BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014585
Article Type:	Research
Date Submitted by the Author:	05-Oct-2016
Complete List of Authors:	Paudel, Susan; Curtin University School of Public Health, Jancey, Jonine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health Subedi, Narayan; Maharajgunj Medical Campus, Institute of Medicine, Department of Community Medicine and Public Health Leavy, Justine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Research methods
Keywords:	Children, Mobile media use, Screen time, Correlates, Systematic review

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

Authors:

Susan Paudel

School of Public Health, Curtin University, Western Australia

replysusan@gmail.com

Dr.JonineJancey

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.jancey@curtin.edu.au

Narayan Subedi

Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University

subedi.narayan@gmail.com

Dr. Justine Leavy

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.leavy@curtin.edu.au

Corresponding author:

Susan Paudel

School of Public Health, Curtin University, Western Australia

Email: replysusan@gmail.com

Contact no: 977-9843061616

Word Count: 4647

Abstract

Background

Young children (0-8years) are increasingly exposed to mobile screen media devices such as smartphones and tablets. Research indicates these young children are exceeding daily screen time recommendations. This paper systematically reviewed the peer-reviewed literature published between 2009 and 2015 to identify the correlates of mobile screen media use among children eight years or less.

Methods

Eight electronic databases were searched usingkeywords such as child*, preschool, infant, kid and toddler , screen time, screen viewing, mobile phone, cell phone, smartphone*, PDA, tablet*, iPad*, handheld media and handheld computer*. Peer-reviewed English language primary research papers published or in press between January 2009 and December 2015 were eligible for inclusion.

Results

Eight studies meeting the inclusion criteria were identified of which a total of 29 correlates were examined. Older young children (aged 4-8 years), 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, gender and education or the child's gender.

Conclusion

Limited research has been undertaken into young children's mobile screen media use and most of the variables were studied too infrequently for a robust conclusion 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.

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

Keywords

Children, mobile media use, screen time, correlates, systematic review

Strengths

- This review summarises current peer-reviewed literature on correlates of mobile screen media use among children aged less than eight-years.
- It has summarised the findings, and gaps and limitations of the literature and highlighting areas for future research.
- The review has adopted a robust research strategy, identified up-to-date key word with the assistance of a public health librarian; searched eight databases based on a comprehensive selection criterion.

Limitations

- All the reviewed studies were cross-sectional in design.
- Association and consistency could not be determined in this review because the study findings were segregated across different mobile media types and hence the findings are largely descriptive.

- Grey literature, non-peer reviewed and non-English papers were not included in this review.

BACKGROUND

Today young children are increasingly exposed to multiple screens including both the traditional fixed screens, such as televisions and desktop computers and newer handheld mobile screen media devices such as smartphones and 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, such as 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 while the time spent on the former has drastically increased (4). This increasing exposure and accessibility to mobile screen media devices has public health implications, due to its impact on children's sedentary behaviour and play opportunities, especially considering the evidence that indicates childhood habits usually track into adulthood (6).

Guidelines recommend that children under the age of two should not be exposed to any form of screen time, while for those aged two-to-five, the daily screen time should be less than one hour (7, 8). However, a significant percentage of young people are exceeding the recommended duration of screen time around the world (5). A Western Australian study reported that nearly half (45%) of year three students (aged eight years) exceeded the screen time recommendation, and this excessive screen time exposure increased with age (5). Furthermore, these guidelines on screen time have focused on the use of screen media for entertainment while the use of these devices for educational purposes, whether at home or at school, has largely been ignored (5).

In an urban community in Philadelphia, USA, nearly half of one-year-old children were reportedly using mobile screen media devices on a daily basis, with increased use as they aged(4). Surprisingly, 75% of children had their own mobile device by the age of four (4). An Australian study reported that 61% of Australians would choose a mobile phone over a television (9). Similarly, 16% of two- to four-year-old Australian children have access to at least one screen media in their bedroom (10).

