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REVOLUTIONISING MEDICINE - THE NEW FRONTIER

The Association of Time Outdoors and Patterns of Light Exposure with Myopia in Children: Implications for Prevention

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INTRODUCTION, AIMS AND METHODS

Introduction and Aims

Bright light levels regulate ocular growth in animal studies[1,2], potentially providing a plausible biological link between protective time outdoors and myopia in children[3].

This cross-sectional study evaluates the association of time outdoors and light exposure patterns with myopia in children from the Singapore Growing Up Towards Healthy Outcomes (GUSTO) cohort.

Methods

483 multi-ethnic children (50% boys; 59.8% Chinese) with cycloplegia, light exposure data and not on myopia treatment (orthokeratology or atropine) were included, of 716 children attending the 9-year visit.

Time outdoors (questionnaire) in the past month and outdoor activity types (activity diary; 7 days) were caregiver-reported. Wrist-worn FitSight watches recorded light patterns over 14 days: light levels (lux), the duration, timing and frequency of light exposure (defined as the number of light episodes; ≥1000 lux continuously ≥5mins). Additionally, the average duration of light episodes was evaluated.

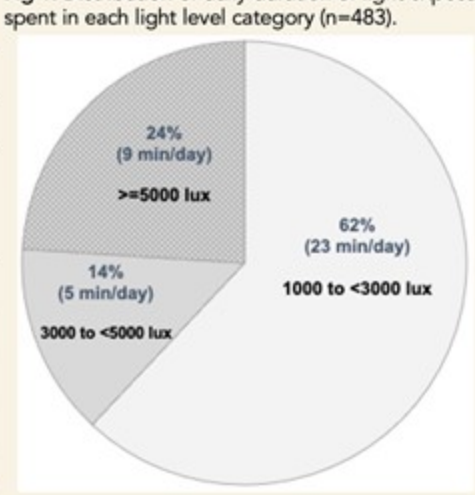
Cycloplegic spherical equivalent (SE), myopia (SE≤-0.5D) and axial length (AL) from 483 children (966 eyes) were analyzed using Generalized Estimating Equations (GEE) with multivariable linear or logistic regression model, accounting for the correlation between paired eyes and confounders. Two-sided P<0.05 was considered statistically significant.

RESULTS

Table 1: Profile of time outdoors and light patterns (n=483).

Variables	All days Mean (SD)
Reported time outdoors (min/day)	100 (93)
Average light levels (lux)	
Average outdoor light levels (lux)	4609 (1736)
Average light levels (lux)	458 (228)
Average daily duration of light exposure (min/day)	
≥1000 lux (min/day)	37 (19)
≥3,000 lux (min/day)	14 (9)
≥5,000 lux (min/day)	9 (7)
≥15,000 lux (min/day)	2 (2)

Fig 1. Distribution of daily duration of light exposure spent in each light level category (n=483).



- Children had 1.7±1.0 daily light episodes, of short duration (6.3±4.5 min/episode); Table 1.
- 76% of total daily duration of light exposure were spent <5000 lux (Fig1).

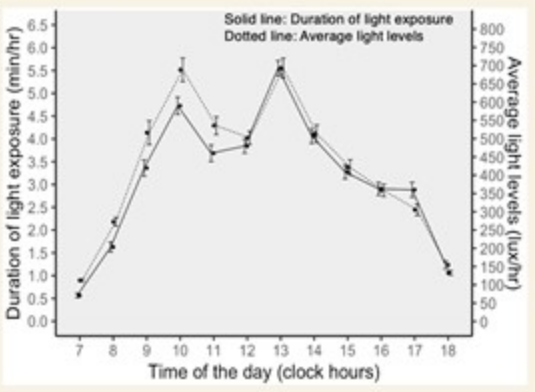
RESULTS AND CONCLUSIONS

Table 2. Light measures across periods of daylight hours (n=483).

