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Correlates of mobile screen media use among children aged 0–8: a systematic review

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ABSTRACT

Objective This study is a systematic review of the peer-reviewed literature to identify the correlates of mobile screen media use among children aged 8 years and less.

Setting Home or community-based studies were included in this review while child care or school-based studies were excluded.

Participants Children aged 8 years or less were the study population. Studies that included larger age groups without subgroup analysis specific to the 0–8 years category were excluded. Eight electronic databases were searched for peer-reviewed English language primary research articles published or in press between January 2009 and March 2017 that have studied correlates of mobile screen media use in this age group.

Outcome measure Mobile screen media use was the primary outcome measure. Mobile screen media use refers to children's use of mobile screens, such as mobile phones, electronic tablets, handheld computers or personal digital assistants.

Results Thirteen studies meeting the inclusion criteria were identified of which a total of 36 correlates were examined. Older children, children better skilled in using mobile screen media devices, those having greater access to such devices at home and whose parents had high mobile screen media use were more likely to have higher use of mobile screen media devices. No association existed with parent's age, sex and education.

Conclusion Limited research has been undertaken into young children's mobile screen media use and most of the variables have been studied too infrequently for robust conclusions to be reached. Future studies with objective assessment of mobile screen media use and frequent examination of the potential correlates across multiple studies and settings are recommended.

Trial registration number This review is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028).

Strengths and limitations of this study

- This review summarises current peer-reviewed literature on correlates of mobile screen media use among children aged 8 years and less. and is guided by a published protocol paper.
- The review incorporated a robust research strategy and inclusion exclusion criteria, which identified up-to-date keywords with the assistance of public health librarian; and searched eight relevant databases.
- All the reviewed studies were cross-sectional in design making it difficult to derive a casual inference.
- Study sample sizes ranged from 149 to 3206, which may have impacted on the findings.
- Association and consistency could not be determined in this review due to the study findings being segregated across different mobile screen media types, making the findings largely descriptive.

BACKGROUND

Young children are increasingly exposed to multiple screens including both the traditional fixed screens, such as televisions and desktop computers and newer mobile screen media devices such as smartphones and electronic tablets.[1] Specifically, there has been a rapid uptake of mobile screen media devices in recent years, among young children.[2 3] This is largely facilitated by the characteristics of handheld devices, their portability, screen size, decreasing cost, multiple applications and interactive ability.[4 5] Because of the increasing uptake and use of mobile screen media devices, the daily screen time of traditional media such as television has decreased[6] while the time spent on the former has increased, especially in many developed countries.[4] Though television is still the dominant media for family time, solitary viewing by children is mostly achieved using mobile screen media devices.[7] This increasing exposure and accessibility to mobile screen media devices creates a conundrum. On one hand, mobile screen devices may increase children's sedentary behaviour, but they also have the potential to increase play opportunities, creating a tension for public health, and parents alike.[8] Furthermore, the pleasure a child derives from interacting with these touch screens may lead to increased and habitual use.[9] Nevertheless, there are also some benefits associated with interactive mobile screen media devices use, such as learning opportunities and

face-to-face connection with distant family and friends and play opportunities.[10 11] Similarly, engagement with active video games has been reported to promote light to moderate physical activity.[12]

Health guidelines recommend that children aged less than 2 should be exposed to a limited amount of educational mobile screen media use, while for those aged 2–5, the daily screen time should be less than 1 hour.[10 13–15] However, worldwide, a significant proportion of young children are exceeding the recommended exposure time.[5] For example, in an urban community in Philadelphia, USA, nearly half of 1-year-old children were reportedly using mobile screen media devices on a daily basis, with use increasing with age.[4] Surprisingly, 75% of children had their own mobile device by the age of 4.[4] It seems parents are increasingly allowing their young children to use mobile screen media devices, especially smartphones and electronic tablets, to keep them occupied when they are doing household chores or shopping, to calm children in public places and to put children to sleep.[3 4 16]

Despite the increase in the use of mobile screen media devices such as smartphones, electronic tablets, handheld computers and personal digital assistants (PDA) by young children, very limited research has been carried out to identify the correlates associated with their increased use.[4] Currently, screen time research is dominated by fixed screens with scant attention paid to mobile screen media devices.[10] Systematic reviews to identify the correlates of mobile screen media use among young children are almost non-existent with previous reviews focusing on sedentary behaviours or television viewing.[17–19]

Considering the increasing availability, ownership and use of mobile screen media devices (smartphones, electronic tablets, handheld computers, PDAs) among young children, identification of the correlates of mobile screen media use specific to children 8 years and less is crucial. The purpose of this review was to systematically search and critically review the published peer-reviewed literature to identify the correlates of mobile screen media use among children 8 years and less. Correlates are classified into proximal and distal factors using a bioecological model to facilitate comparison with the existing literature.[17 20] The model provides a strong theoretical basis to understand human behaviour[21] and has been described in detail elsewhere.[22]

METHODS

This systematic review is based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement[23–25] and is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028). The study used already published, deidentified data and hence is exempt from the ethics approval process. A detailed description of the methods is available in the protocol article.[22] As discussed in the protocol article, initially the database search was planned for articles published between 2009 and 2015.[22] However, considering the increasing number of articles studying mobile screen media recently, the search was extended to March 2017.

Outcome measure

Mobile screen media use was the primary outcome measure. Mobile screen media use refers to children's use of mobile screens, such as mobile phones, electronic tablets, handheld computers or PDAs. The term 'screen time' is used to denote both the fixed screens and mobile media screen device use. This terminology is used when referring to the screen time guidelines for children and to refer to other articles that have studied children's total screen time including both fixed and mobile screens.