Parents are increasingly allowing their young children to use mobile screen media devices, especially smartphones and tablets, when they are busy doing household chores or shopping, to calm children in public places or to put children to sleep (3, 4, 11). Research indicates that they are potentially ignoring the negative impact these devices may have such as these devices being associated with poor physical and psychosocial health (6, 12-15).

Despite the increase in the use of mobile screen media devices such as smartphones, electronic tablets, handheld computers and Personal Digital Assistants(PDAs) by young children, very limited research has been carried out to identify the factors associated with theirincreased use (4). Presently, screen time research is largely dominated by fixed screens with scant attention paid to mobile screen media devices (16). Systematic reviews to identify the correlates of mobile screen media use among young children are almost non-existent. Previous reviews have focused 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 eight years and less is crucial. The purpose of this review is to systematically search and critically review the published peer-reviewed literature to identify the correlates of mobile screen media use

among children eight years or less. Correlates are classified into proximal and distal factors using a bio-ecological 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 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (23-25) and is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028). The study uses already published, de-identified data and hence is exempt from the ethics approval process. A detailed description of the methods is available in the protocol paper(22) .

Outcome measure

Mobile screen media use is the primary outcome measure of this review. There are two sub-categories within the 0-8 year range, the younger young children defined as 0-3 years and the older young children defined as 4-8 years.Screen time in the review refers to the total amount of time spent in front of mobile screens, such as mobile phones, electronic tablets, handheld computers or PDAs. This review focuses on mobile screen media devices rather than on traditional fixed screens.

Correlates of mobile screen media use have been categorised into five categories as per the bio-ecological model (17, 18). The five categories are:

- *Child biological and demographic factors* include age, gender, 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 media skills, beliefs and attitudes towards the media and self-efficacy to limit their children's screen viewing behaviours.

Direction of association has been reviewed separately for: a) smartphones; b) tablets; c) touchscreens; and d) any media device (defined as the combination of traditional media with at least one form of mobile screen media devices).

Eligibility criteria

The studies eligible for inclusion are peer-reviewed primary research papers with screen time, parent-child co-use or adherence to screen time guidelines as the outcome measure that have investigated the correlates of screen time among children under eight years; based in home or community settings; and published, or in press in English language journals between January 2009 to December 2015. The full description of the alignment of the research question to the Population, Exposure, Comparison and Outcome (PECO) format along with the exclusion criteria is detailed in the study protocol (22).

Search strategy and study selection

Eight electronic databases: Medline, Scopus, Embase, CINAHL Plus, Pubmed, ProQuest, PsycINFO and Web of Science were searched for papers published between January 2009 and December 2015. 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 in September-October 2015. In order to track the papers published beyond this date, email alerts were created in Medline, Scopus and ProQuest. 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 1. A total of 1574 papers were identified through searching these eight databases. To ensure that all relevant papers were identified, a manual search of the reference lists of 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. Altogether, 1581 papers were identified.

Table 1: Search strategy used in Medline database

Database: Ovid Medline (R) 1946 to 20th October 2015		
SN	Search strategy	Results
1	Only Child/ or Child/ or child.mp. or Child, Preschool/	1767004
2	Infant/ or infant.mp.	1030660
3	Kid.mp.	1251
4	Toddler.mp.	2240
5	1 or 2 or 3 or 4	2242988
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.	16724
15	Tablets/ or Tablets.mp.	34967
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	64324
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

* Sign denotes for any character(s), SN= Serial number, 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

Endnote (version X7.5) software was used for managing all the identified papers (n=1581). Duplicate papers (n= 287) were removed. The remaining papers (n=1294) were then screened by title. From this, irrelevant titles (n=845) were excluded. The abstract of the remaining papers (n= 449) were reviewed; and a further 385 papers were excluded. Full texts of the remaining papers (n=64) were retrieved and reviewed by the three researchers(SP, JJ and JL) against the inclusion/exclusion criteria, resulting in eight papers being included in this systematic review. The authors of this review paper were not blinded to the name, journal titles or institutional affiliation of the authors of the paper selected for the final review. This 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 (questions 1-3, 6, 7, 10-12, 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. Any discrepancies were re-assessed 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. Mean duration of screen-viewing was also extracted whenever available. Adjusted Odds Ratio (AOR) and Standardised Coefficients (SC) 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.

