Supplementary Materials to:
Using light meters to investigate the light-myopia association – a literature review of devices and research methods

Supplementary Table 1 Keywords and dates of the conducted abstract searches

search term	dates of searching
PubMed searches	
myopi* AND light	2021/11/30, 2023/01/02 (2022 only)
myopi* AND light sensor	2021/12/14, 2023/01/02 (2022 only)
myopi* AND "light exposure"	2021/12/14, 2023/01/02 (2022 only)
myopi* AND "light intensity"	2021/12/23, 2023/01/02 (2022 only)
myopi* AND "light level"	2021/12/23, 2023/01/02 (2022 only)
myopi* AND "light meter"	2021/12/23, 2023/01/02 (2022 only)
myopi* AND sunlight	2022/01/11, 2023/01/02 (2022 only)
myopi* AND "ambient illumina*"	2022/01/11, 2023/01/02 (2022 only)
myopi* AND lux	2022/01/11, 2023/01/02 (2022 only)
myopi* AND RGB	2022/01/25, 2023/01/02 (2022 only)
myopi* AND "circadian rhythm"	2022/01/25, 2023/01/02 (2022 only)
myopi* AND outdoor	2022/02/15, 2023/01/02 (2022 only)
myopi* AND wearable device	2022/02/22, 2023/01/02 (2022 only)
"refractive error" AND light sensor	2022/02/22, 2023/01/02 (2022 only)
"axial length" AND light sensor	2022/02/22, 2023/01/02 (2022 only)
Web of Science searches	
myopi* AND light	2022/05/13, 2023/01/02 (2022 only)

Supplementary Table 2 Identified devices from literature search and subsequent search terms

device	searched for "… AND myopi*"	comment
Actigraph GT3X+	Actigraph GT3X+	
Actillume	Actillume	
Action W Actigraph Watch with Motion Logger-L	Action W Actigraph Watch with Motion Logger-L	
Actiwatch 2	Actiwatch 2	
Actiwatch-L	Actiwatch-L	
Actiwatch Spectrum	Actiwatch Spectrum	
Actiwatch Spectrum Plus	Actiwatch Spectrum Plus	
Actiwatch Spectrum PRO	Actiwatch Spectrum PRO	
AKESO	AKESO	identified later during "cited references search"
Clouclip / Clouclip M2	Clouclip	sometimes version (M2) specified, sometimes not
Daysimeter	Daysimeter	different names and versions found (Dimesimeter, Daysimeter-D, Daysimeter-S)
FitSight	FitSight	
GENEActive	GENEActive	

HOBO Pendant UA-002-08	HOBO	only differs from version UA-002-64 regarding storage capacity
HOBO Pendant UA-002-64	HOBO	only differs from version UA-002-08 regarding storage capacity
LuxBlick	LuxBlick	
Mumu	Mumu	
MyLyt	-	identified during final literature search in January 2023; thus, no keyword search for ([device name]) AND (myopi*) was conducted
Octagonal Sleep Watch-L	Octagonal Sleep Watch-L	
Sleepwatch-L	Sleepwatch-L	
StowAway	StowAway	
Vitalog PMS-8	Vitalog PMS-8	

Notes: Included are all devices that were identified after the first part of the literature, for which a search for ([device name]) AND (myopi*) was then conducted. This encompasses both devices that had been used in a myopia-related study before as well as devices that – based on our knowledge – had not, but may be used in one, based on their capacity to measure light intensity. The two devices (AKESO and MyLyt) identified later during the literature search are included as well.

Supplementary Information S1: Results of the Excluded Publications

Four publications were identified, in which primarily other aspects of light exposure and/or myopia were investigated, but the association between the two was also considered, the results of which will be presented here. Abbott et al (2018)[1] investigated the relationship between intrinsically photosensitive retinal ganglion cell (ipRGC)-driven pupil response and light exposure, also examining relationships between light exposure, sleep, and melatonin in emmetropic and myopic adults. No significant differences were detected between refractive groups regarding time outdoors (>1,000 lux) or white light exposure, measured with Actiwatch Spectrum. Ostrin (2018)[2] evaluated the ipRGC-driven pupil response in children and examined it with Actiwatch Spectrum-measured light exposure and refractive error, revealing similar average white light exposure over 24h between myopic and non-myopic participants. Burfield et al (2019)[3] examined ocular and systemic diurnal rhythms in emmetropic and myopic adults as well as relationships with light exposure measured with Actiwatch Spectrum. Time outdoors (≥1,000 lux) as well as white light exposure during the day and night were similar between myopic and emmetropic participants. Lastly, Flanagan et al (2020)[4] studied the relationship between refractive error, circadian phase, and melatonin in young adults, also considering prior light exposure measured with Actiwatch 2. Myopic participants were found to have spent more time in “indoor” photopic light (3 - ≤1,000 lux) than non-myopic participants, but time “indoors” was not correlated to either SER or AL. Various other light parameters exhibited no refractive group differences. Another publication excluded from the review despite being closely related to its scope was by Fan et al (2022)[5], who longitudinally examined the effects of visual behavior in online versus traditional learning on myopia progression in children wearing the Akeso eye care glasses. They found a negative correlation between outdoor time and AL growth. This was the only analysis on the association between light exposure and myopia, and outdoor time was classified by means of UV and lux data together. As there was no analysis on light intensities alone, the publication was not included. Finally, Tanrıverdi et al. (2019)[6] presented a conference poster comparing percentages of different illumination conditions, measured with the Vivior Monitor, in progressive myopic children. They reported 15.5% time in >50 lux, 61.3% in 10-50 lux, and 23.2% in <10 lux. Since no analysis of light exposure data with regard to different refractive groups or refractive error was conducted, this publication was also not included.

Supplementary Table 3 Detailed information about the included publications

publication	type of publication	general purpose of the study	kind of study	device[a]	device position & orientation[a]	logging interval[a]	place & time of light data acquisition
Backhouse et al (2011)[7]	conference poster	examination of school-aged children's light exposure patterns in relation to refractive error	observation - longitudinal	HOBO Pendant UA-002-64	*not reported*	10 s	place: *not reported* – probably Auckland, New Zealand (cf. affiliations) time: June, July, August (year: *not reported*) – one measurement period/month
Dharani et al (2012)[8]	journal article	comparison of outdoor activities diary & light meter to assess two possible myopia predictors – light exposure and outdoor time – in Singapore children	observation – cross-sectional; methodological	HOBO Pendant UA-002-64	worn on shirt with safety pin, light sensor facing outward	5 min	place: Singapore time: April-June 2011
Schmid et al (2013)[9]	journal article	exploration of the relationship between near work, indoor illumination, daily sunlight & UV exposure in emmetropic & myopic university students	observation – cross-sectional	HOBO Pendant UA-002-08	clipped on shirt pocket, collar, or midline in stable upright position & chain through eyelet at end cap	5 min	place: Brisbane, Queensland, Australia time: *not reported*
Alvarez & Wildsoet (2013)[10]	journal article	report of a technique for quantifying light exposure with wearable sensors	observation – cross-sectional; methodological	HOBO Pendant UA-002-64	mounted on custom pedestal attached to Velcro armband worn on upper arm, light sensor pointing skyward	10 s	place: Northern California, USA time: March, 30-April, 13 2011 (spring season), November, 3-November, 17 2011 (fall season), February, 23-March, 8 2012 (winter season)
Read et al (2014)[11]	journal article	objective assessment of daily light exposure and physical activity in myopic & emmetropic children	observation – cross-sectional	Actiwatch 2	non-dominant wrist	30 s	place: Brisbane area, Australia time: July-December 2012

Read et al (2015)[12]	journal article	examination of the relationship between objectively measured ambient light exposure and longitudinal changes in axial eye growth in children	observation – longitudinal	Actiwatch 2	non-dominant wrist	30 s	place: Brisbane area, Queensland, Australia time: July-December 2012 (1st measurement period) & February-August 2013 (2nd measurement period)
Ostrin (2017)[13]	journal article	continuous light exposure & activity measurement across seasons & refractive error groups for assessment of objectively measured differences & comparison with subjective data	observation – cross-sectional	Actiwatch Spectrum	wrist	30 s	place: Houston, Texas, USA time: January-November 2014
Wu et al (2018)[14]	journal article	investigation of the effectiveness of a school-based program promoting outdoor activities for myopia prevention & identification of protective light intensities	intervention; observation – longitudinal	HOBO Pendant UA-002-08	collar (Fig. 1 indicates that the device was clipped near the collar & secured with a lanyard)	5 min	place: Taiwan (various locations) time: September 2013-February 2014 (total trial time), light measurement at baseline & end of study
Ostrin et al (2018)[15]	journal article	examination of objectively measured time outdoors, light exposure, activity & sleep in children during school & summer and assessment with eye growth as well as evaluation between parent and child behaviors	observation – longitudinal	Actiwatch Spectrum	wrist	1 min	place: Houston, Texas, USA time: January-May (spring school session), June-August (summer session), September-December (fall school session) (year: *not reported*)
Read et al (2018)[16]	journal article	comparison of daily light exposure patterns in similarly aged children from Australia and Singapore who are known to exhibit differences in myopia prevalence	reanalysis; methodological	Actiwatch 2; HOBO Pendant UA-002-08	Actiwatch: non-dominant wrist; HOBO: on shirt, fastened with safety pin, light sensor facing outward	Actiwatch: 30 s; HOBO: 5 min	Actiwatch: place: Brisbane, Australia time: September 2012-June 2013; HOBO: place: Singapore time: April-June 2011