Correlates of mobile screen media use have been placed into five categories as per the bioecological model.[17 18] The five categories are:

- Child biological and demographic factors include age, sex and body mass index (BMI).
- Family biological and demographic factors include demographic and biological characteristics of the family members (particularly parents) and their education, occupation and income.
- Family structure factors include the number of siblings, family size and family type.
- Behavioural factors include the child's behavioural characteristics and their skills and attitudes.
- Sociocultural/environmental factors include social, physical and environmental factors within the home setting and community, and parental behavioural factors such as their screen media skills, beliefs and attitudes towards the mobile screen media and self-efficacy to limit their children's screen viewing behaviours.

Direction of association has been reviewed separately for: (A) smartphones, (B) electronic tablets, (C) touch screens, and (D) any media device (defined as the combination of traditional media plus at least one other mobile screen media device).

Eligibility criteria

The studies eligible for inclusion were peer-reviewed primary research articles with information on mobile screen media use, parent-child co-use or adherence to screen time guidelines as the outcome measure, which investigated the correlates of mobile screen media use among children aged 8 and less; based in home or community setting; and published, or in press in English language journals between January 2009 and March 2017. The full description of the alignment of the research question to the PECO (Population, Exposure, Comparison and Outcome) format along with the exclusion criteria is presented in table 1.

Table 1 Research question using PECO format

Criteria	Description
P: Population	Children aged 8 years and less
E: Exposure	Correlates of mobile screen media use
C: Comparison	With versus without the correlates
O: Outcome	Use of mobile screen media (eg, mobile phones, electronic tablets, handheld computers, PDAs)
Types of studies	Quantitative studies using all designs (cross-sectional, case–control, cohort and intervention studies)
Exclusion	Studies that have not reported correlates of mobile screen media use Studies that have not included at least one form of mobile screen media device Systematic reviews and meta-analysis Grey literature Qualitative studies Studies carried out in settings other than home or community Studies carried out among unhealthy participants Studies with broader age groups and no subgroup analysis for the target group Papers published before 2009 to March 2017 Papers published in language other than English Non-peer-reviewed articles Studies involving children older than 8 years

PDA, personal digital assistant.

Search strategy and study selection

Eight electronic databases (Medline, Scopus, Embase, CINAHL Plus, Pubmed, ProQuest, PsycINFO and Web of Science) were searched for articles published between January 2009 and March 2017. Child-related keywords including child*, preschool, infant, kid and toddler and screen-related keywords including screen time, screen viewing, mobile phone, cell phone, smartphone*, PDA, tablet*, iPad*, handheld media, handheld computer* were used to locate potential papers in the databases. The search was carried out during September to October 2015 and replicated in March 2017. The search commenced with Medline and the identified papers were excluded when searching other databases. However, only Embase, ProQuest and CINAHL Plus provided that option. Duplicate records were manually removed after compiling all the searches. The search strategy used in Medline database is presented in table 2. A total of 1909 articles were identified through searching the eight databases. To ensure that all relevant articles were identified, a manual search of the reference lists of the systematic reviews was also carried out along with the checking of the *Google Scholar* profile of authors with frequent publication in this field. A total of seven papers were retrieved from the manual searching process.

Endnote (V.X7.5) software was used for managing all the identified articles (n=1916). Duplicate articles (n=376) were removed. The remaining articles (n=1540) were then screened by title by two authors (SP and NS). From this, irrelevant titles (n=1029) were excluded. The abstracts of the remaining articles (n=511) were also reviewed by SP and NS; and a further 427 articles were excluded. Full texts of the remaining articles (n=84) were retrieved and reviewed by all the four researchers (SP, NS, JJ and JL) against the inclusion/exclusion criteria, resulting in 13 papers being included in this systematic review. The authors of this systematic review were not blinded to the name, journal title or institutional affiliation of the authors of the articles selected. The process of study selection has been presented using the PRISMA flow diagram in figure 1.

Assessment of included papers

A modified version of the checklist by Downs and Black[26] was used to assess the quality of studies and the risk of bias. Out of 27 suggested checklist items, relevant items in the themes of reporting (questions 1–3, 6, 7, 10), external validity (questions 11, 12) and internal validity bias (questions 18, 20) were considered appropriate for this review. A score of '1' was allocated for 'Yes' and a score of '0' was allocated for 'No' and 'Unable to determine'. Out of a possible score of 10, a total score greater than 5 indicated a quality paper. Three researchers (SP, JJ and JL) independently carried out the appraisal using the checklist and the final quality score was ascertained by comparing each of their scores. Discrepancies in scores were reassessed jointly, and a consensus reached.

Data extraction and management

In order to maintain consistency and avoid bias, a data extraction table was developed. Information on study design, country of study, age group of participants, sample size, main outcome variables, correlates and measures of association was extracted by one author (SP). Mean duration of screen viewing specific to individual devices was also extracted when available. Adjusted OR and standardised coefficients were extracted in order to establish the correlates. Since there were few studies that assessed a particular variable, association and consistency could not be determined.

Table 2 Search strategy used in Medline database

Database: Ovid Medline (R) 1946 to March 2017		
SN	Search strategy	Results
1	Only Child/or Child/or child.mp. or Child, Preschool/	1 767 004
2	Infant/or infant.mp.	1 030 660
3	Kid.mp.	1251
4	Toddler.mp.	2240
5	1 or 2 or 3 or 4	2 242 988
6	Screen time.mp.	639
7	Smartphones.mp. or Cell Phones/	5961
8	Mobile phones.mp.	1627
9	Handheld computers.mp. or Computers, Handheld/	2721
10	Smartboard.mp.	2
11	PDA.mp.	5860
12	Screen media.mp.	42
13	Mobile screen.mp.	5
14	Microcomputers/or Computers, Handheld/or electronic tablets.mp.	16 724
15	Tablets/or Tablets.mp.	34 967
16	Mobile Applications/or iPads.mp.	699
17	Handheld media.mp.	1
18	Touchscreens.mp.	22
19	Mobile devices.mp.	552
20	Digital technology.mp.	348
21	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20	64 324
22	5 and 21	6648
23	('Screen-viewing' or 'screen time' or 'mobile use' or 'use of smartphones' or 'Cell phone use' or 'increased screen time' or 'use of electronic tablets' or 'use of mobile screens').mp.	965
24	5 and 21 and 23	525
25	Limit 24 to (English language and humans and yr='2009 -Current' and 'all child (0 to 18 years)')	482

mp: title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier.
*Sign denotes for any character(s).
SN, serial number.