RESULTS

Study characteristics

Eight papers were selected for inclusion in the review and all were published between 2013 and 2015. Six were published in 2015 (1, 27-31), one in 2014 (32) and 2013 (33). All of the eligible studies were conducted in high-income countries with three from the United States (1, 27, 31) and United Kingdom (28, 29, 33), one from Netherlands (30) and Hong Kong (32). All the eight studies were cross-sectional in design. The studies quality scores ranged from 6 to 9 with a mean score of 7.75.

The studies sample size ranged from n=202 to n=2326. Two studies reported using weighted data to be representative of the national population (1, 31), while all other studies used non-representative techniques(27-30, 32, 33). The mean age of participants was clearly stated in three papers (28, 30, 31) while the remaining four provided frequencies in different age-groups (27, 29, 32, 33). However, Connell et. al. (1) did not report children's mean age. Based on the data available from these seven papers, the mean age of children was (4.8 ± 1.4) years. The descriptive characteristics of the included studies are presented in Table 2.

Screen time

Six studies reported screen viewing as the primary outcome measure (28-33), while one study reported adherence to the American Academy of Paediatrics (AAP) guidelines on screen time (27) and other reported parent-child co-use of media (1).

Mobile screen media use in all eight studies was measured by parental self-report of their children's screen viewing behaviour. One study reported face validity, content validity and test-retest reliability of the instrument used to measure screen time (32) and three study questionnaires had been used in other studies (1, 27, 31). The other three studies stated parental-proxy reports to have reasonable reliability and validity to measure children's screen viewing behaviour (28, 29, 33). Whilst, Nikken and colleagues did not report on the reliability and validity of their instrument (30). Overall, the mean duration of screen-viewing could not be determined as only three studies reported the average duration of screen-viewing (27, 30, 31), while other studies categorised participants into screen times, such as less than 2 hours and more than 2 hours.

Device use and correlates

In total, 29 correlates were studied in the eight papers. Of those, two variables (child age and parental media use) were reported five times, one variable (parental age) was reported three times, seven variables (child gender, parent's gender, family income, parental education, race/ethnicity, parental belief on positive effects of media and number of screens at home) were reported twice, and the remaining 19 variables were reported once (See table 3 and 4). 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 smart phones (1, 29, 31, 33), while three were specific to electronic tablets (1, 28, 31). Nikken et. al. (30) reported combined results for touchscreens (smartphones and tablets) while the other two studies reported correlates for electronic media, that included both traditional and modern devices such as televisions, computers, mobile phones and tablets (27, 32). Use of a PDA was not studied in any of the papers.

Correlates of mobile media use

Child biological and demographic factors

Three of the five studies (60%) reported a positive association between the child's age and mobile screen media use (27, 31, 32) (Table 3). Older children (>3years) were more likely to use smartphones, tablets or any media than younger children (<3 years) (27, 31, 32). However, Lauricellaet. al. examined parent-child co-use of smartphones and tablets and reported an inverse association indicating that older children are less likely to co-use with their parents (31). By way of contrast, Nikken et. al. (30) concluded that the child's age had no significant association with the use of touchscreens. No association was found between the use of smartphones, tablets or any other touchscreens and child's gender (1, 30) and body mass index (BMI) (27).

