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Supplemental Material

Shedding Some Light in the Dark—A Comparison of Personal Measurements with Satellite-Based Estimates of Exposure to Light at Night among Children in the Netherlands

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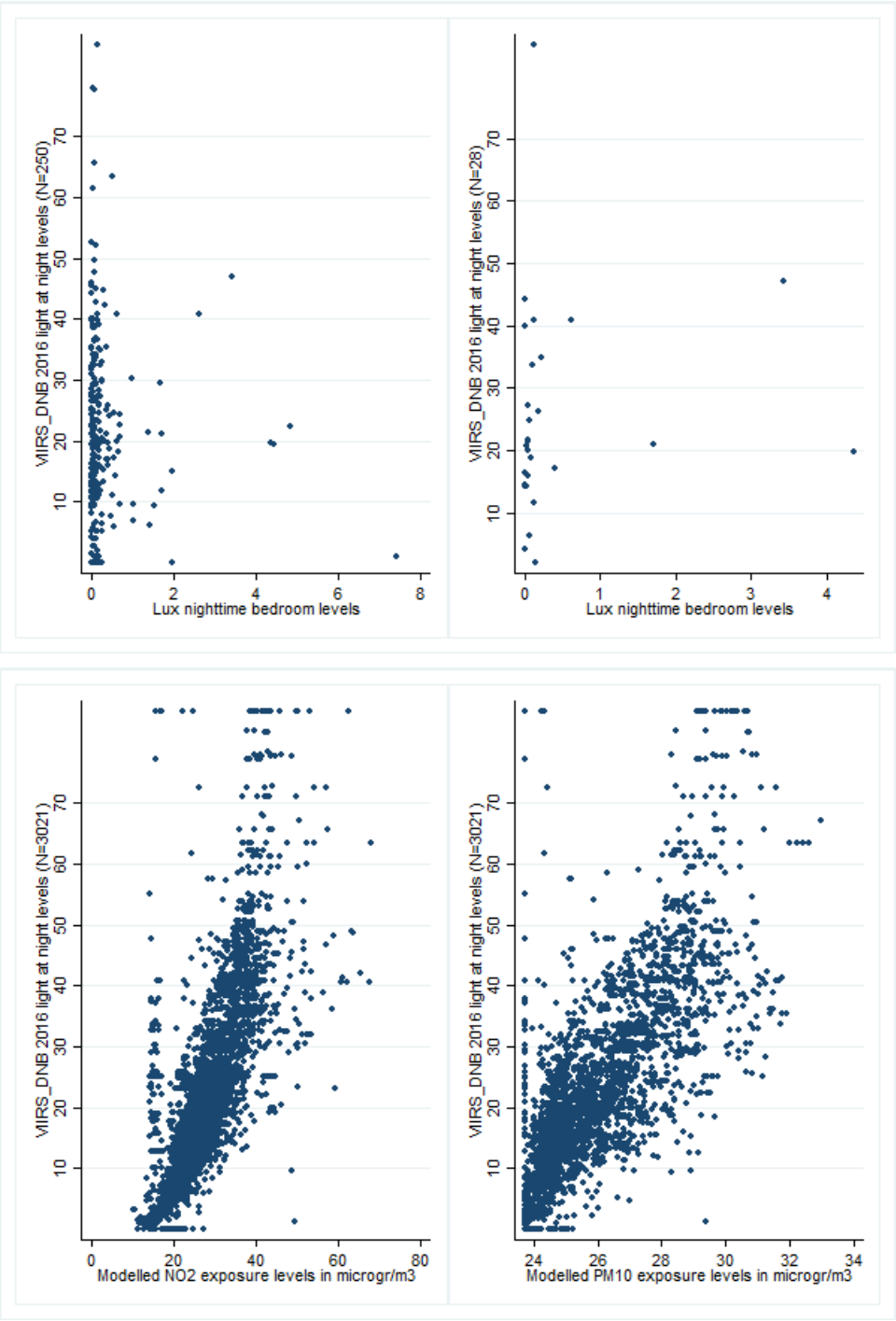
Table of Contents