Landis et al (2018)[17]	journal article	evaluation of dim light exposure in myopia in children and adolescents	reanalysis	Actiwatch 2	non-dominant (cf. Read et al, 2014[11], 2015[12]) wrist	30 s	place: Brisbane area, Queensland, Australia time: baseline ocular measurements May-November 2012 & 1st light measurement period over following 14 days, 2nd light measurement period 6 months later
Ulaganathan et al (2019)[18]	journal article	investigation of the association between objectively measured ambient light exposure and longitudinal AL changes & their seasonal variations over 12 months in emmetropic & myopic young adults	observation – longitudinal	Actiwatch 2	non-dominant wrist	30 s	place: Brisbane, Australia time: May 2015-September 2015 (winter light measurement period), November 2015-February 2016 (summer light measurement period)
Wen et al (2020)[19]	journal article	reassessment of the association between near work, outdoor exposure & myopia in children with an objective approach	observation – cross-sectional	Clouclip	right arm of eyeglass frame (frames without lenses provided for subjects not wearing spectacles)	2 min	place: Ningxiang, Hunan Province, China time: *not reported*
Franklin (2020)[20]	dissertation	exploration of average daily light exposure and impact of season, day of week & latitude on said exposure, assessment of time spent outdoors and provision of data on the influence of light exposure upon eye growth in UK school children	observation – longitudinal	Actiwatch 2	wrist	30 s	place: United Kingdom (various locations) time: May 2017-June 2019 (including baseline, year 1 & year 2 follow-up)

Li et al (2020)[21]	journal article	development of a practical approach to quantify the exposure to environmental risk factors of myopia	observation – cross-sectional; methodological	Clouclip	right side of spectacle frame (frames without lenses provided for subjects not wearing spectacles)	2 min	place: *not reported* – probably China (cf. affiliations) time: *not reported*
Li et al (2021)[22]	journal article	evaluation of the association of reported time outdoors and light exposure patterns with myopia in 9-year-old children from the Growing Up in Singapore Towards Healthy Outcomes (GUSTO) birth cohort	observation – cross-sectional	FitSight	wrist	1 min	place: Singapore time: *not reported*
Mirhajianmoghadam et al (2021)[23]	journal article	assessment of behaviors during COVID-19 in myopic and non-myopic children	observation – cross-sectional	Actiwatch Spectrum Plus	wrist	1 min	place: Houston area, Texas, USA time: July-August 2020
Bhandari et al (2022)[24]	journal article	subjective & objective assessment of behaviors in myopic and non-myopic school children in the US during the Covid-19 pandemic	observation – cross-sectional	Clouclip	mounted on right spectacle frame (glasses with plano spectacles provided for non-myopic children)	2 min	place: Houston, Texas time: December 2020-May 2021
He et al (2022)[25]	journal article	evaluation of dose-response efficiency of (increasing) time outdoors per school day over 2 years on myopia onset & shift	intervention; observation – longitudinal	Mumu	wrist	20 s	place: Shanghai, China time: October 2016-December 2018 (total trial time; light data collection during second year)
Li et al (2022)[26]	journal article	investigation if SMS text messages to parents increase light exposure & time outdoors in school-aged children and provide effective myopia control	intervention; observation – longitudinal	HOBO Pendant UA-002-64	fixed on clothes, light sensor facing outward	10 s	place: Anyang, China time: May 2017-May 2018 (group allocation, then observation for 3 years; light data collection within 2 weeks before and after the intervention)

Supplementary Table 3 – Continued Detailed information about the included publications

publication	device calibration & additional measurements[a]	visual measurements & respective classifications[b]	subjects[c]	measurement duration & protocol[a] (incl. compliance enhancement measures)
Backhouse et al (2011)[7]	*n/a*	cycloplegic autorefraction	N = 12 school-aged children; 13-14 years	7 days per measurement period; 3 measurement periods over 3 consecutive months
Dharani et al (2012)[8]	two persons wore device under five conditions: a) outdoors – bright sunny day, b) outdoors – dark cloudy day, c) indoors – enclosed space, d) indoors – near window with stream of bright sunlight, e) indoors – device not worn & left on table) → revealed overlap between b) and d)	subject groups: **myopic** (≤ -0.50D SER) & **non-myopic**, underlying measurements *not reported*	N = 117 children participating in Family Incentive (FIT) trial included in analysis; 6-12 years (M±SD 8.3±1.6); 57 female, 60 male; 103 Chinese, 8 Indian, 6 other subject groups: n = 65 myopic, n = 52 non-myopic exclusion criteria: medical conditions like type 1 diabetes, severe asthma, mental illness	continuously for 7 days; parental guidance; e-mails & phone calls once to ensure compliance
Schmid et al (2013)[9]	measurements under different representative lighting conditions at place & time of year of study to categorize light data → see "IO-cut-off & other data categorization"	myopia (≤ -0.50D SER) & emmetropia (-0.25±1.00D SER) based on non-cycloplegic subjective refraction (maximum plus for best visual acuity methodology & blur back techniques) right eye measurements analyzed myopia progression status retrospectively determined from 2-3 years prior (initial measurement, IM)	N = 30 3rd- & 4th-year university students; 17-25 years; 77.1% female; 48.6% Asian, 49% European/white & 11.4% Indian; all best-corrected distance acuities at least 6/6 in each eye & no strabismus subject groups: n = 13 emmetropic (SER M±SD +0.11±0.39D), n = 12 stable myopic (SER M±SD -3.61±1.47D),	3 days (Wed, Fri, Sat); advised to wear during waking hours

		subject groups: **emmetropic** (both at IM & study time), **stable myopic** (myopia at IM & ≤0.25 D progression), **progressing myopic** (myopia at IM & ≥0.50 D progression)	n = 10 progressing myopic (SER M±SD -2.48±1.74D) exclusion criteria: hyperopia ≥ +1.50D, anisometropia ≥ 1.50D, astigmatism ≥ 1.50D, amblyopia, keratoconus, past myopia progression treatment	
Alvarez & Wildsoet (2013)[10]	sample light measurements with device at desk height & sensor pointing skyward in indoor environments frequented by subjects → never > 1,000 lux; simultaneous outdoor measurements with device, photometer (calibrated to CIE photopic function) & pyranometer for one day → discrepancies at high lux levels, explained with device sensitivity differences & coarser sampling interval for photometer & pyranometer; test of devices' responses mounted horizontally (sensor facing skyward) & vertically (sensor facing outward) for 1 h of simultaneous collection with 0.1 Hz sampling rate → vertical orientation on average (mean) 90% & 52% lower than horizontal outdoors in sunlight & indoors with non-directional light source, respectively	myopia (≤-1.00D SER) & emmetropia (0±0.50D SER) classified based on non-cycloplegic autorefraction (Grand Seiko WE-5100K) refractive errors reported as right eye SER	N = 27 UC Berkeley students; 18-25 years (M±SD 20.67±2); 17 females, 10 males; 48% Asian, 15% Caucasian, 37% other; all no anisometropia >1.50D, normal corrected visual acuity (20/20), age-appropriate accommodative amplitudes & facilities, no ocular health or binocular vision anomalies; 23 myopic (SER -1.06D - -8.56D, M±SD -3.76±2.09D; 39.1% progressing), 4 approx. emmetropic (SER M±SD -0.10±0.31) exclusion criteria (not conclusive): eye disease, refractive surgery	over 14 consecutive days, simultaneously for all subjects of the same season (n = 7 in spring, n = 10 in fall, n = 10 in winter); instructed to wear all day, every day & to place by bed when sleeping; daily morning text messages to encourage compliance
Read et al (2014)[11]	all devices manufacturer-calibrated prior to study & pilot study in which they were mounted together on a board and carried through a range of	subject groups: **myopes** (average SER from right & left eyes ≤ -0.50D, with at least one eye ≤ -0.75D) & **emmetropes** (average SER	N = 102 children enrolled in role of outdoor activity in myopia (ROAM) study; 10-15 years (M±SD 13.1±1.4);	2 weeks (14 days) during school term; instructed to wear 24 h/day & to ensure no obstruction of device by clothing;