RESULTS

Study characteristics

Thirteen studies published between 2013 and 2017 were included in the review. Six were published in 2015,[1 27–31] four in 2016[32–35] and one in 2014,[36] 2013[37] and 2017.[38] The majority of the eligible studies were conducted in high-income countries with four from the USA,[1 27 31 33] three from the UK,[28 29 37] two from Canada[34 38] and one from the Netherlands,[30] Hong Kong,[36] Malaysia[32] and Czech Republic.[35] All 13 studies were cross-sectional in design. The studies' quality scores ranged from 6 to 10 with a mean score of 7.85, indicating all were considered quality studies.

The study sample sizes ranged from n=149 to n=3206. Two studies reported using weighted data to be representative of the national population,[1 31] two studies used random sampling,[34 35] one used stratified random sampling,[32] while all other studies used non-representative techniques.[27–30 33 36–38] The mean age of participants was clearly stated in eight studies[28 30–35 38] while four provided frequencies in different age groups.[27 29 36 37] However, Connell *et al*[1] did not report children's mean age. Based on the available data, the mean age of the children was (4.74±1.72) years. The descriptive characteristics of the included studies are presented in table 3.

Mobile screen media use

Eleven studies reported screen viewing as the outcome measure,[28–38] one reported adherence to the American Academy of Paediatrics (AAP) screen time guidelines[27] and one reported parent-child co-use of media.[1]

Children's mobile screen media use in all 13 studies was measured by parental self-report. One paper reported face validity, content validity and test-retest reliability of the instrument used,[36] and five of the research questionnaires had been used in previous studies.[1 27 31 32 38] Three studies stated parental-proxy reports as having reasonable reliability and validity to measure children's mobile screen media use.[28 29 37] The other studies did not report on the reliability and validity of their instrument.[30 33–35] Overall, the mean duration of mobile screen media use could not be determined as only five studies reported the average duration,[27 30–32 35] while all other studies categorised participants into groups, such as less than 2 hours and more than 2 hours of screen media use.[1 28 29 33 34 36–38]

Device use and correlates

In total, 36 correlates of mobile screen media use were studied. Of these correlates, children's age was reported eight times, parental media use (fixed and mobile screens) seven times, family income five times and three variables (child sex, parental age and education) four times. The remaining correlates were studied even fewer times (see tables 4 and 5). Association and consistency of the variables could not be determined as a majority of the variables were studied in less than three studies.

Four studies reported an association specific to smartphones[1 29 31 37] and electronic tablets.[1 28 31 33] Nikken and Schols[30] reported combined results for touch screens (smartphones and electronic tablets) while the other six studies reported correlates for electronic media, which included both traditional (eg, televisions, computers) and new devices (eg, mobile phones and electronic tablets).[27 32 34–36 38] Use of a PDA was not studied.