Table 2: Description of included studies

S.N	Author	Year	Country	Study design	Sample size	Age group	Outcome measure	Screen studied	Independent variables	Quality score
1	Nikken et al. (30)	2015	Netherlands	Cross-sectional	896	0-7 years	Media ownership and use	TV, game consoles, computers and touchscreens	Parent and child characteristics (age, access, concerns about media use)	6
2	Lauricella et al. (31)	2015	US	Cross-sectional	2300	0-8 years	Children's screen time	Television, computers, smartphones, and tablets	Parental media use, parental attitudes, child's age	8
3	Connell et. al. (1)	2015	US	Cross-sectional	2326	0-8 years	Parent-child co-use of media	Books, TV, computers, video games, tablets, and smartphones	Parent's time with child, parent's media use, parental and child demographics	7
4	Kesten et al. (29)	2015	UK	Cross-sectional	735	6-8 years	Children's screen-time	TV, computer, smartphone, game-console and multi-SV	Parent's employment, education, number and gender of children, screen related limits	8
5	Jago et al. (28)	2015	UK	Cross-sectional	954	5-6 years	Children's screen-time	TV, computer/laptop use including tablets	Parenting styles and parental self-efficacy to limit screen time	8
6	Asplund et al.(27)	2015	US	Cross-sectional	314	0-5 years	Adherence to AAP guidelines for screen time	TV, video games, computers, cell phones and other electronic devices	Child BMI, child/parent demographics, and household media environment, parental attitudes towards TV viewing	9
7	Wu et al. (32)	2014	Hong Kong	Cross-sectional	202	3-6 years	Use of digital products	Television, digital tablets, smart phones, etc	Participants' demographics, parenting approach (restrictive, instructive and co-using)	8
8	Jago et al. (33)	2013	UK	Cross-sectional	750	6-8 years	Children's screen-time	TV, game console, smart-phone and multiscreen-viewing	Parental media use, parental attitudes and access to media equipment	8

Table 3: Demographic and biological correlates of mobile screen media use and direction of association

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Association	Study	Association	Study	Association	Study	Association	Study
Child biological and demographic factors	Child age	+	(31)	+	(31)	0	(30)	+	(27, 32)
		-	(1) (co-use)	-	(1)(co-use)				
	Child gender (0= boy)	0	(1)	0	(1)	0	(30)		
	BMI							0	(27)
Family biological and demographic factors	Parental age	0	(1)	0	(1)			0	(27)
								-	(32)
	Parent's gender (0 = father)	0	(1)	0	(1)	0	(30)		
	Family income					+	(30)	-	(32)
	Parent's occupation (0= unemployed)							-	(32)
	Parent's education	0	(1)	0	(1)	0	(30)		
	Language							0	(27)
	Race/Ethnicity	+	(1)(Non-Hispanic)	+	(1)(Hispanic)			0	(27)
Family structure factors	Family size					0	(30)		
	Number of children in the family							+	(32)

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$)

Empty cells denote that association for that variable has not been studied, '( )' denotes reference.

Family biological and demographic factors

Three studies reported an association between parental age and their children's mobile screen media use (1, 27, 32) (see Table 3). Of these, two reported no statistically significant association (1, 27), while Wu et. al. found a negative association, indicating that digital technologies were more frequently used by children with younger parents (32).

Mixed associations were found between family income and children's mobile screen media use (see Table 3). Nikken et. al. (30) reported a positive association, indicating that children from high-income families were using touchscreens longer than those from low-income families. On the other hand, Wu et. al. (32) found a negative association. The same study reported a negative association between parent's occupational status and children's mobile screen media use (32). Furthermore, children's of stay-at-home parents were using digital devices more frequently than children whose parents were engaged in an occupation (32).

No association was identified between young children's smartphone, tablet or any touchscreen use and parent's gender (1, 30). Similarly, parent's educational status (1, 30) and language (27)also did not show any significant association with children's mobile media use.

Family structure factors

Only two studies reported family factors associated with children's mobile screen media use (Table 3). There was a positive association reported between number of children and use of digital devices, such as televisions, computers, tablets and mobile phones (32), while when there were two or more children, they were more likely to use digital devices frequently for talking with friends compared to those families with one child (32).