	lighting environments with a range of movements (recording every 30 s for 60 min) → inter-device intraclass correlation 0.99 for light data	from right & left eyes < +1.25D and > -0.50D, with neither eye ≤ -0.75D) based upon non-cycloplegic spherical equivalent subjective refraction	all normal best-corrected visual acuity of logMAR 0.00 or better, no history or evidence of significant ocular disease, no hyperopic refraction errors > +1.25D subject groups: n = 41 myopes (SER M±SD -2.39±1.50D, 51% female), n = 61 emmetropes (SER M±SD +0.34±0.30 D, 53% female), of which n = 41 were age & gender matched to a myope and wore device at the same time; similar distribution of age & gender among matched (n = 82; for both groups: mean age 13.0 years & 51.2% female) and unmatched (n = 20; mean age 13.4 years & 55.0% female) subjects *reported results based on the 82 matched myopes & emmetropes*	if device was removed for any reason (e.g., swimming continuously for > 30 min or engaging in activity where watch-wearing was prohibited), asked to complete diary to document type of activity & environment (indoors/outdoors)
Read et al (2015)[12]	see Read et al (2014)[11]	see Read et al (2014)[11] for subject groups; refractive error determination described here as non-cycloplegic subjective refraction aiming for maximum plus/least minus for best visual acuity & then binocular balancing for AL, five repeated measurements from both eyes taken with optical biometer (Lenstar LS 900)	N = 101 children (of 102, 1 excluded from analyses due to retinal dystrophy signs at 2nd visit) enrolled in ROAM study; 10-15 years; all best-corrected visual acuity of logMAR 0.00 or better in each eye, no history or evidence of significant ocular disease, no anisometropia > 1.25D	2x14 days during school academic term with 5.3-9.4 months (M±SD 6.4±0.7) between baseline & follow-up; measurement protocol similar to Read et al (2014)

		ocular measurements taken at baseline (prior 1st light measurement period) & every 6 months after that over 18 months, all scheduled between 3PM & 5PM to limit potential influence of diurnal AL changes upon data	subject groups (classified based on baseline measurement): n = 41 myopic (SER M±SD -2.39±1.50D; age M±SD 13.0±1.5 years; 51% female), n = 60 non-myopic (SER M±SD +0.34±0.30D; age M±SD 13.1±1.2 years; 52% female) exclusion criteria: non-cycloplegic hyperopic refractive errors of > +1.25D, any optical or pharmacological treatments to slow myopia progression over 18 months, 3 subjects lost to follow-up (2 after baseline, 1 after 2nd ocular measurement visit) & 4 excluded from analysis due to beginning orthokeratology contact lens wear (3 after 2nd, 1 after 3rd ocular measurement visit) → 99 subjects with data from at least 2 visits, 94 with complete data (59 non-myopic, 35 myopic subjects)	
Ostrin (2017)[13]	5 randomly chosen devices mounted on holder with sensors oriented upwards & measured against calibrated luxmeter & UV sensor in 14 conditions (inside 10 buildings on University of Houston campus & in 4 outdoor locations) for 5 min & with 5 individual measurements with luxmeter & UV sensor → significant correlation (R^2 = 0.99) between ambient illuminance	subject groups: **emmetropic** & **myopic** subjects classified based on history & habitual correction	N = 55 adults; 21-64 years (M±SD 37.0±8.8); 24 males, 31 females subject groups: n = 18 emmetropic, n = 37 myopic	continuously for 14 days (n = 15 in winter, n = 19 in spring, n = 15 in summer, n = 6 in fall); instructed not to remove device (even during sleep) & to ensure that light sensor was unobstructed & not covered by clothes

	measured with devices & luxmeter for all conditions; no relationship between device & UV sensor measurements indoors, but correlation between increase in UV & higher ambient illuminance outdoors; 5 devices mounted on a holder with sensor directed upwards & measured light levels in various conditions (winter sun & shade, summer sun & shade, rooms in homes, elementary school classroom) for 7 days → rarely during summer sun, outdoors > 199,999 lux (devices' upper boundary, replaced by 200,000 lux), outdoor means during brightest 2 h/day averaged over days & devices 1,443 lux (winter shade) - 176,497 lux (summer sun), means in homes (7PM-9PM) 3.15 lux (home office) - 248 lux (family room), classroom during school hours mean 248 lux; 2 devices tested outdoors with 14% transmitting sunglasses placed over sensors at 10 mm & directed upwards in full sun & full cloud cover during summer (10 min each) → full sun mean 34,207 lux, full cloud cover mean 2,973 lux			
Wu et al (2018)[14]	light intensities measured with luxmeter at different areas of schools → ≥ 1,000 lux in any area outside classrooms	myopia (≤ -0.50D SER) classified based on cycloplegic autorefraction (KR-8100; 1 drop of 0.5% proparacaine followed by 1 drop of 1%	N = 930 grade 1 school children enrolled in Recess Outside Classroom Trial 711 (or control group wait list); 6-7 years (M±SD 6.34±0.48);	2x7 consecutive days; additional recording of activities in diary every half hour to determine outdoor activity time;

		tropicamide & 1% cyclopentolate hydrochloride administered 5 min apart; measurements 30 min after administration of initial drop & pupil size > 6 mm diameter; 5-8 consecutive readings) ocular assessments at baseline and end of study	47.85% female; 10.53% myopic (from n = 927, after exclusion of myopic children with current treatment) n = 693 completed full 1-year program (120 excluded for myopia treatment, 117 did not attend final assessments) – baseline characteristics (calculated from data given for trial & control group separately in Appendix): 65.08% 6 years, 34.92% 7 years; 52.38% male, 47.62% female; 8.95% myopic; SER M±SD 0.36±0.80D trial group, 0.41±0.82D control group exclusion criteria: best-corrected visual acuity not achieving 20/25, amblyopia, orthokeratology, atropine eye drop treatment *analysis based on the 693 children*	teachers were responsible for reminding subjects to wear device at school & parents were informed about importance of using device & diary out of school
Ostrin et al (2018)[15]	*n/a*	subject groups: **hyperopes** (> +2.00D SER), **emmetropes** (+2.00D - -0.25D SER) & **myopes** (< -0.25D SER) classified based on cycloplegic autorefraction (WAM-5500; eyes dilated with 0.5% proparacaine, 1% tropicamide,	N = 60 children (of 64, 4 lost to follow-up) from 38 families at one-year exam & analyzed; 5-10 years (recruited; M±SD 7.6±1.8); 24 females, 38 males; 45 Caucasian, 8 Asian, 4 Hispanic, 3 African American; all best-corrected visual acuity of 20/25 or better;	3x continuously for 2 weeks across the year (2 school & 1 summer session per subject); instructed not to remove device for entire period

		2.5% phenylephrine; ≥ 5 measurements) of right eye for AL, 3 measurements averaged per eye (LenStar; after eye dilation) measurements taken at enrollment & after one year only right eye data included in analyses; SER similar between right and left eyes	baseline SER -2.41 - +7.75D (M±SD +0.85±1.49) subject groups (baseline): n = 5 hyperopes (SER M±SD +4.12±2.26D), n = 47 emmetropes (SER M±SD +0.86±0.50D), n = 8 myopes (SER M±SD -1.28±0.67D) exclusion criteria: ocular pathology, treatment for myopia (incl. atropine drugs or multifocal contact lenses)	
Read et al (2018)[16]	pilot experiment in Brisbane to determine comparability between the two devices with 10 adults wearing them simultaneously (Actiwatch on non-dominant hand, HOBO fastened to shirt) for 60 min, light measures collected every 60 s, mean light exposure & minutes of outdoor light exposure analyzed within each subject → high correlation between both devices (*r* = 0.79 mean light exposure, *r* = 0.95 min of outdoor light exposure), M±SD 4,677±11,048 lux difference for mean light exposure (greater for HOBO; difference M±SD 104±151 lux for < 1,000 lux & M±SD 9,760±15,117 lux for > 1,000 lux), M±SD 0.4±1.1 min difference for outdoor light exposure times (more with HOBO) → mean light exposure	subject groups: **myopic** (≤ -0.50D SER) & **non-myopic** (+1.25 - < -0.50D SER) see Read et al. (2014)[11] for information on ocular measurement procedures for Actiwatch sample	N = 112 children with valid light exposure measures from ROAM study (n = 43; Actiwatch) or FIT trial, Singapore (n = 69; HOBO) analyzed; ROAM: 10-12 years (M±SD 11.3±0.6), FIT: 8-12 years (M±SD 9.2±1.1); ROAM: 44% female, FIT: 38% female; ROAM: 36 Caucasian, 6 East Asian, 1 South Asian, FIT: 64 East Asian, 5 South Asian; all residing in urban regions, good general health, best-corrected vision in both eyes logMAR 0.00 or better; all no history or evidence of ocular disease or hyperopic refraction error of > +1.25D; SER +1.16 - -9.06D (M±SD -1.57±2.05), ROAM: SER +1.00 – -6.25D (M±SD -0.71±1.43),	Actiwatch: 2x14 days (separated by ca. 6 months) during school term, worn continuously for 24h/day; for more information on protocol see Read et al. (2014, 2015)[11,12] HOBO: continuously over 7 days from waking until end of day, n = 40 children during school term & n = 29 children during school vacation; for more information on protocol see Dharani et al. (2012)[8]