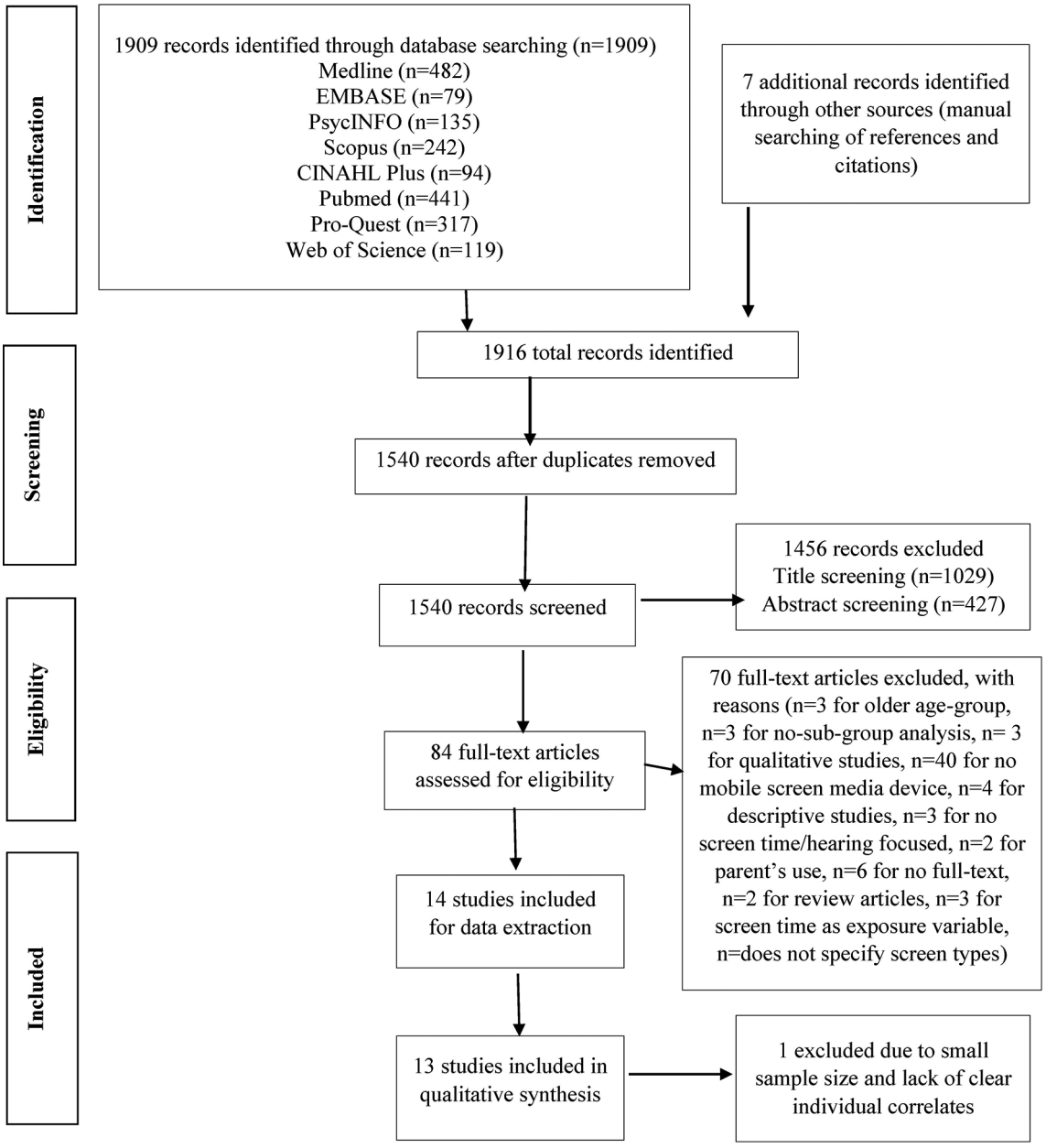

Figure 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart for study selection.

Correlates of mobile media use

Child biological and demographic factors

Six of the eight studies (75%) reported a positive association between the child's age and mobile screen media use[27 31 33 34 36 38] (table 4). Older children were more likely to use smartphones, tablets or any media compared with younger children.[27 31 33 34 36 38] Carson and Kuzik concluded that for every 1-month increase in age, the use of any media increased by 9.3 min/day (95% CI 2.8 to 15.8).[38] However, Connell *et al* examined parent-child co-use of smartphones and electronic tablets and reported an inverse association, indicating older children were less likely to co-use with parents.[1] In contrast, Nikken and Schols[30] concluded that the child's age had no significant association with the use of touch screens. Women were more likely to use any media for a longer duration than their male counterparts[32 38] but there was no association with sex specifically in regard to touch screen use.[1 30] No association was found between the use of any media and child BMI.[27]

Family biological and demographic factors

Four studies reported an association between parental age and their children's mobile screen media use[1 27 33 36] (see table 4). Of these, three reported no statistically significant association,[1 27] while Wu *et al* found a negative association, indicating that screen devices (both fixed and mobile screens) were more frequently used by children with younger parents.[36]

Mixed associations were found between family income and children's mobile screen media use (see table 4). Two studies[30 38] reported a positive association, indicating

Table 3 Description of included studies

Author	Year	Country	Study design	Sample size	Age group	Outcome measure	Screen studied	Results specific to	Independent variables	Measure of association	Quality score
Carson and Kuzik[38]	2017	Canada	Cross-sectional	149	12–35 months	Children's screen time	Television, videos, or DVDs on a television, computer, or portable device	Electronic media (fixed and mobile screens)	Parental and child demographics	Unstandardised beta coefficients and 95% CI	8
Lee *et al*[32]	2016	Malaysia	Cross-sectional	835	4–6 years	Children's screen time	Watching television or video, or playing with computer, smartphones, or other electronic gadgets	Electronic media (fixed and mobile screens)	Parental and child demographics, places for play, barriers and motivators for active play	p Value from χ^2 test	7
Pempek and McDaniel[33]	2016	USA	Cross-sectional	358	12–48 months	Children and mother's tablet use	Electronic tablets	Electronic tablets	Child age, mother's tablet use, income, education, personal well-being and age	Standardised coefficients	7
Pyper *et al*[34]	2016	Canada	Cross-sectional	3206	Under 18/screen time: 1–18	Children's screen time	Television, DVD player; computer or laptop; tablet or iPad; and video game console	Electronic media (fixed and mobile screens)	Different types of parental support behaviours (motivational, instrumental, regulatory and conditional), parental and child demographics	OR and 95% CI	10
Sigmund *et al*[35]	2016	Czech Republic	Cross-sectional	197	4–7 years	Children's screen time	Watching TV (DVD, video) and PC (notebook, tablet, smartphone)	Electronic media (fixed and mobile screens)	Days of week, parental step count and screen time	Pearson's correlations with 95% CIs	8
Nikken and Schols[30]	2015	Netherlands	Cross-sectional	896	0–7 years	Media ownership and use	TV, game consoles, computers and touch screens	Touch screens (smartphones and electronic tablets)	Parent and child characteristics (age, access, concerns about media use)	Standardised coefficients	6
Lauricella *et al*[31]	2015	USA	Cross-sectional	2300	0–8 years	Children's screen time	Television, computers, smartphones and tablets	Smartphones and electronic tablets	Parental media use, parental attitudes, child's age	Standardised coefficients	8
Connell *et al*[1]	2015	USA	Cross-sectional	2326	0–8 years	Parent-child co-use of media	Books, TV, computers, video games, tablets and smartphones	Smartphones and electronic tablets	Parent's time with child, parent's media use, parental and child demographics	Standardised coefficients	7
Kesten *et al*[29]	2015	UK	Cross-sectional	735	6–8 years	Children's screen time	TV, computer, smartphone, game console and multi-SV	Smartphones	Parent's employment, education, number and sex of children, screen-related limits	OR and 95% CI	8
Jago *et al*[28]	2015	UK	Cross-sectional	954	5–6 years	Children's screen time	TV, computer/laptop use including tablets	Electronic tablets	Parenting styles and parental self-efficacy to limit screen time	OR and 95% CI	8
Asplund *et al*[27]	2015	USA	Cross-sectional	314	0–5 years	Adherence to AAP guidelines for screen time	TV, video games, computers, cellphones and other electronic devices	Electronic media (fixed and mobile screens)	Child BMI, child/parent demographics, and household media environment, parental attitudes towards TV viewing	OR and 95% CI	9
Wu *et al*[36]	2014	Hong Kong	Cross-sectional	202	3–6 years	Use of digital products	Television, digital tablets, smartphones, and so on	Electronic media (fixed and mobile screens)	Participants' demographics, parenting approach (restrictive, instructive and co-using)	p value from χ^2 test	8
Jago *et al*[37]	2013	UK	Cross-sectional	750	6–8 years	Children's screen time	TV, game console, smartphone and multiscreen viewing	Smartphones	Parental media use, parental attitudes and access to media equipment	OR and 95% CI	8