Figure S1: Example picture of LightWatcher worn during daytime

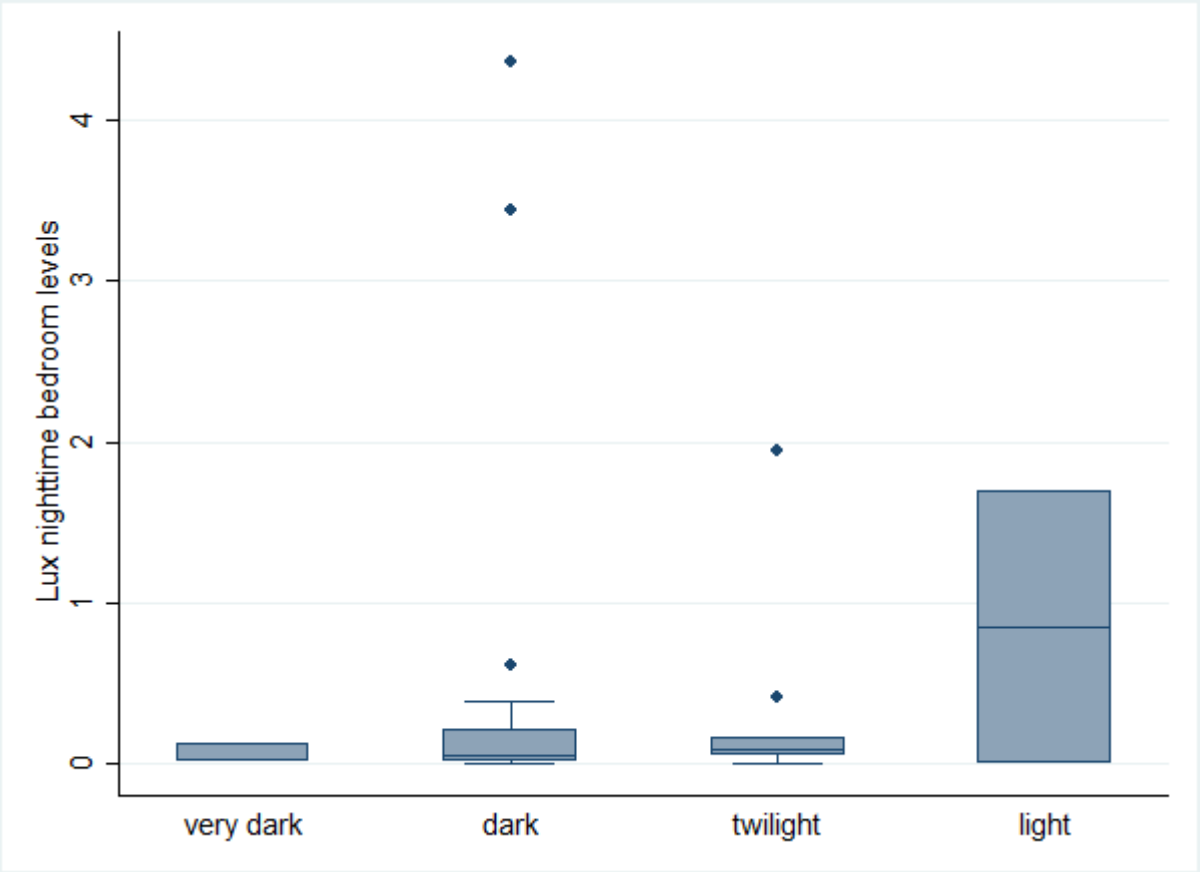
Photo by L. v. Wel

Figure S2: Scatter plots of VIIRS-DNB light at night levels



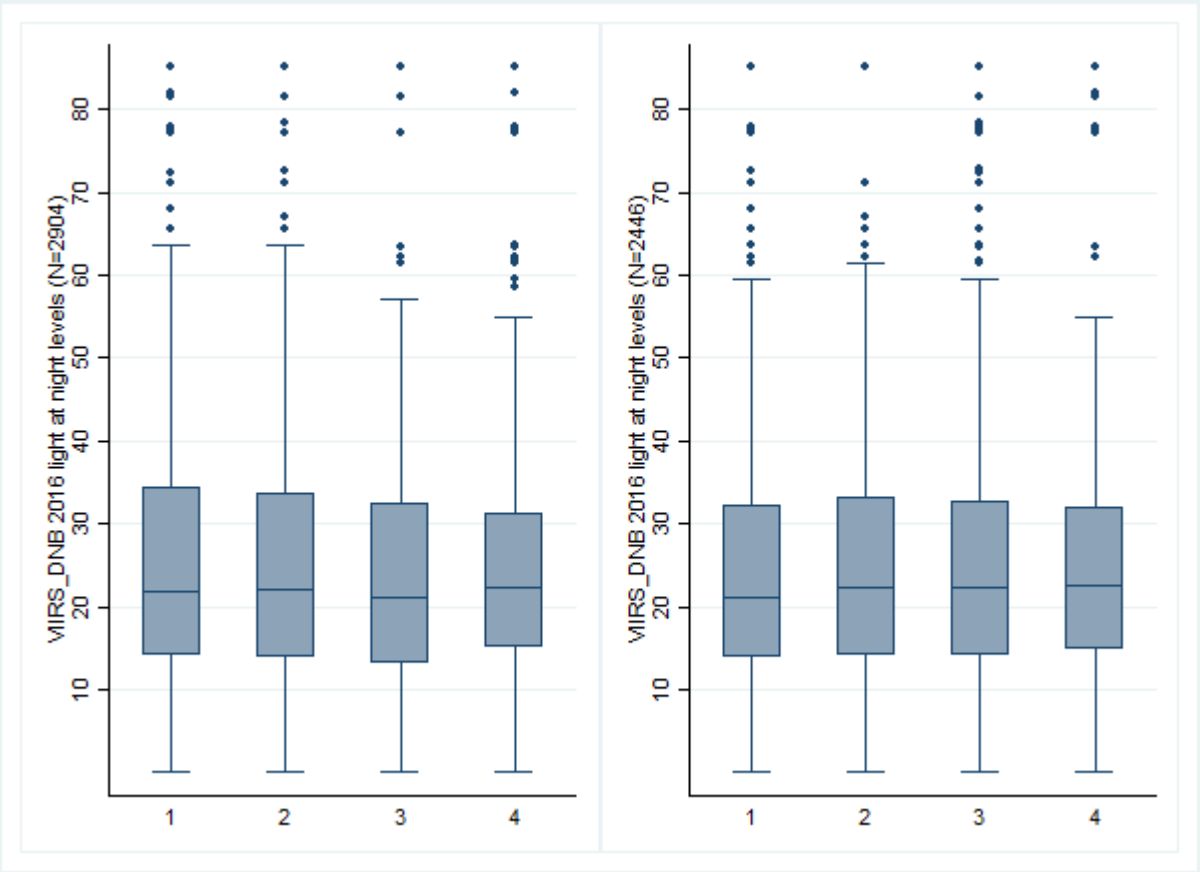
VIIRS-DNB: Visible and Infrared Imaging Radiometer Suite Day/Night band. Air pollutants NO_2 and PM_{10} are modelled average values in microgram per cubic meter. Top left panel: VIIRS-DNB and bedroom lux levels among 250 children with measurements between 0:12 and 3:10 AM, top right panel: VIIRS-DNB and bedroom lux levels among 28 children with measurements where outdoor light levels were reported to influence indoor light levels, light levels between 0:12 and 3:10 AM. Bottom left panel: VIIRS-DNB and modelled annual average NO_2 levels; Bottom right panel: VIIRS-DNB and modelled annual average PM_{10} levels.