	levels overestimated with HOBO, but similar outdoor light exposure estimates & thus data analysis concentrated on measures of time exposed to > 1,000 lux for any measurements in the respective data acquisition studies, see Read et al (2014)[11] for Actiwatch & Dharani et al (2012)[8] for HOBO		FIT SER +1.16 - -9.06D (M±SD -2.14±2.22) subject groups: ROAM: n = 19 myopic & n = 24 non-myopic, FIT: n = 40 myopic & n = 29 non-myopic	
Landis et al (2018)[17]	sensitivity of device at dim illuminance levels measured by comparison with calibrated luxmeter across 16 dim (0-40 lux) light levels by placing both devices in same room facing vertically upwards with device taking 3 readings per level, which were averaged → device's light sensor high agreement with luxmeter (R^2 = 0.9958; differences M±SD 2.1±1.1 lux with greater differences at higher levels), indicating high sensitivity for assessing dim lights	subject groups: **myopic** (average SER from right & left eyes ≤ -0.5D & at least one eye ≤ -0.75D) & **non-myopic** (average SER from right & left eyes < +1.25D and > -0.5D & neither eye ≤ -0.75D) based on non-cycloplegic subjective refraction aiming for maximum plus/least minus for best visual acuity ocular measurements at baseline, 6 months & 1 year later	N = 80 ROAM study participants analyzed; 10-15 years; all no history of ocular disease; all best-corrected VA of logMAR 0.00 or better in each eye subject groups (based on baseline measures): n = 40 myopic (SER M±SD -2.39±1.5D), n = 40 non-myopic (SER M±SD 0.34±0.3D); each myopic child paired with nonmyopic child of same sex & similar age, wearing device over same period, one additional pair excluded due to development of ocular pathology in non-myopic child	2x14 days 6 months apart; activity diary to record if watch removed (e.g., for sports practice or bathing); for more information on protocol see Read et al (2014, 2015)[11,12]
Ulaganathan et al (2019)[18]	*n/a*	subject groups: **emmetropes** (< 0.75D & > -0.75D SER) & **myopes** (≤ -0.75D SER) based on subjective, non-cycloplegic SER of right eye	N = 43 Queensland University of Technology students completing baseline; 18-30 years (M±SD 21.9±3.8); 29 female, 14 male; all visual acuity of 0.00 logMAR or better & no anisometropia >	2x14 days (1x winter, 1x summer), worn continuously for 24h/day; instructed to ensure that sensor was not covered by clothing; for details on protocol, referred

		AL (i.e., distance from anterior corneal surface to retinal pigment epithelium) of right eye measured with Lenstar LS 900 between 9AM & 11AM to avoid diurnal AL variations influencing results prior each measurement session, subjects asked to view 5 m distance target binocularly with optimal distance spectacle correction for 10 min to minimize influence of previous activities on measurements AL measured every 6 months over 12 months: baseline May 2015-September 2015 (winter), follow-up 1 November 2015-February 2016 (summer), follow-up 2 May 2016-September 2016 (winter)	1.00D or cylindrical refraction > 1.25DC & no history or evidence of ocular or systemic diseases and/or ocular surgeries/injuries subject groups: n = 21 emmetropes (M±SD 21.9±3.7 years; SER +0.26 - -0.62D, M±SD +0.06±0.31), n = 22 myopes (M±SD 21.8±4.0 years; SER -0.75 - -8.25D, M±SD -3.76±2.11) → each myope paired with an emmetrope to wear device over same period & had AL measured during same week exclusion criteria: SER > +0.75D, conditions disruptive to habitual light exposure patterns (e.g. insomnia, night shift work), optical or pharmacological myopia control treatment (e.g. orthokeratology lenses, multifocal spectacle/contact lenses, atropine), rigid contact lenses; regular spherical soft contact lens wearers included (n = 2) & asked to not use on measurement days all enrolled subjects wore device in winter & n = 37 (19 myopes, 18 emmetropes) in summer	to Ulaganathan et al (2017)[27], where the following is reported: advised to remove device only if planning to be in water for > 30 min & if device was removed, they recorded type, duration & environment (indoors/outdoors) of the activity performed during removal in diary

Wen et al (2020)[19]	*n/a*	subject groups: **myopic** (≤ -0.5D SER) & **non-myopic** based on cycloplegic autorefraction (AR-1; 3 cycles of cyclopentolate 1% (1 drop) instilled 5 min apart, cycloplegic status tested with light reflex 30 min later)	N = 86 5th graders from Lao Liangcang Primary School in Ningxiang; M±SD 10.31±0.48 years; 42 (48.84%) male, 44 (51.16%) female; SER M±SD -0.35±1.26D subject groups: n = 28 (32.56%) myopic, n = 58 (67.44%) non-myopic inclusion criteria: normal ocular health, SER -6.00D - +1.00D, anisometropia of < 1.00D	continuously for 1 week (5 weekdays, 2 weekend days); required to wear during day, except for bathing & sleeping; teachers & parents asked to check whether subjects wore device to improve compliance
Franklin (2020)[20]	all devices carried through 4 environments (indoors/outdoors, high/low illuminance) side-by-side for 15 min each with 15 s logging interval → all except 2 devices (one broken) ≥ 0.99 correlation coefficient, same in repeat study; after manufacturer repaired/replaced the 2 devices, 1.00 correlation coefficient with 2 others; investigation of degree to which device's rotational orientation may affect light exposure readings by placing 5 devices in touching proximity at 5 orientations & recording light intensity in the 4 conditions as above (15 min each, logging every 30 s) → significant difference in illuminance in all orientations across all conditions and all tested orientations (0, 45, 90 degrees)	myopia (≤ -0.50D SER in at least one eye) & emmetropia (> -0.50D & < +2.00D SER in both eyes), hyperopia (≥ 2.00D SER in at least one eye & neither eye myopic) based on objective cycloplegic autorefraction (WAM-550; while focusing on 3 m distance target; 1 drop of 1.0% cyclopentolate hydrochloride & < 2D defined as acceptable level of residual accommodation – if not after 40 min in subjects with darker irises, additional drop; 10 measurements taken per eye & averaged) AL measured with ocular biometer (Aladdin), after cycloplegia	N = 68 school children analyzed; 7.5-11.3 years (M±SD 9.2±1.1); 61.8% female; 85.9% white, 4.7% Asian, 1.6% Chinese, 7.8% mixed (information available for 95.6% of subjects); -4.75D - +5.57D SER (M±SD +1.20±1.44D); 3 (4.4%) myopic, 11 (16.2%) hyperopic, 54 (79.4%) emmetropic exclusion criteria: previous adverse reaction to or medicine that may interact with cycloplegic drops, ocular condition requiring medication, past/present myopia control intervention (atropine, orthokeratology, multifocal soft contact lenses, bifocal or	11 days during school term (recording Fri 12PM-Mon 12PM) with 12 months ± 6 weeks between baseline, year 1 & year 2 follow-up; advised to wear 24 h/day & prevent clothing obstruction; originally advised that waterproof for 1 m for ≤ 30 min, but later found that seals were prone to leaking in 40°C, thus advised not to swim, shower, or bath with device *in results reported here, only light exposure data of summer seasons (i.e., collected during British Summer Time) included*