AAP, American Academy of Paediatrics; BMI, body mass index; SV, screen viewing.

Table 4 Demographic and biological correlates of mobile screen media use and direction of association

		Smartphones		Tablets		Touch screens		Any media device	
Variable type	**Variables**	**Association**	**Study**	**Association**	**Study**	**Association**	**Study**	**Association**	**Study**
Child biological and demographic factors	Child age	+	31	+	31 33	0	30	+	27 34 36 38
		– (co-use)	1	– (co-use)	1				
	Child sex (0=boy)	0	1	0	1	0	30	+	32 38
	BMI							0	27
Family biological and demographic factors	Parental age	0	1	0	1 33			0	27
								–	36
	Parent's sex (0=father)	0	1	0	1	0	30		
	Family income			0	33	+	30	0	32
								+	38
								–	36
	Parent's occupation (0=unemployed)							–	36
	Parent's education	0	1	0	1 33	0	30	0	32
	Language							0	27
	Race/ethnicity	+ (non-Hispanic)	1	+ (Hispanic)	1			0	27
								– (European-Canadian-Caucasian)	32
	Country of birth							0	32 38
Family structure factors	Family size					0	30		
	Number of children in the family							+	36

Touch screens include combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.
'+' denotes positive association, '–' denotes negative association, '0' denotes no association (significant at 95% confidence level, $p<0.05$), empty cells denote association for that variable has not been studied.
BMI, body mass index.

Table 5 Environmental and behavioural correlates of mobile screen media use and direction of association

		Smartphones		Tablets		Touch screens		Any media device	
Variable type	**Variables**	**Association**	**Study**	**Association**	**Study**	**Association**	**Study**	**Association**	**Study**
Behavioural factors	Child media skills					+	30		
Sociocultural/ environmental factors	Parental media use/screen time	+ (>2 years)	31	+	1 31 33	+	30	+	(≥2 years)[27 35]
		0	1 37						
	Parent attitudes on effects of media on children	+ (>6 years)	31	+(>2 years)	31				
	Parental belief that media has positive effects on children	0	37			0	30		
	Parental belief that media has negative effects on children					0	30		
	Parents' belief on pacifying nature of media					+	30		
	Parents' belief that media are too complicated for young children to use					0	30		
	Parent's time with child	0	1	0	1				
	Parental limit setting on media use	0	(boys)[29]						
		+ (always)	(girls)[29]						
	Collaborative rule setting	0	29						
	Parental control on media use			0	28				
	Parental nurturance			–	28				
	Parental self-efficacy			–	28				
	Type of child care (0=parental care)							–	38
	Mother's relational well-being			0	33				
	Mother's personal well-being			0	33				
	Days of week (0=weekdays)							+	35
	Parental step count/physical activity							–	35
	TV on during dinner							+	(≥2 years)[27]
	Number of TVs/screens at home	+	37					0	27
	Computers outside children's bedroom							+	36
	Screen viewing items in child's bedroom	+	37						

Touch screens include combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.
'+' denotes positive association, '–' denotes negative association, '0' denotes no association (significant at 95% confidence level, p<0.05), empty cells denote association for that variable has not been studied.

that children from high-income families were using touch screens or any media device longer than those from low-income families. Conversely, studies by Pempek and McDaniel[33] and Lee *et al*[32] found no association with family income, and Wu *et al*[36] reported a negative association. Wu *et al* also found a negative association between parent's occupational status and children's mobile screen media use.[36] Furthermore, children of stay-at-home parents used screen devices more frequently than those whose parents were employed.[36]

No association was identified between young children's smartphone, electronic tablet or any touch screen use and parent's sex.[1 30] Similarly, parent's educational status,[1 30 32 33] country of birth[38] and language[27] did not show any significant association with children's mobile screen media use.