Figure S3: Box plots of measured night at light levels (lux) and self-reported bedroom darkness in a subset of children (N=44)



For categories of self-reported bedroom darkness, see also Table S1. Number of observations are 3, 29, 10 and 2 for the categories “very dark”, “dark”, “twilight”, and “light”, respectively.
Boxes correspond to the 25th and 75th percentile, the middle line to the median. Whiskers extend to the most extreme value within 1.5 interquartile ranges of the closer quartile.

Figure S4: Box plots of VIIRS-DNB LAN levels across quartiles of average daily screen time and frequency of electronic device use in the hour before going to bed



VIIRS-DNB: Visible and Infrared Imaging Radiometer Suite Day/Night band.
LAN: Light at night.
Left panel: VIIRS-DNB satellite LAN levels over quartiles of screen time as reported by ABCD children during age 11 follow-up. Screen time was reported as average time spent per day watching TV, or using a computer, laptop, tablet, mobile telephone or video game console; categories are 1= lowest quartile, to 4=highest quartile; cut-offs are 82, 116 and 166 minutes per day, respectively. The Spearman correlation coefficient of VIIRS-DNB levels with children's screen time was -0.01.
Right panel: VIIRS-DNB satellite LAN levels over self-reported frequency of electronic device use in the hour before children go to bed. Categories 1-4 correspond to answers 1= nearly never; 2=once in a while, but less than once a week, 3= sometimes, 4=every evening. The Spearman correlation coefficient of VIIRS-DNB levels over categories of electronic device use was 0.02.

Table S1

Characteristics of subset of ABCD cohort with light measurements, by satellite light at night levels in tertiles

	Low VIIRS-DNB	Medium VIIRS-DNB	High VIIRS-DNB
N	98	91	61
N (%) girls	52 (53.1)	51 (56.0)	37 (60.7)
N (%) boys	46 (46.9)	40 (44.0)	24 (39.3)
Age (mean ±SD)	12.4 ±0.6	12.3 ±0.6	12.5 ±0.6
Maternal educ. Low: N (%)	6 (6.1)	1 (1.1)	1 (1.6)
Medium N (%)	10 (10.2)	20 (22.0)	10 (16.4)
High: N (%)	80 (81.6)	70 (76.9)	50 (82.0)
Missing: N (%)	2 (2.0)	0 (0.0)	0 (0.0)
NO_2	22.5 (19.9-26.0)	29.3 (26.0-31.6)	35.5 (32.0-38.6)
PM_{10}	24.6 (24.2-25.0)	25.7 (24.9-26.5)	27.8 (27.0-29.1)
Green 100m	2288 (360-4917)	1984 (303-4355)	0 (0-1511)
Green 1000m	1.14×10^6 ($0.81 \times 10^{6-}$ 1.63×10^6)	0.63×10^6 ($0.51 \times 10^{6-}$ 0.87×10^6)	0.24×10^6 ($0.13 \times 10^{6-}$ 0.52×10^6)
Rurality	3 (2-4)	1 (1-2)	1 (1-1)
Population density	3767 (2064-6590)	6674 (4243-6674)	11677 (8465-18266)
Area SEP	33 (29-38)	35 (20-38)	39 (32-45)

Categories of low, medium and high satellite-measured light at night exposure based on tertiles, see also Table 1 for explanations.

Values are medians (25^{th} – 75^{th} percentiles) unless otherwise indicated. Air pollutants NO_2 and PM_{10} are modelled average values in microgram per cubic meter. Green corresponds to the amount of square meters of green in a buffer of 100 and 1000m around the place of residence, respectively. Degree of rurality, population density and area-level SEP derived from the smallest area unit ("buurt") by Statistics Netherlands. Degree of rurality ranges from 1 (very urban) to 5 (rural), population density to number of inhabitants per square kilometer, and area-level SEP to the percentage of the population with low income.