		visual measurements taken at baseline, 1-year & 2-year follow-up (each 12 months ± 6 weeks apart)	progressive addition spectacle lenses) *reported results based on subsample of n = 25 subjects with valid summer data & longitudinal eye growth data and for which no separate information on demographics is available*	
Li et al (2020)[21]	*n/a*	myopia (SER ≤ -0.5D) based on cycloplegic autorefraction average SER from both eyes used for analyses	N = 179 fourth graders recruited from 3 schools; M±SD 9.17±0.52 years; 92 male; M±SD 0.22±1.18D SER; 33 (18.44%) myopic inclusion criteria: normal ocular health (except refractive error), anisometropia of < 1.00D	continuously for 1 week (5 weekdays & 2 weekend days); required to wear throughout day, except when bathing & sleeping; teachers & parents asked to check whether subjects wore device to improve compliance
Li et al (2021)[22]	*n/a*	subject groups: **myopia** (≤ -0.5D SER) & **non-myopia** based on cycloplegic (3 drops of 1% cyclopentolate hydrochloride, instilled 5 min apart) autorefraction (Canon RK5/RK-F2, performed ≥ 30 min after 1st drop, with pupil dilation ≥ 6 mm) AL assessed with optical biometer (IOL Master 500) paired eyes analyzed	N = 483 children (of 716 returning to 9-year-visit of GUSTO birth cohort) analyzed; 9 years; 50.0% male; 59.8% Chinese; M±SD -0.61±1.83D SER; subject groups: n = 204 (42.2%) myopes, n = 279 (57.8%) non-myopes (applied) exclusion criteria: myopia treatment (orthokeratology, atropine)	14 days, recording during daylight hours (7 AM-7 PM)
Mirhajianmoghadam et al (2021)[23]	*n/a*	subject groups: **myopes** & **non-myopes** based on questionnaire using indirect method technique (i.e., series	N = 53 children; 5-12 years (M±SD 8.3± 2.4); 39 white, 7 African American, 5 Asian, 1 mixed, 1 unknown	continuously for 10 days & nights during Covid-19 related quarantine measures

		of questions about use of eyeglasses & age of first dispensing)	(parent report); 43 non-Hispanic, 10 Hispanic (self-report) subject groups: n = 14 myopes (M±SD 8.9±2.3 years), n = 39 non-myopes (M±SD 8.1±2.4 years)	
Bhandari et al (2022)[24]	devices validated for illuminance as described in Bhandari et al (2020)[28], where the following is reported: devices mounted to spectacle frame & placed in various indoor & outdoor locations in shade & full illumination, light levels compared with luxmeter (sensor oriented along line of sight at same level as device), each light level for ≥ 4 min & ≥ 2 measurements, 2 min apart, recorded with luxmeter → results *not reported* in Bhandari et al (2022)[24]	subject groups: **myopes** & **non-myopes** based on University of Houston Near Work, Environment, Activity, and Refraction (UH NEAR) questionnaire with a series of questions about use of eyeglasses & age of first dispensing & further confirmation by observing refractive correction worn when dispensing study material	N = 40 (of 58 enrolled) children analyzed; 10-18 years (M±SD 14.6±0.4); 22 Asian, 14 White, 2 African-American, 1 American Indian or Alaskan native, 1 other (parent report); 37 non-Hispanic, 3 Hispanic subject groups: n = 25 myopes, n = 15 non-myopes; age distribution similar between groups, Asian children more likely myopic than non-Asian children	1 week during virtual online schooling for most participants (only n = 2 non-myopic children reported attending in-person classes)
He et al (2022)[25]	*n/a*	myopia (right eye ≤ -0.50D SER), hyperopia (≥ +2.00D SER), emmetropia (SER ≥ -0.50D & ≤ + 0.75D) based on cycloplegic autorefraction (KR-8900; 2 (3 if insufficient) drops of 1% cyclopentolate 5 min apart & refractive error assessed 40 min later when pupils > 6 mm with no light reflex); incident myopia: myopia development in children non-myopic at baseline	N = 6295 grade I & grade II school children enrolled in Shanghai Time Outside to Reduce Myopia (STORM) trial; 6-9 years (M±SD 7.2±0.7); 3346 (53.2%) male, 2949 (46.8%) female; M±SD +1.00±1.01D SER; 429 (6.8%) myopes, 5866 (91.2%) non-myopes exclusion criteria: strabismus, amblyopia, myopia control treatment strategies (e.g.,	required to wear device every day from 7 AM to 8 PM throughout second trial year

		AL measured with optical biometer (IOL Master; measured 3x/eye, if difference between any 2 measurements > 0.05 mm, repeated until difference below that) only right eye data analyzed & only children with full myopia included in analysis of myopia onset & myopic shift	atropine, orthokeratology lens), refusing cycloplegia 5067 & 5340 subjects eligible for 2-year cumulative incidence & progression analysis, respectively	
Li et al (2022)[26]	*n/a*	myopia (SER < -0.5D) based on cycloplegic autorefraction (HRK-7000A; 2 drops of 1% cyclopentolate 5 min apart; refractive error assessed 30 min after last drop; 3 measurements averaged) AL measured with ocular biometry system (Lenstar LS900; 5 measurements averaged) only right eye data analyzed	N = 268 grade 2 students at baseline (n = 135 SMS group, n = 133 control group); M±SD 8.4±0.3 years; 147 (54.9%) male, 121 (45.1%) female; SMS: M±SD 0.66±1.05D SER, control: M±SD 0.37±1.34D SER; SMS: 19 (14.3%) myopic, 114 (85.7%) non-myopic, control: 23 (17.3%) myopic, 110 (82.7%) non-myopic inclusion criteria: best-corrected visual acuity of 20/20 or better in both eyes; -6.0D ≤ SER ≤ 1.5D & astigmatism < 1.5D per eye & anisometropia > 1.0D; no strabismus, amblyopia, or other ocular or systemic disease that may affect myopia development; ability to cooperate with ocular examinations & survey; no other myopia control intervention than school-based eye exercises	3 randomly selected days (2 weekdays, 1 weekend day) within 2 weeks prior & 2 weeks after intervention, respectively, recording time from 7 AM to 7 AM the following day; free annual ocular examinations & counseling for all children to help achieve good compliance

			of these participants, 261 took part in complete study & were analyzed	

Supplementary Table 3 – Continued Detailed information about the included publications

publication	data pre-processing (in-/exclusion, replacement procedures & rates)[a]	IO-cut-off & other data categorization[a]	main results & conclusion on light-myopia associations	comments
Backhouse et al (2011)[7]	*n/a*	IO-cut-off: > 1,000 lux to calculate amount of time spent outdoors amount of time spent indoors calculated from time in 10-1,000 lux	no significant correlation between refractive error & cumulative light exposure or between change in refractive error & cumulative light experienced over the 3 months measurement period	albeit longitudinal, the study only covered 3 months, and the change in refractive error was calculated from measurements directly before & after the 3 months of light data acquisition
Dharani et al (2012)[8]	for any day with all light measurements < 100 lux, assumption that child forgot wearing device & exclusion of day from analysis → exclusion rate *not reported* time outdoors derived from data from 7 AM to 7 PM	IO-cut-off: > 1,000 lux to assess outdoor time, based on similar IO-cut-offs from previous studies (Backhouse et al, 2010[29]; Alvarez & Wildsoet, 2011[30])	time outdoors (h/day) not significantly different between myopic and non-myopic subjects for both weekdays and weekend days	
Schmid et al (2013)[9]	*n/a*	IO-cut-off: > 10,000 lux (most definitely outdoors) & > 500 lux (some bright indoor activity potentially included) categories chosen based on measurements described in "device calibration & additional measurements": sunlight (≥ 30,000 lux), outdoor shade (10,000-30,000 lux), bright indoor/dim outdoor light (500-10,000 lux), dim room illumination (< 500 lux)	no significant difference in daily illuminance, amount of time per day in each light data category/condition or number of daily alternations from indoors to outdoors (respective IO-cut-off: *not reported*) between subject groups; no correlation between daily illuminance & refractive error	
Alvarez & Wildsoet (2013)[10]	only data between sunrise & sunset analyzed	IO-cut-off: ≥ 1,000 lux measurements as "outdoor exposure", citing other literature (Backhouse et al, 2010[29];	no correlations between refractive error (D) and the analyzed light exposure measurements (mean maximum	some information on additional measurements, subjects & main results taken from Alvarez (2012)[31]