Behavioural factors

Media skill was the only children's behavioural characteristic studied (see Table 4), with their ability or skill to use mobile screen media devices being positively associated with the frequency and duration of such devices used (30). 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, 16 sociocultural/environmental correlates were investigated (see Table 4). Parental screen time/media use was the most studied variable (1, 27, 30, 31, 33). Two studies concluded that there was no statistically significant association between parental smartphone use and their children's use (1, 33). However, Lauricellaet. al. found children (older than 2 years) had higher levels of smartphone use if their parents spent more time using their smartphones (31). Positive associations have also been reported for parental screen time and children's use of tablets, touchscreen devices or any media (1, 27, 30, 31).

Parental attitudes about the effects of mobile screen media on children were positively associated with smartphone and tablet use for older young children (4-8 years) (31). The more positive parental attitudes towards the devices resulted in a greater use by the children (31). Similarly, parental belief in the negative effects of media on children and the belief that these mobile screen media devices were too complicated for their young children were 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

pacifier (30). On the other hand, parental nurturance and self-efficacy to limit screen-time were negatively associated with tablet use (28).

Keeping the television on during dinner time (27) and the presence of a computer outside children's bedroom (32) were physical environmental correlates positively associated with increased mobile screen media use among young children. The number of media devices at home, and in the child's bedroom were also positively associated with increased smartphone use (33). Jagoet. al. (33) concluded that the greater the number of devices, the greater the use, while Asplund et. al. (27)reported no such association.

Table 4: Environmental and behavioural correlates of mobile screen media use and direction of association

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Assoc	Study	Assoc	Study	Assoc	Study	Assoc	Study
Behavioural factors	Child media skills					+	(30)		
Sociocultural/ environmental factors	Parental media use/screen time	+	(31)(>2 yrs)	+	(1, 31)	+	(30)	+	(27) (≥2 yrs)
		0	(1, 33)						
	Parent attitudes on effects of media on children	+	(31)(>6 yrs)	+	(31)(>2 yrs)				
	Parental belief that media has positive effects on children	0	(33)			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	(29) (boys)						
		+ (always)	(29) (girls)						
	Collaborative rule setting	0	(29)						
	Parental control on media use			0	(28)				
	Parental nurturance			-	(28)				
	Parental self-efficacy			-	(28)				
	TV on during dinner							+	(27) (≥2 yrs)
	Number of TVs/screens at home	+	(33)					0	(27)
	Computer's outside bedroom							+	(32)
	Screen viewing items in child's bedroom	+	(33)						

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, p<0.050).

DISCUSSION

This systematic review summarised correlates of mobile screen media use among young children of eight years or less from eight studies. Previous reviews have focused on traditional fixed screen media, while reviews specifically focused on mobile screen media use among young children are limited. In this context, this systematic review of mobile screen media use among children (0-8 year), adds somewhat to the understanding of this area. Despite the review being conducted between 2009 to 2015, all the studies were published between 2013 and 2015, indicating limited but recent and increasing interest in this area.

This review found that older young children (4-8 years) were more likely to have higher mobile screen media use.Similarly, those who were better skilled in using such devices, had more access to media devices at home, and higher parental use of mobile screen media were more likely to have higher mobile screen media use. The bio-ecological model states that human behaviour is affected by intrapersonal factors, inter-personal factors and distal factors which interact to shape our behaviour (21, 34). However, the findings of this review support the fact that inthe case of young children of eight 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 (4-8 years) were more likely to use mobile screen media devices compared to their younger counterparts (0-3 years). This finding is consistent with a systematic review of traditional screen time among children under three years (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 (35, 36). Studies have found that parents tend to set more rules regarding screen time for younger children (35), with childhood screen time habits reflected in adolescence and adulthood (6), highlighting the importance of managing mobile screen media use with children. Higher mobile screen media use by older children in the family also has implications on the younger siblings. One of the studies in the review reported households with more than one child use digital devices more frequently (32). This could partly 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 (37, 38),and could be an important strategyto decrease young children's mobile media use

Mixed results in regards to parental age and children's mobile screen media use were reported. Two of the three studies found that children's mobile screen media use was not affected by parental age (1, 27), whereas another study reported higher use among children with younger parents (32). This may be due togreater mobile screen media use by young parents which would provide a supportive home environment for screen-viewing. Previous systematic reviews on traditional screens have reported an unclear association with parental age, which is consistent with this review (17-19).

