 months of life | 0.000 (0.003) | 0.001 (0.001) |
| average temperature/rainfall 6 to 11 months after birth | 0.000 (0.003) | -0.001 (0.001) |
| average temperature/rainfall 12 to 80 months after birth | 0.003 (0.003) | 0.000 (0.004) |
| | | |
| average temperature/rainfall in pregnancy | 0.001 (0.001) | 0.000 (0.001) |
| average temperature/rainfall first 6 months of life | 0.001 (0.002) | 0.000 (0.001) |
| average temperature/rainfall 6 to 11 months after birth | 0.001 (0.002) | -0.001 (0.001) |
| average temperature/rainfall 12 to 80 months after birth | 0.000 (0.001) | 0.002 (0.002) |
| | | |
| average temperature/rainfall in pregnancy | 0.000 (0.001) | 0.000 (0.0004) |
| average temperature/rainfall first 6 months of life | 0.000 (0.001) | 0.000 (0.0003) |
| average temperature/rainfall 6 to 11 months after birth | 0.001 (0.001) | 0.000 (0.0002) |
| average temperature/rainfall 12 to 80 months after birth | 0.001 (0.001) | 0.000 (0.001) |
| | | |
| Observations | 664,307 | 666,084 |

*Notes:* The table reports the effects of average temperature (in Celsius, column (1)) and cumulative rainfall (sum of rainfall per hour in millimeters, column (2)) during pregnancy, in the first six months after birth, between months 6 to 12 after birth, and between months 12 and 80 after birth, on children's risk of overweight, obesity and severe obesity at age six. Overweight, obesity, and severe obesity are defined, respectively, as >=85th, >=95th, and >=99th percentile in the gender- and age (in months)-specific BMI distributions. In both columns, we estimate linear probability models and control for, as in equation (1), district-by-birth year and month of birth fixed effects. Coefficients show the effects of an increase by one standard deviation in temperature and rainfall on adiposity risk at age 6. Standard errors are clustered at the "weather station district" level (districts that are assigned different weather station combinations (28 clusters)).
* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

**Table B2: Effects of Sunshine Hours During Pregnancy and First Years of Life on Adiposity Risk at Age 6 by Subgroups**

**Panel I: No Interactions; Effects of sunshine hours in first six months**

| Sample: Minority Status | | Sample: Check-up Participation | |
|---|---|---|---|
| Overweight | -0.113 | Overweight | -0.138 |
| | (0.123) | | (0.117) |
| Obesity | -0.214** | Obesity | -0.193*** |
| | -(0.084) | | -(0.056) |
| Severe Obesity | -0.079*** | Severe Obesity | -0.060** |
| | -(0.019) | | -(0.024) |
| Obs | 243,344 | Obs | 363,382 |

**Panel II: Interactions between Minority Status and Complete Check-ups; Effects of sunshine hours in first six months after birth**

| Sample: Minority Status | | Sample: Check-up Participation | |
|---|---|---|---|
| **Overweight** | | | |
| Sunshine hours first 6 months of life | -0.086 | Sunshine hours first 6 months of life | -0.25 |
| | (0.121) | | (0.149) |
| Minority | 0.403*** | Complete check-ups | -0.085 |
| | (0.087) | | (0.058) |
| Sunshine hours first 6 months of life x minority | -0.471*** | Sunshine hours first 6 months of life x complete check-ups | 0.149 |
| | (0.152) | | (0.207) |
| **Obesity** | | | |
| Sunshine hours first 6 months of life | -0.205** | Sunshine hours first 6 months of life | -0.254*** |
| | (0.083) | | (0.077) |
| Minority | 0.210*** | Complete check-ups | -0.047* |
| | (0.062) | | (0.025) |
| Sunshine hours first 6 months of life x minority | -0.124 | Sunshine hours first 6 months of life x complete check-ups | 0.079 |
| | (0.108) | | (0.093) |
| **Severe Obesity** | | | |
| Sunshine hours first 6 months of life | -0.073*** | Sunshine hours first 6 months of life | -0.066* |
| | (0.018) | | (0.033) |
| Minority | 0.052*** | Complete check-ups | -0.003 |
| | (0.009) | | (0.012) |
| Sunshine hours first 6 months of life x minority | -0.058 | Sunshine hours first 6 months of life x complete check-ups | 0.008 |
| | (0.071) | | (0.047) |
| Obs | 243,344 | Obs | 363,382 |

Notes: The table shows the effects of 100 additional sunshine hours (in percentage points (pp.)) in the first six months after birth on children's risk of overweight, obesity and severe obesity at age six. Overweight, obesity, and severe obesity are defined, respectively, as >=85th, >=95th, and >=99th percentile in the gender- and age (in months)-specific BMI distributions. Estimates in Panel I refer to our baseline specification as specified in equation (1) but re-estimated on the smaller samples for which minority status and check-up participation are available. In Panel II, we allow the effects of sunshine hours in the first six months of life (and the three other time periods) to vary by minority status and check-up participation. 8.1 percent of the children in the sample are classified as minority children and 76.2 percent have participated in all check-ups. For brevity, we only report estimates for sunshine hours in the first six months of life. Standard errors are clustered at the "weather station district" level, that is, districts with different weather station combinations (28 clusters).

Data sources: School entry examinations, Schleswig-Holstein, Lower Saxony, Brandenburg. Sunshine hours from 21 weather stations. p<0.1; ** p<0.05; *** p<0.01.