Family structure factors

Two studies reported family factors associated with children's mobile screen media use[30 36] (table 4). A positive association was reported between the number of children and use of televisions, computers, tablets and mobile phones,[36] and when there were two or more children, they were more likely to use screen devices (both fixed and mobile screens) for talking with friends compared with those families with one child.[36]

Behavioural factors

Ability or skill of children to use mobile screen media devices was the only behavioural skill studied and was found to have a positive association with frequency and duration of device use[30] (see table 5). Furthermore, children who were better skilled in using mobile screen media devices had greater access to these devices in their bedrooms and spent more time on them than less skilled children.[30]

Sociocultural/environmental factors

In total, 21 sociocultural/environmental correlates were investigated (see table 5). Parental screen time/media use (both mobile and fixed screens) was the most studied variable.[1 27 30 31 33 35 37] Two studies concluded that there was no statistically significant association between parental smartphone use and their children's use.[1 37] Positive associations have also been reported for parental screen time and children's use of tablets, touch screen devices or any media.[1 27 30 31 33 35] Sigmund *et al* concluded that the association between parental and children any media use was stronger during weekends than on weekdays.[35]

Parental attitudes about the effects of mobile screen media on children were positively associated with smartphone and electronic tablet use for older young children (4–8 years).[31] More positive parental attitudes towards these devices resulted in greater use by the children.[31] Similarly, parental belief in the negative effects of mobile screen media devices was not associated with children's use of these devices.[30] However, children were more likely to use mobile screen media devices when parents believed that these devices were helpful as a behavioural regulation tool,[30] while parental nurturing and self-efficacy to limit mobile media use were negatively associated with electronic tablet use.[28]

Children in parental care were more likely to have higher any media use than children in child care.[38] Similarly, any media use was higher during weekends than weekdays.[35] The number of media devices at home and in the child's bedroom was positively associated with increased smartphone use.[37] Jago *et al*[37] concluded that the greater the number of devices, the greater the use, while Asplund *et al*[27] reported no such association.

DISCUSSION

This systematic review identified 36 reported correlates of mobile screen media use among children aged 8 years or less from 13 studies. Although this review searched for eligible articles published between 2009 and 2017, the included studies were published between 2013 and 2017, indicating limited but recent and increasing interest in mobile screen media use-related research.

This review found that children aged between 4 and 8 years were more likely to have higher mobile screen media use. Similarly, those who were better skilled in using the devices had more access to media devices at home, and higher parental use of mobile screen media was more likely to have higher mobile screen media use. The bioecological model posits that human behaviour is affected by intrapersonal factors, interpersonal factors and distal factors which interact to shape our behaviour,[21 39] however, the findings of this review suggest that in the case of children aged 8 years and less, distal factors such as parental behaviours, and the home environment can be more influential in shaping their behaviour.

The majority of studies in this review reported a positive association between the child's age and their mobile screen media use. Older children were more likely to use mobile screen media devices compared with their younger counterparts. This finding is consistent with a systematic review of traditional screen time use among children 3 years and younger.[17] Potential reasons for increased mobile screen media use with increasing age include: greater access/ownership of these devices; decreased parental control and media use rules; and greater skills as a child ages.[40 41] Studies have found that parents tend to set more rules regarding screen time for younger children[40] and report that supervising the use of these devices becomes more difficult as the age of children increases.[7] This suggests childhood screen habits are reflected in adolescence and adulthood,[8] and highlights the importance of managing mobile screen media use with younger children.

Higher mobile screen media use by older children in the family has influence on younger siblings. One study in the review reported households with more than one child used screen devices (both fixed and mobile screens) more frequently,[36] which could be the result of younger children observing and modelling the behaviour of older

siblings. Of interest, role modelling either by parents or older siblings has been used effectively in other areas to influence children's behaviours,[42 43] and could be an important strategy to decrease young children's mobile media use.

This review found no association between child's BMI and mobile screen media use. In contrast to this, a prospective study carried out in Finland reported that the increase in screen time during a 2-year follow-up period was smaller for children who had lower BMI at 13 months,[44] while a previous research reported a positive association between TV viewing and being overweight but no association with computer use.[45]

Mixed results in regard to parental age and children's mobile screen media use were reported. Three studies reported no association,[1 27 33] while Wu *et al* found a negative association, indicating higher any media use among children of younger parents.[36] A prospective study carried out in Finland has also found that the increase in the screen time was smaller when the mother was younger[44] while previous systematic reviews on traditional media have reported an unclear association with their use and parental age.[17–19] Parents who used mobile screen media were more likely to have children who used these devices and for a longer time.[1 27 30 31] Furthermore, children of families who watch more TV are more likely to engage in higher screen viewing.[17 19 46–48] Therefore, children of parents with higher mobile screen media use may be more likely to have higher use due to parent role modelling, thus being considered 'normal behaviour'.[49]

Parent-child co-use of mobile screen media was highest for children younger than 2 years and decreased as the child aged.[1] This may be due to younger children being less able to manipulate technology or inability to unlock password-protected devices and therefore requiring parental support to operate the device. Furthermore, younger children may spend more time at home with their parents, providing more opportunities for parent-child co-use.[1] It should be noted that decreased co-use with increasing age of children reduces monitoring opportunities for parents.

The review found that children of stay-at-home parents had higher mobile screen media use.[36] This suggests parents could be more engaged in screen viewing, providing a supportive environment for mobile screen media use for their children. Conversely, self-reported data from employed parents might under-report their children's media use. Other systematic reviews focusing on children's traditional screen time report that parental occupation is rarely studied, thus it is difficult to draw any specific conclusion.[17 18] This is an area worthy of future research as parents working long hours or bringing their work home may minimise monitoring of children's mobile screen media habits.