Parents who used mobile media screens 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, 39-41). Therefore, children of parents with higher mobile screen media use may be more likely to have higher use due to parental modelling, thus being considered 'normal behaviour' (42).

Parent-child co-use of mobile screen media was highest for children less than two 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 however, that decreased co-use with increasing age of children minimises parents monitoring opportunities.

Children who were more skilled at using mobile screen media devices were using these devices for a longer time period than those who were less skilled (30). It can be posited that, withincreased exposure, it is possible children will gain even more skills over time, ultimately leading to higher mobile screen media use as they age (35, 36). Increased skills, and use with age may have both positive and negative impacts. For example, it may put children at greater risk of exposure to inappropriate media content and in the absence of parent-child co-use, these activities may go unnoticed by parents (43).

Mixed associations were found for family income. Wu et. al. (32)found a negative association for any media use which is consistent with a previous review with traditional screen media(19), while Nikken et. al. concluded that children from higher-income households had higher use of smartphones and tablets (30), which may be due to greater ownership and access. On the other hand, a study on electronic media use (both fixed and mobile screens) among children less than six years concluded no association between family income and children's screen time (44).

The review found, children of stay-at-home parents had higher mobile screen media use (32). This suggests parents could be more engaged in screen-viewing, providing a supportive environment for mobile screen media use.It should be noted self-reported data,

from employed parents might under-report their children's media use. Other systematic reviewsfocusing on children's traditional screen timereport 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, with parents working long hours or bringing their work home, may minimise monitoring of children's screen habits.

Use of mobile screen media devices was higher among children whose parents believed in the pacifying effects of these devices. Parents are using these devices as babysitters to secure free time or when busy with household chores or shopping (4, 11, 45). Parents may not be aware that they are contributing to the development of their children's mobile screen media use behaviours or the possible impacts that these devices and their unmonitored use may have (46).

Consistent with this review, previous systematic reviews, focusing on television viewing, reported that child's gender is not associated with any particular screen-viewing behaviour (17-19). Similarly, no association was found with parent's gender, potentially because both parents were equally engaged with these mobile screen media as in case of young boys and girls (47).

Methodological limitations of studies reviewed

Only two of the eight studies used a representative sample,the remaining studies relied on non-representative techniques such as self-selected samples which could have introduced elements of selection bias. A major limitation of the studies was the lack of objective measure to assess children's media use. Parental proxy reports were used in all of the studies included in the review. This approach may underestimate or overestimate true exposure because of recall bias, social desirability bias or simply not being aware of screen viewing (6). Furthermore, often studies included mobile screen media use as an

average of weekdays and weekend days while others focused only on weekdays. There can be broad variations in the duration of mobile screen media use during the week and weekend days and there can be differential effect of correlates. In addition, only one study tested reliability and validity of their instrument(32)while others either relied on previously used questionnaires with unknown validity/reliability estimates.

Altogether, 29 correlates were examined in the eight papers. However, the vast majority (19 variables) were examined only once. Even for variables such as a child's age and parental media use which were studied more frequently, findings were disaggregated across different media types making it difficult to reach an overall conclusion.Heterogeneity of the studies limited carrying out meta-analysis.

CONCLUSION

This review has identified limited research undertaken on young children's mobile screen media use,despite the rapid growth in mobile screen media device use.The review found that correlates such as child's age and media skills, parental media use and access to media devices at home appear to impact on determining the mobile screen media use by children aged eight years and less. Future studies using valid and reliable objective measures to assess children's mobile screen media use and frequent examination of the potential correlates across multiple studies and settings are required. There is a need for research to be undertaken in mobile screen media use across weekdays and weekend days to establish a precise estimate of the time spent by these young children on mobile screen media; the impact of parental behaviours on child's mobile screen media use; parental rules on mobile screen media use and the impact on children; use of mobile screen devices as pacifiers and its impact; parents and older siblings as role models; and parental self-efficacy to influence children's behaviours.