		Dharani et al, 2012[8]) & referring to sample light measurements indoors (cf. "additional measurements") never exceeding 1,000 lux; Initially, an 882 lux IO-cut-off was used based on local solar radiation data, outdoor measurements on typical day during study & indoor measurements, but there were no significant differences in the data analysis outcomes between the 882 lux & 1,000 lux IO-cut-offs, so 1,000 lux was used for the sake of consistency with the aforementioned literature bright sunlight: > 10^5 lux	daily light intensity, average daily light intensity, mean % of daily time spent outdoors, mean daily time spent in bright sunlight, mean daily transitions between indoors & outdoors, solar-normalized cumulative light exposure)	
Read et al (2014)[11]	removal of invalid data (i.e., ≥ 15 min complete inactivity (indicates device removal) and/or complete darkness during daytime (indicates covered light sensor) → accounted for M±SD 6±11% of total data; for any of "off wrist" times documented in diary by subject, light level estimated based upon average of light levels measured 5 min prior & 5 min after device removal if these light levels were consistent with diary as indoors (<1,000 lux) or outdoors (>1,000 lux) – in case of inconsistency, which only	IO-cut-off: > 1,000 lux to estimate daily minutes in outdoor light levels, citing other literature (Dharani et al, 2012[8]; Guillemette et al, 1998[32]; Goulet et al, 2007[33]) daily minutes in > 1,000 lux, > 2,000 lux & > 3,000 lux examined in ROC curve analyses	emmetropes significantly greater daily light exposure than myopes; emmetropes significantly greater light exposure between 10 AM & 12 noon, 1 PM & 2 PM & 2 PM & 3 PM than myopes & no group differences at other times (all days considered), only significant for 1 PM-2 PM in both weekends and weekdays (if considered separately); emmetropes significantly more time in > 1,000 lux than myopes (difference 36 min/day) with a nonsignificant tendency of a greater difference on weekends than weekdays; in multivariate analysis, only daily time exposed to > 1,000 lux –	

	occurred for diary-recorded outdoor activities, the mean outdoor light level over the same period of time, averaged across all other measured days, used as estimate & only days including ≥ 90% valid data included in analysis to determine average min/day in > 1,000 lux → exclusion of one subject with only 7 h valid data overall; for remaining 101 subjects, M±SD 13.4±1.5 valid days (range: 6.0-14.0) & final data analyzed included M±SD 32±50 min (range: 0-271) of data per day estimated with diary (ca. 2% of data used) 6 AM-6 PM considered for calculation of daily light exposure, but e.g. daily pattern of light exposure analyzed throughout 24 h		and not e.g. daily time of moderate to vigorous activity or near work – independently, significantly associated with refractive error; in ROC analyses, all light exposure metrics (mean daily light exposure, minutes in > 1,000, > 2,000 and > 5,000 lux) significantly discriminated myopic from emmetropic subjects, with time in 2,000 lux showing best performance	
Read et al (2015)[12]	see Read et al (2014)[11] → over both measurement periods, M±SD 26.2±3.1 days of valid light exposure data (M±SD 13.4±1.5 days from 1st measurement period, M±SD 13.1±1.7 days from 2nd measurement period); between-session reliability of average daily light exposure measurements: 0.759	IO-cut-off: *not relevant* intensity thresholds of > 1,000 lux, > 2,000 lux, > 3,000 lux & > 5,000 lux to examine potential associations of eye growth with light exposure above certain intensity	mean daily light exposure over both measurement periods significantly lower in myopic than non-myopic subjects, not dependent on season (i.e., warmer or cooler measurement period); greater light exposure significantly associated with smaller longitudinal AL changes; significant associations between greater light exposure & less axial growth for mean (log) daily	1st measurement period equals Read et al's (2014)[11] data acquisition period

	mean daily light exposure between 6 AM & 6 PM used as primary light exposure measure; mean light exposure during other times uniformly low (6 PM-6 AM light exposure M±SD 7±5 lux & on average < 30 s/day exposure to > 1,000 lux)		minutes of exposure to > 3,000 lux & > 5,000 lux and no significant association for > 1,000 lux & > 2,000 lux; AL changes over time varied significantly between groups receiving low, moderate or high light exposure based on tertile split, with children with low light exposure exhibiting significantly greater axial eye growth than those with high and moderate light exposure & no significant difference between high and moderate light exposure groups; significant association between axial growth and both light exposure group & refractive error group (greater in myopic group) without interaction between them, suggesting independent effects	
Ostrin (2017)[13]	light exposure data only included if device was worn the entire day; days excluded if subject removed device for > 30 min, or if light exposure dropped to 0 for ≥ 30 min during daylight (indicating obstruction); nights excluded if subject removed device for all or part of night → days included M±SD 13.2±1.4 → nights included M±SD 14.2±1.3	IO-cut-off: ≥ 1,000 lux classified as outdoor light; in Discussion, no indoor values having been recorded > 1,000 lux given as reason for assuming measures > 1,000 lux as being outdoors light grading: darkness (< 9 lux), dim indoor light (10-99 lux), standard indoor light (100-999 lux), standard outdoor light (1,000-9,999 lux), bright outdoor light (> 10,000 lux) light parameters described as adapted from previous validation studies using a similar wrist-worn Actiwatch	no significant difference in objectively measured time outdoors between emmetropic and myopic subjects; no significant difference in daily white light exposure between emmetropic and myopic subjects	

		accelerometer in adults (Alvarez & Wildsoet, 2013[10]) and as having been used in a publication with children (Read et al, 2014[11])[d]		
Wu et al (2018)[14]	out of school, device wearing compliance decreased, so device only used to calculate outdoor time during school time (weekday mornings & Tuesday afternoons) & diary log used when not in school; 96% compliance of wearing device at the end of study during weekday in-school time *the results reported here are based on in-school measurements only*	IO-cut-off: ≥ 1,000 lux to calculate time outdoors, based on "additional measurements" additionally, total minutes of exposure to ≥ 3,000 lux, ≥ 5,000 lux & ≥ 10,000 lux calculated	after separation of all subjects into groups based on weekly in-school outdoor time (< 125 min, 125-199 min, ≥ 200 min) in various intensities (≥ 1,000 lux, ≥ 3,000 lux, ≥ 5,000 lux & ≥ 10,000 lux), those with ≥ 200 min in ≥ 1,000 lux & ≥ 3,000 lux exhibited significantly less myopic shift than the respective < 125 min group both for all subjects & for those without myopia at baseline only (for ≥ 5,000 lux, said association only found in those without myopia at baseline & for ≥ 10,000 lux, too few observations for ≥ 200 min to test this cut-off in this group); for 125-199 min vs. < 125 min, this was only true for subjects without myopia at baseline & the ≥ 10,000 lux cut-off – suggesting that for school children with less outdoor time, high bright light intensities may be necessary to achieve protective effects, while moderate intensities may be enough for those with longer durations	results (& many methods) of the intervention trial are not reported here, as only the reported results of a post-hoc analysis on different durations of weekly outdoor time measured with the device during school hours and SER changes are within the review's scope
Ostrin et al (2018)[15]	data only included if device worn for entire day, thus partial first & last days excluded; data excluded if device removed for ≥ 30 min or if light	IO-cut-off: minutes exposed to > 1,000 lux as approximation for time spent outdoors during daylight hours, citing other	mean daily white light exposure & time exposed to outdoor light not significantly correlated with AL growth, but negative directionality;	red and blue light exposure were also analyzed, but not included here due to the focus on illuminance measurements

	exposure dropped to 0 for ≥ 30 min during daylight hours (indicating sensor obstruction) → M±SD 13.9±2.9 days included in analysis per subject per session → ca. 18 days (< 1%) of data removed due to obstructed light sensor for all subjects over all 3 seasons	literature (Dharani et al, 2012[8]; Ostrin, 2017[13]) additionally, mean exposure time to > 2,000 lux, > 5,000 lux, > 10,000 lux & > 50,000 lux calculated light parameters described as adapted from previous validation studies with similar wrist-worn Actiwatch accelerometer in children (Deng et al, 2010[34]; Guo et al, 2013[35])[d]	controlling for baseline AL, age, sex, activity & parental myopic status: small, but non-significant effect of average daily white light exposure on AL at 1 year, but after exclusion of an influential observation, directionality was not given anymore & analysis did not reach significance, and similar findings occurred in repeated analysis using estimated amounts of light exposure adjusted for amount of available sunlight; controlling for baseline SER, age, sex, activity & parental myopia status: small, non-significant effect of average daily white light exposure on SER at 1 year detected, which was also non-significant after exclusion of the same influential observation; for no ambient illumination threshold (> 1,000 lux, > 2,000 lux, > 5,000 lux, > 10,000 lux, > 50,000 lux), significant effects of refractive group (myopes vs. emmetropes only) or significant differences in seasonal effects between refractive groups	
Read et al (2018)[16]	Actiwatch: M±SD 25.4±3.3 days (out of 28) of valid light exposure available for analysis; data resampled at 5 min intervals for comparability with HOBO data HOBO:	IO-cut-off: minutes in > 1,000 lux as minutes of outdoor light exposure, citing the publications whose results are reanalyzed (Read et al, 2014[11], 2015[12]; Dharani et al, 2012[8])	no significant effect of refractive group upon mean hourly outdoor light exposure overall, but myopic children in Australia received significantly lower outdoor light exposure than non-myopic children in Australia, while no such effect was observed in Singapore;	reanalysis & comparison of data reported in Read et al (2014[11], 2015[12]) & Dharani et al (2012)[8]