Average light levels (lux)	Mean (SE) Morning	Mid-day	Evening	P*
Average outdoor light levels (lux)	4709 (161)	4532 (91)	3560 (84)	<0.001[b,c]
Average light levels (lux)	434 (16)	574 (17)	318 (11)	<0.001[a,b,c]
Average daily duration of light exposure (min/day)	**Morning**	**Mid-day**	**Evening**	**P***
≥1000 lux (min/day)	10 (0.4)	17 (0.5)	10 (0.4)	<0.001[a,b]
≥3,000 lux (min/day)	4 (0.2)	7 (0.3)	4 (0.2)	<0.001[a,b]
≥5,000 lux (min/day)	2 (0.1)	4 (0.2)	2 (0.1)	<0.001[a,b]
≥15,000 lux (min/day)	0.6 (0.05)	0.9 (0.07)	0.4 (0.03)	<0.001[a,b,c]

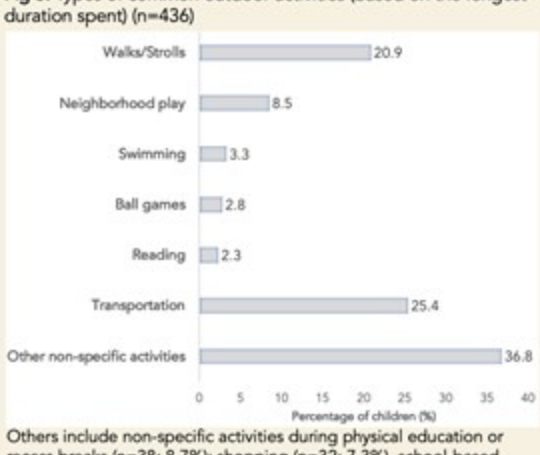
SE, Robust standard errors.*P values from univariable linear regression model with GEE.
[a,b,c] Significant pair-wise comparisons of mean values denoted by superscripts a (mid-day versus morning), b (mid-day versus evening), or c (morning versus evening) respectively.

Fig 2. Light patterns across Singapore daylight hours (n=483).



- Light exposure peaked at mid-day *(Table 2)*.
- Hourly light levels were <693 lux/hr and light exposure duration were <5.6min/hr *(Fig 2)*.

Fig 3. Types of common outdoor activities (based on the longest duration spent) (n=436)



Others include non-specific activities during physical education or recess breaks (n=38; 8.7%); shopping (n=32; 7.3%), school-based activities such as assembly time (n=21; 4.8%), mealtime (n=19; 4.4%) and other non-defined activities.

- The most common outdoor activities were walks, neighbor-hood play and swimming (Fig 3).

Conclusions

- Time outdoors, light levels and light episodes were low in Singaporean children aged 9 years.
- Children spent 76% of light exposure duration at <5000 lux.
- Reported time outdoors was protective against myopia, but not light levels or specific light measures. Longitudinal studies are needed to confirm findings.
- We recommend boosting duration spent outdoors, via group-based activities or by improving access to age-relevant outdoor facilities, walking trails and parks.

Table 3: Association between exposures with outcomes (n=483).

	Myopia (≤-0.5D) OR (95% CI)†	P‡	SE (D) β (95%CI)†	P§	AL (mm) β (95% CI)†	P§
Reported daily time outdoors (hr/day)						
Per hourly increment	0.82 (0.70, 0.95)	0.009	0.12 (0, 0.23)	0.051	-0.04 (-0.10, 0.02)	0.17
Average daily light levels (lux) [per 1000 lux increment]						
Outdoor light levels	0.91 (0.81, 1.02)	0.11	0.04 (-0.04, 0.12)	0.36	-0.02 (-0.06, 0.02)	0.39
Average light levels	0.60 (0.21, 1.71)	0.34	0.31 (-0.30, 0.93)	0.32	-0.28 (-0.57, 0.01)	0.056
Average daily duration of light exposure (hr/day)						
Per hourly increment at ≥1000 lux	0.78 (0.41, 1.48)	0.45	0.14 (-0.36, 0.64)	0.59	-0.16 (-0.41, 0.08)	0.19

OR, odds ratio.
†Multivariable models adjusted for: gender, ethnicity, near-work, number of myopic parents, maternal educational level and child's height (for models with outcome AL).
‡P values from logistic (or § linear) regression model with GEE using paired eyes.

- Time outdoors was protective against myopia (Table 3).
- Light levels, the timing and frequency of light exposures were not associated with outcomes (Ps>0.05).

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