Mixed associations were found between family income and children's mobile screen media use. Children from high-income families were using touch screens for longer durations than those from low-income families,[30] which may be due to greater ownership and access to touch screen devices in these households. Conversely, a study on electronic media use (both fixed and mobile screens) concluded no association between family income and children's screen time,[50] while the number of media devices at home and in the child's bedroom was positively associated with mobile screen media use,[37] which is consistent with other studies.[51 52] It seems that when these devices are in the bedroom, children have easy access and autonomy to use them, ultimately leading to increased use.[51] This also holds true in the case of traditional media devices such as televisions and computers.[45 51]

Use of mobile screen media devices was higher among children whose parents believed in their pacifying effects, with parents using these devices as behavioural regulation tools to secure free time or when busy with household chores or shopping.[4 10 16 53 54] Studies have shown that although parents are aware of the negative effects of using these devices for longer durations, many of them are high screen users themselves and are comfortable allowing their children to use these devices.[49 55] Parents are concerned about their children going online, but research indicates they are less concerned about their children using a smartphone or watching television.[7]

Methodological limitations of studies reviewed

A strength of this study was the protocol paper that guided the methodology of the review,[22] however, we did not search the grey literature or include qualitative studies. A major limitation of the studies reviewed was the lack of objective measures to assess children's media use with parental proxy reports used in all of the studies. This approach may underestimate or overestimate true exposure because of recall bias, social desirability bias or simply not being aware of screen viewing behaviours.[8] In addition, only one study tested reliability and validity of their instrument[36] while others either relied on previously used questionnaires with unknown validity/reliability estimates. The review was also challenging due to the lack of standardised terminology when researching mobile media screen use research, as well as the lack of standardised reporting of findings by age. The AAP[15] recommendations for children's screen media use the age categories: (A) younger than 18 months, (B) 18–24 months, (C) 2–5 years, and (D) 6 and older. However, the studies in this review often reported across these age groups or failed to provide detailed information of the target group's age when undertaking analysis. Finally, meta-analysis was not conducted due to the study findings being segregated across different mobile screen media types, making the findings largely descriptive. Future research in this area should consider undertaking randomised controlled trials with larger sample sizes and (standardised) study outcomes that can be aggregated and compared.

CONCLUSION

Despite the rapid growth in mobile technologies, this review on the correlates of mobile screen media use among children 0–8 years identified limited but increasing research being undertaken in this area. The review found that correlates such as child's age and media skills, parental media use and access to media devices at home appeared to impact on determining the mobile screen media use. Screen media use can certainly enhance life experiences and learnings, however, it is important that it is used appropriately and the family environment can play a key role in maintaining a 'healthy media diet'. To better understand the impact of environmental factors on children's mobile screen media and stimulate discussion, we need to better understand the role of parental rules; the use of mobile screen devices as behavioural regulation tools; and the role of parents and older siblings as role models. To achieve this, we need valid and reliable objective measures such as a smartphone/tablet applications that measure the time the screen is on,[56] use of standardised terminology and the reporting of findings against specific age groups. These approaches will support a better understanding of the correlates of mobile screen media use and traditional screen media use when undertaking future research.

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REFERENCES

1. Connell SL, Lauricella AR, Wartella E. Parental co-use of media technology with their young children in the USA. *J Child Media* 2015;9:5–21.
2. Holloway D, Green L, Livingstone S. Young children and their internet use. *Zero to eight*. London: EU kids, 2013.
3. Rideout V. *Zero to eight: children's media use in America*. United States of America: Common sense media, 2013.
4. Kabali HK, Irigoyen MM, Nunez-Davis R, *et al*. Exposure and use of mobile media devices by young children. *Pediatrics* 2015;136:1044–50.
5. Houghton S, Hunter SC, Rosenberg M, *et al*. Virtually impossible: limiting Australian children and adolescents daily screen based media use. *BMC Public Health* 2015;15:1.
6. Ofcom. 2016. Communications market report bite-sized.
7. Ofcom. 2016. Children and parents: media use and attitudes report.
8. Downing KL, Hnatiuk J, Hesketh KD. Prevalence of sedentary behavior in children under 2years: a systematic review. *Prev Med* 2015;78:105–14.
9. Christakis DA. Interactive media use at younger than the age of 2 years: time to rethink the American academy of pediatrics guideline? *JAMA Pediatr* 2014;168:399–400.
10. Radesky JS, Schumacher J, Zuckerman B. Mobile and interactive media use by young children: the good, the bad, and the unknown. *Pediatrics* 2015;135:1–3.
11. Troseth GL, Russo CE, Strouse GA. What's next for research on young children's interactive media? *J Child Media* 2016;10:54–62.
12. Biddiss E, Irwin J. Active video games to promote physical activity in children and youth: a systematic review. *Arch Pediatr Adolesc Med* 2010;164:664–72.
13. Strasburger V, Hogan M. children policy statement: adolescents and the media. *Pediatrics* 2013;132:958–61.
14. Department of Health. *Australia's physical activity and sedentary behaviour guidelines*. Australian government, 2015. http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#npa05
15. American Academy of Pediatrics. American academy of pediatrics announces new recommendations for children's media use USA, 2017. https://www.aap.org/en-us/about-the-aap/aap-press-room/pages/american-academy-of-pediatrics-announces-new-recommendations-for-childrens-media-use.aspx
16. Radesky JS, Peacock-Chambers E, Zuckerman B, *et al*. Use of mobile technology to calm upset children: associations With social-emotional development. *JAMA Pediatr* 2016;170:397–9.
17. Duch H, Fisher EM, Ensari I, *et al*. Screen time use in children under 3 years old: a systematic review of correlates. *Int J Behav Nutr Phys Act* 2013;10:102–10.
18. Hinkley T, Salmon J, Okely AD, *et al*. Correlates of sedentary behaviours in preschool children: a review. *Int J Behav Nutr Phys Act* 2010;7:66.
19. Hoyos Cillero I, Jago R. Systematic review of correlates of screen-viewing among young children. *Prev Med* 2010;51:3–10.
20. Vanderloo LM. Screen-viewing among preschoolers in childcare: a systematic review. *BMC Pediatr* 2014;14:205.
21. Lawman HG, Wilson DK. A review of family and environmental correlates of health behaviors in high-risk youth Obesity (Silver Spring). 2012;20:1142–57.
22. Paudel S, Leavy J, Jancey J. Correlates of mobile screen media use among children aged 0-8: protocol for a systematic review. *Syst Rev* 2016;5:1.
23. Moher D, Liberati A, Tetzlaff J, *et al*.Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg* 2010;8:336–41.
24. Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. *J Craniomaxillofac Surg* 2011;39:91–2.
25. Liberati A, Altman DG, Tetzlaff J, *et al*. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol* 2009;62:e1–34.
26. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998;52:377–84.
27. Asplund KM, Kair LR, Arain YH, *et al*. Early childhood screen time and parental attitudes toward child television viewing in a low-income latino population attending the special supplemental nutrition program for women, infants, and children. *Child Obes* 2015;11:590–9.
28. Jago R, Wood L, Zahra J, *et al*. Parental control, nurturance, self-efficacy, and screen viewing among 5 to 6 year children: a cross-sectional mediation analysis to inform potential behavior change strategies. *Child Obes* 2015;11:139–47.
29. Kesten JM, Sebire SJ, Turner KM, *et al*. Associations between rule-based parenting practices and child screen viewing: A cross-sectional study. *Prev Med Rep* 2015;2:84–9.
30. Nikken P, Schols M. How and why parents guide the media use of young children. *J Child Fam Stud* 2015;24:3423–35.