	M±SD 6.6±0.7 days (out of 7) of valid light exposure available for analysis; only weekend data included for children who wore device during school vacation & analyses comparing daily minutes of exposure to > 1,000 lux on weekends between data collected during school term & school vacation revealed no significant difference for both data sets, data recorded between 7 AM & 7 PM each day analyzed		no significant effect of refractive group upon outdoor light exposure either within or outside of school hours, respectively; no significant effect of refractive group on number of outdoor episodes (i.e., instances of continuous exposure to > 1,000 lux for ≥ 5 min)	
Landis et al (2018)[17]	activity diary used to estimate illuminance during times when the device was not worn day eliminated from analyses if device removed for > 90% of day (documented in diary) → M±SD of 23.5±0.34 days per subject included (over both measurement periods) only data during waking hours used as determined by Actiwatch sleep & wake detection algorithms and diaries → myopic & non-myopic children equal amounts of time awake/day data from both measurement periods combined as they did not differ significantly in light exposure or time awake	IO-cut-off: > 1,000 lux classified as outdoor light light exposure four light intensity categories: scotopic (< 1-1 lux), mesopic (1-30 lux), indoor photopic (> 30-1,000 lux) & outdoor photopic (> 1,000 lux) light; based on similar studies in case of higher light intensity and on device's ability to detect dim light in case of scotopic light threshold, see "additional measurements"	daily light exposure patterns across light levels & weekend (WE)/weekdays (WD) that were found to differ significantly between myopic and non-myopic participants, or only found in one group: amount of exposure to the individual light levels: myopic children less scotopic light during WE than non-myopic, scotopic light exposure in non-myopic children higher on WE than WD, non-myopic children more time in mesopic light on WE than WD, myopic children more time in mesopic light than non-myopic on WE & myopic children more indoor photopic light than non-myopic on WE, non-myopic children more outdoor photopic light than myopic on WE; average time (h/day) in light	reanalysis of data from Read et al (2014[11], 2015[12])

			levels on WE/WD: non-myopic children more time in scotopic light during WE than WD, myopic children more time in mesopic light than non-myopic on WD and WE, myopic children less time in outdoor photopic light than non-myopic on WE & similar non-significant trend on WD; comparison of average of initial & 1-year follow-up refractive status with time in each intensity: no association for non-myopic, but lower daily outdoor photopic & higher mesopic light exposure significantly correlated with more myopic refractive errors in myopic children (no significant association for other levels – but scotopic light similar pattern as outdoor photopic)	
Ulaganathan et al (2019)[18]	for data screening, referred to Ulaganathan et al (2017)[27], where the following is described: removal of any invalid data where there was evidence of device removal for ≥ 15 min (i.e., complete inactivity and/or complete darkness during day) & light levels at these times estimated based upon average level 5 min before removal if these levels consistent with diary report of activity during removal – if not, deletion of off-wrist period data	IO-cut-off: daily time of exposure to > 1,000 lux to estimate daily outdoor time	daily time in > 1,000 lux not significantly different between emmetropes & myopes averaged over both seasons, but significantly longer daily > 1,000 lux exposure in summer than winter for both groups with significantly higher seasonal difference in emmetropes than myopes; daily > 1,000 lux exposure significantly longer in emmetropes than myopes in summer & no significant difference in winter; mean night-time light exposure slightly, significantly higher in emmetropes than myopes due to	

	→ 2 (4) emmetropes (myopes) < 5 valid data days in summer & thus excluded as < 7 days provide significantly lower personal light exposure reliability estimates in young adults (Ulaganathan et al, 2017)[27] → light data from 21 (16) emmetropes & 22 (15) myopes analyzed for winter (summer) → on average, each subject 13.5±2.0 (13.3±1.8) days of valid light measures in winter (summer) night-time defined as 6 PM-6 AM		emmetropes exposed to higher light levels between 7 PM & 9 PM; greater daily > 1,000 lux exposure associated with smaller longitudinal AL changes with a negative association between AL changes & daily > 1,000 lux exposure in summer & winter, but only significant in winter; no significant association between night-time light exposure & longitudinal AL changes; emmetropes (other than myopes) small AL reduction in summer, which together with their exposure to significantly higher light levels in summer suggests inverse relationship between seasonal AL differences & light levels; significant moderate negative association between seasonal difference in AL change & in daily time exposed to bright lights, i.e. subjects with greater daily light exposure in summer than winter exhibited less AL change in summer than winter & vice versa	
Wen et al (2020)[19]	only data obtained from at least 80% of total required wearing time during day considered valid; subject's data set valid if it spanned at least 3 days during week & 1 day during weekend → mean daily device wearing time: M±SD 11.72±1.14 h	IO-cut-off: ≥ 1,000 lux as outdoor exposure additional light intensity thresholds to calculate average daily exposure time: > 2,000 lux, > 3,000 lux, > 5,000 lux	myopic & non-myopic children similar temporal light exposure patterns, but some variations: significantly greater light intensity experienced by non-myopic than myopic children 10:10 AM-10:30 AM, 12:20 PM-14:10 PM & 16:00 PM-17:30 PM; no significant difference between refractive groups in average daily	

	→ mean valid weekdays (weekend days): M±SD 3.98±0.36 (1.13±0.11) data between 7 AM & 8 PM used for analysis as vast majority of light exposure & near work occurred within this period for all subjects		exposure duration to > 1,000 lux & > 2,000 lux, but myopic children exposed to > 3,000 lux & > 5,000 lux for significantly shorter durations than non-myopic; no significant difference between refractive groups for average daily light intensity & average frequency of continuous outdoor exposure (i.e., number of transitions between indoor & outdoor exposure); time spent in > 3,000 lux & time spent in > 5,000 lux found to be protective against myopia in two independent analyses	
Franklin (2020)[20]	167 data acquisition sessions from 109 participants → 18 unsuccessful & removed → 149 successful data sets screened for compliance only full days included → 9-day period; removal of invalid data (i.e., ≥ 15 min with 0 activity (indicates watch removal) and/or 0.01 lux recorded during daytime (7 AM-7 PM; indicates covered light sensor)) & only days including 90% of valid data during daytime included – for these days, substitution of removed data with average data for same time period on valid days → 39.7% of collected days invalid & removed;	IO-cut-off: > 1,000 lux to estimate outdoor exposure due to establishment of cut-off in studies on light levels and change in refractive error (Ostrin, 2017[13]; Dharani et al, 2012[8]; Alvarez & Wildsoet, 2013[10]; Ostrin et al, 2018[15]; Read et al, 2014[11], 2015[12])	no significant correlation between AL growth and daily light exposure or daily outdoor time; no significant difference in AL between groups receiving low, average or high exposure based on tertile split of average daily light exposure & also not between groups experiencing low, average, or high outdoor exposure	the stated purpose of the study refers to the respective chapter (9) rather than the entire dissertation

	analysis only performed on data sets with at least 5 valid days → 36.2% of data sets removed → 95 data sets from 68 subjects included → 1.1% of analyzed light exposure data based upon substitution daily light exposure derived from measurements from 7 AM-7 PM			
Li et al (2020)[21]	data preprocessing in creation of working distance (WD) – light intensity (LI) space: 1) denoising raw data with fast Fourier transformation & inverse fast Fourier transformation after scaling LI with $\log_{10}$ → smoother data with more explicit distributions, 2) creating 2-dimensional space for WD & LI where both variables were continuously measured as a time series, summarized in 40x40 pixels heatmap, each pixel representing specific circumstance (specific WD & LI) in which visual behavior occurred & pixel color representing percentage of time (PoT) spent in this circumstance → PoT in each pixel = ratio of time falling into pixel to total measured time for each subject; 3) dealing with	*not relevant*	shorter WD & lower LI generally manifested detrimental effect on refractive error towards myopia; strength of impact of both factors varied with relative level between them: split up, limit of statistical significance (i.e., detrimental effect related to myopia) ca. 40 cm for WD & ca. 6300 lux for LI – so for WD of > 40 cm, near work no detrimental effect toward myopia regardless of LI & for eye-level LI > 6,300 lux, LI[e] no detrimental effect on refractive error toward myopia regardless of WD, but for < 40 cm WD or < 6,300 lux eye-level LI, final impact of one factor depends on other; under < 10 lux LI, < 20 cm WD modest protective effect against myopia; proposed parameter "visual behavior index (VBI), calculated from subject's PoT of each pixel	in this study, it was aimed at establishing a parameter (VBI) to quantify exposure to environmental risk factors (WD & LI) by mapping them in a two-dimensional space – therefore, not all of this table's categories apply well, but since results on the association between light exposure & myopia are reported, the publication is included here and some results on WD are also presented as they are closely related to those on LI due to the VBI