Table S2

Characteristics of the ABCD cohort and the subsets of the study population with light measurements, and with light measurements and self-reports

	ABCD cohort	Light measurements	Light measurements and self-reports
N	3021	256	44
N (%) girls	1533 (50.7)	143 (56.0)	21 (47.7)
N (%) boys	1488 (49.3)	113 (44.0)	23 (52.3)
Maternal educ. Low: N (%)	251 (8.2)	8 (3.1)	1 (2.3)
Medium N (%)	524 (17.4)	41 (16.0)	6 (13.6)
High: N (%)	2199 (72.8)	205 (80.1)	37 (84.1)
Missing: N (%)	47 (1.6)	2 (0.8)	0 (0.0)
NO_2	28.6 (23.8-34.3)	27.9 (22.8-32.6)	27.5 (23.5-33.6)
PM_{10}	25.6 (24.6-27.2)	25.5 (24.6-27.0)	25.1 (24.6-27.2)
Green 100m	1570 (0-4575)	1633 (0-4331)	1384 (0-4454)
Green 1000m	0.68×10^6 (0.35×10^{6}-1.08×10^6)	0.68×10^6 (0.36×10^{6}-1.08×10^6)	0.72×10^6 (0.24×10^{6}-1.08×10^6)
Rurality	1 (1-2)	2 (1-3)	2 (1-2)
Population density	7030 (3986-10991)	6481 (3379-10467)	7686 (4036-12298)
Area SEP	36 (30-41)	36 (29-40)	39 (32-45)
VIIRS-DNB	22.2 (14.3-32.7)	19.6 (12.5-27.9)	21.2 (14.3-34.6)

VIIRS-DNB (Visible and Infrared Imaging Radiometer Suite Day/Night band) satellite-measured light at night exposure are given in nanoW/cm2/sr.

Values are medians (25^{th} – 75^{th} percentiles) unless otherwise indicated. Air pollutants NO_2 and PM_{10} are modelled average values in microgram per cubic meter. Green corresponds to the amount of square meters of green in a buffer of 100 and 1000m around the place of residence, respectively. Degree of rurality, population density and area-level SEP derived from the smallest area unit (“buurt”) by Statistics Netherlands. Degree of rurality ranges from 1 (very urban) to 5 (rural), population density to number of inhabitants per square kilometer, and area-level SEP to the percentage of the population with low income.

Table S3: Self-reported bedroom darkness

"What describes best how dark it is in your bedroom during the night?"			Nearly always uses curtains [a)]		At least one window of child's bedroom is facing a road [b)]		Lux during darkest period of night [c)]
	N	%	N	%	N	%	mean (±SD)
"very dark – can't see a hand in front of my eyes"	3	7	3	7	1	4	0.09 (0.06)
"dark – reading a book would be impossible"	29	66	29	71	16	73	0.37 (0.99)
"twilight – could read a book with a lot of effort"	10	23	8	20	5	23	0.30 (0.59)
"light – can easily read a book"	2	4	1	2	0	0	0.85 (1.19)

a) Information from additional questionnaire answered by parents and children; b) information from last follow-up questionnaire filled in by mothers; c) from measurements.

Table S4: Lux levels of different time frames of evening and night exposure

	Geometric means ±GSD	Median, 25^{th}-75^{th} percentile
A) Average bedroom exposure during the darkest period of the night (N=250)	0.07 ±6.6	0.08 (0.03-0.21)
B) Average exposure in the time children reported to be in bed	1.6 ± 4.7	1.40 (0.54-3.57)
C) Average exposure during the time period of civil twilight	0.99 ±5.6	1.34 (0.44-3.67)
D) Average exposure between start of civil twilight and bedtime (N=217)	9.1 ±3.5	11.22 (5.97-17.88)
E) Average exposure in the hour before children went to bed	21.8 ±3.6	16.08 (9.58-42.58)

For more information on the light level metrics, please see text and Table 2 for more explanations. N=256 unless otherwise indicated.