31. Lauricella AR, Wartella E, Rideout VJ. Young children's screen time: The complex role of parent and child factors. *J Appl Dev Psychol* 2015;36:11–17.
32. Lee ST, Wong JE, Ong WW, *et al*. Physical activity pattern of malaysian preschoolers: environment, barriers, and motivators for active play. *Asia Pac J Public Health* 2016;28(Suppl 5):S21–34.
33. Pempek TA, McDaniel BT. Young children's tablet use and associations with maternal well-being. *J Child Fam Stud* 2016;25:2636–47.
34. Pyper E, Harrington D, Manson H. The impact of different types of parental support behaviours on child physical activity, healthy eating, and screen time: a cross-sectional study. *BMC Public Health* 2016;16:568.
35. Sigmund E, Badura P, Vokacova J, *et al*. Parent-child relationship of pedometer-assessed physical activity and proxy-reported screen time in czech families with preschoolers. *Int J Environ Res Public Health* 2016;13:740.
36. Wu CST, Fowler C, Wyy L, *et al*. Parenting approaches and digital technology use of preschool age children in a Chinese community. *Ital* 2014;40:1–8.
37. Jago R, Sebire SJ, Lucas PJ, *et al*. Parental modelling, media equipment and screen-viewing among young children: cross-sectional study. *BMJ Open* 2013;3:e002593.
38. Carson V, Kuzik N. Demographic correlates of screen time and objectively measured sedentary time and physical activity among toddlers: a cross-sectional study. *BMC Public Health* 2017;17:187.
39. Bronfenbrenner U, Evans GW. Developmental science in the 21st century: emerging questions, theoretical models, research designs and empirical findings. *Soc Dev* 2000;9:115–25.
40. Warren R. Parental mediation of preschool children's television viewing. *J Broadcast Electron Media* 2003;47:394–417.
41. Australian Communications and Media Authority (ACMA). *Broadband and mobile phones in family households*. Australia, 2008.
42. Brown R, Ogden J. Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. *Health Educ Res* 2004;19:261–71.
43. Draxten M, Fulkerson JA, Friend S, *et al*. Parental role modeling of fruits and vegetables at meals and snacks is associated with children's adequate consumption. *Appetite* 2014;78:1–7.
44. Matarma T, Koski P, Löyttyniemi E, *et al*. The factors associated with toddlers' screen time change in the STEPS Study: A two-year follow-up. *Prev Med* 2016;84:27–33.
45. de Jong E, Visscher TL, HiraSing RA, *et al*. Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. *Int J Obes* 2013;37:47–53.
46. Xu H, Wen LM, Rissel C. Associations of parental influences with physical activity and screen time among young children: a systematic review. *J Obes* 2015;2015:1–23.
47. Birken CS, Maguire J, Mekky M, *et al*. Parental factors associated with screen time in pre-school children in primary-care practice: a TARGet Kids! study. *Public Health Nutr* 2011;14:2134–8.
48. Jago R, Thompson JL, Sebire SJ, *et al*. Cross-sectional associations between the screen-time of parents and young children: differences by parent and child gender and day of the week. *Int J Behav Nutr Phys Act* 2014;11:54–64.
49. Schoeppe S, Rebar AL, Short CE, *et al*. How is adults' screen time behaviour influencing their views on screen time restrictions for children? A cross-sectional study. *BMC Public Health* 2016;16:201.
50. Vandewater EA, Rideout VJ, Wartella EA, *et al*. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics* 2007;119:e1006–15.
51. Veldhuis L, van Grieken A, Renders CM, *et al*. Parenting style, the home environment, and screen time of 5-year-old children; the 'be active, eat right' study. *PLoS One* 2014;9:e88486.
52. Dumuid D, Olds TS, Lewis LK, *et al*. Does home equipment contribute to socioeconomic gradients in Australian children's physical activity, sedentary time and screen time? *BMC Public Health* 2016;16:736.
53. Chiong C, Shuler C. *Learning: Is there an app for that? Investigations of young children's usage and learning with mobile devices and apps*. New York: Sesame Workshop, 2010.
54. Carson V, Tremblay MS, Spence JC, *et al*. The Canadian sedentary behaviour guidelines for the early years (zero to four years of age) and screen time among children from kingston, ontario. *Paediatr Child Health* 2013;18:25–8.
55. He M, Piché L, Beynon C, *et al*. Screen-related sedentary behaviors: children's and parents' attitudes, motivations, and practices. *J Nutr Educ Behav* 2010;42:17–25.
56. Christensen MA, Bettencourt L, Kaye L, *et al*. Direct measurements of smartphone screen-time: relationships with demographics and sleep. *PLoS One* 2016;11:e0165331.