	sparsity in WD-LI measurements: "borrowing" information from neighboring pixels behavior for each pixel to address sparsity by using 2-dimensional Gaussian kernel function		& influence of each pixel on SER to theoretically reflect overall effect, significantly positively related to SER – when VBI increased (decreased), SER towards hyperopia (myopia)	
Li et al (2021)[22]	light data excluded for poor compliance, if (1) missing at least 1 weekday & 1 weekend of device wear, (2) wear days with average daily light intensity of ≤ 100 lux or proportion of 0 lux entries ≥ 60% per day (considered implausibly low & highly suggested covered sensor over extended period) → 93 (16.1%) subjects excluded (n = 72 for (1), n = 21 for (2)) → thus, 483 of 576 subjects with light data included device recorded light levels during daylight hours 7 AM-7 PM	IO-cut-off: ≥ 1,000 lux for outdoor environments, citing prior literature (Wu et al, 2018[14]; Read et al, 2014[11]; Verkicharla et al, 2017[36]; Ostrin et al, 2018[15]) additional increasing light level cut-offs analyzed: ≥ 3,000 lux, ≥ 5,000 lux, ≥ 15,000 lux	average light levels (outdoor only & overall) & duration of daily light exposure (≥ 1,000 lux) not associated with myopia, SER or AL in multivariable analyses adjusted for covariates (gender, ethnicity, near-work, number myopic parents, maternal education & for AL models, also height); no associations between duration of light exposure at higher cut-offs (≥ 3,000 lux, ≥ 5,000 lux, ≥ 15,000 lux), timing of light levels or duration of light exposure at different periods during daylight hours or number & duration of daily light exposure episodes (≥ 1,000 lux continuously for ≥ 5 min) with myopia, SER or AL; average outdoor light levels significantly associated with myopia, but not SER or AL, in univariable analysis (no significant association with any outcome for light level overall or daily duration of light exposure in univariable analyses); when stratified by weekdays & weekend, average outdoor light levels on weekdays associated with lower odds of myopia, but	

			not with SER or AL; longer duration of light exposure episodes on weekdays associated with shorter AL; light levels or duration of light exposure episodes on weekend not associated with myopia, SER or AL; duration, timing or frequency of light exposure on either weekday or weekend not associated with myopia, SER or AL	
Mirhajianmoghadam et al (2021)[23]	→ device worn for M±SD 7±1 weekdays & M±SD 2.4±0.7 weekend days	IO-cut-off: > 1,000 lux as outdoors, citing other literature (Read et al, 2014[11]; Ostrin et al, 2018[15]; Dharani et al, 2012[8])	During COVID-19 & compared to non-myopic children, myopic children significantly lower daily light exposure & tended to spend non-significantly less time outdoors	
Bhandari et al (2022)[24]	only days with ≥ 8h of Clouclip data during wake time considered valid; ≥ 3 valid weekdays & ≥ 1 valid weekend day required for subject to be included in analysis → for n = 18 subjects, data not valid (some not compliant with wearing, some ≤ 8 h/day of valid data) → mean valid days (of included subjects) 6.6±0.7 (range 4-6) → average daily wear time 15.1±0.2h (13.7±1.6h) for weekdays (weekend days), mean 14.7±0.2h, similar between refractive error groups	IO-cut-off: duration exposed to illuminance ≥ 1,000 lux as time outdoors, citing other literature (Ostrin, 2017[13]; Dharani et al, 2012[8]; Read et al, 2014[11]) additionally, duration in the following light intensities analyzed: < 1,000 lux (indoors), > 2,000 lux, > 3,000 lux & > 5,000 lux (all outdoors)	daily white light exposure & time outdoors significantly less for myopes than non-myopes; no refractive error group difference in average daily number of transitions from indoor to outdoor; myopes significantly more time indoors & significantly less time in all thresholds of outdoor light levels than non-myopes; when analyzed by period of the day (school, after school, nighttime), significantly lower white light exposure & time outdoors for myopes than non-myopes during school period	children also wore Actiwatch Spectrum Plus, but not for illuminance analysis, so information regarding the Actiwatch (e.g. calibration measures, wearing protocol) is not included here

	data collected from wake to bed time			
He et al (2022)[25]	required to wear device daily from 7 AM-7 PM	IO-cut-off: data classification as "indoor" & "outdoor" based on machine-learning-based support-vector machine (SVM) model (Ye et al, 2019)[37], and the variables lux, UV, and steps as measured by the device are reported to have been used in model building (Ye et al, 2019)[37]; *see comment column for further explanation*	post-hoc analysis over all subjects: no variation in 2nd year myopia incidence by indoor light intensity, but reduction in myopia incidence observed with increasing level of outdoor light intensity & increasing outdoor time; analysis of individual time & light variables: increasing time outdoors significantly reduced risk of incident myopia & cumulative outdoor lux/day significantly reduced risk of myopia onset, but myopia incidence not associated with time indoors or indoor light intensity; reduced shift in SER & AL with increasing outdoor time; increasing cumulative outdoor lux/day associated with reduced myopic shift in SER & AL; protective effects of outdoor time on myopic shift in SER & AL observed only in non-myopes, not in those already myopic; those already myopic significantly less outdoor exposure than non-myopes; pooled data of all subjects indicated that cumulative outdoor lux of 10,000 per day reduced risk of myopia onset compared with no outdoor exposure; simulation: compared with controls, 15-24% relative	some subject characteristics taken from He et al (2019)[38]; as described under "IO-cut-off", the indoor/outdoor classification was realized via an SVM machine learning algorithm considering the variables lux, UV, and steps (Ye et al, 2019)[37]; yet, as the relationship between light intensity (lux) & myopia is analyzed – though split up indoor & outdoor light intensity –, the publication is listed here, and results on the association between time outdoors & myopia are also reported since they are often closely related to the results on light intensity & myopia, though it should be kept in mind that the indoor/outdoor distinction itself generally does not fall under the review's inclusion criteria

			reduction in myopia would require 600,000-750,0000 outdoor lux/day or 120-150 outdoor min at 5,000 lux/min	
Li et al (2022)[26]	measurements excluded if illuminance value was fixed, (as this means the device has not been worn, because illuminance should fluctuate in normal use) recording time 7 AM-7 AM the following day *the analysis description indicates that all of the recording time was included in the analysis*	IO-cut-off: time outdoors defined as illuminance of ≥ 1,000 lux, citing other literature (Read et al, 2015[12]; Alvarez & Wildsoet, 2013[10]; Dharani et al, 2012[8])	among all children, negative correlation between axial elongation and time outdoors at weekends as well as time outdoors x light exposure, both at year 2 and 3, in linear regression analysis *(no information for year 1 and 4)* in mixed-effect models for outcomes AL & SER and parameters time (grade), group allocation, baseline outcomes, time outdoors & light exposure, the latter two n.s.	results (& many methods) of the intervention trial are not included here, as only the reported results on the correlation between device-measured light parameters and myopia metrics are within the review's scope

Notes: The publications are sorted by the time when they were first published – publications published in the same month are sorted by the first author's name.
[a]relevant for lux measurements.
[b]only measurements relevant for the results and/or the respective refractive group classification reported; usually, more visual measurements were conducted.
[c]Presented are demographics for the (sub)sample relevant for the results reported here – if no or only few information is given for this (sub)sample in the publication, the next largest (sub)sample is presented along with any information found on the (sub)sample relevant for said results. Generally, we report the overall number and main description of the subject sample as well as information on age, gender/sex, ethnicity, general visual information (including SER, but excluding AL specifications), information on the subject groups relevant for the reported results, and in- or exclusion criteria given in the publication. Often, the respective publications report more information about the subjects.
[d]In a few cases, there might have been misplaced citations: (1) Contrary to what is stated, for some of the publications directly cited for light parameters and/or the IO-cut-off, we could not ascertain where a similar light meter or light measurements at all might have been used. (2) In case of light parameters having been adapted from elsewhere, we were not always able to identify where in the cited publications they were taken from.
[e]In the publication, it says near work at this point, but based on overall context and other text passages, we suspect this to be a typo that should actually read LI.
Abbreviations: AL = axial length. SER = spherical equivalent refraction.

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