1

2

3 1

4

5

6 2

7

8 3

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

List of abbreviations used

PDA: Personal Digital Assistants

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

Declarations:

Ethics approval and consent to participate

Since this systematic review uses already published, de-identified data, it is hence exempt from the ethics approval process. It does not involve any contact with the human participants and has not collected any primary data.

Consent for publication

This is "Not applicable" for this study as it does not report any individual level data.

Availability of data and material

The findings of this review rely on the data presented on the papers that are already published and are easily accessible on public domains.

Competing interests

The authors declare that they have no financial and non-financial competing interests.

Funding

This study has not received any funding from any source.

Author's contribution

SP, JL and JJ jointly conceived and designed the study. SP was responsible for searching the literature, screening the papers, working on design, critically reviewing the papers and drafting the manuscript. JJ provided overall supervision for the study, finalised

methodology, screening of full text, quality assessment, and edited the manuscript. NS was involved in searching the database, initial screening of title and abstracts and revised the manuscript. JL contributed to design, screening of full text, quality assessment, and organised and revised the manuscript. All authors have read and approved the final version of manuscript.

Acknowledgements

We would like to acknowledge the support of Public health faculty librarian of Curtin University, Ms. Diana Blackwood for her guidance during the database searching stage.

Author's information

Susan Paudel(BPH, MPH, MHlthProm): School of Public Health, Curtin University, Western Australia, Email: replysusan@gmail.com

Dr.JonineJancey (BSc (Hons) PhD) : Associate Professor, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.jancey@curtin.edu.au

Narayan Subedi (BPH, MPH, PGDPHN): Assistant Professor, Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University, Nepal, Email: subedi.narayan@gmail.com

Dr. Justine Leavy (BSc, MPH, PhD): Senior Lecturer, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.leavy@curtin.edu.au

References

1. Connell SL, Lauricella AR, Wartella E. Parental Co-Use of Media Technology with their Young Children in the USA. Journal of Children and Media. 2015;9(1):5-21.
2. Holloway D, Green L, Livingstone S. Zero to eight: Young children and their internet use. London: LSE, EU Kids Online; 2013.
3. Rideout V. Zero to eight: Children's media use in America 2013. United States of America: Common Sense Media, 2013.
4. Kabali HK, Irigoyen MM, Nunez-Davis R, Budacki JG, Mohanty SH, Leister KP, et al. Exposure and use of mobile media devices by young children. Pediatrics. 2015:2015-151.
5. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. BMC Public Health. 2015;15(1):1.
6. Downing KL, Hnatiuk J, Hesketh KD. Prevalence of sedentary behavior in children under 2years: A systematic review. Preventive Medicine. 2015;78:105-14.
7. Strasburger V., Hogan M. Policy Statement: children, adolescents and the media. Pediatrics. 2013;132:958-61.
8. Department of Health. Australia's Physical Activity and Sedentary Behaviour Guidelines: Australian Government; 2015 [Available from: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#npa05.
9. Mackay M. M. Australian Mobile Phone Lifestyle Index: Mobile Phone Use Compared To The Tablet And Personal Computer. Australia: AIMIA, 2014.
10. Australian Bureau of Statistics (ABS). Australian Health survey: Physical Activity, 2011-12. Canberra: Australian Bureau of Statistics, 2013.
11. Radesky JS, Peacock-Chambers E, Zuckerman B, Silverstein M. Use of Mobile Technology to Calm Upset Children: Associations With Social-Emotional Development. JAMA Pediatrics. 2016;170(4):397-9.
12. Hinkley T, Verbestel V, Ahrens W, Lissner L, Molnár D, Moreno LA, et al. Early childhood electronic media use as a predictor of poorer well-being: a prospective cohort study. JAMA Pediatrics. 2014;168(5):485-92.
13. Epstein LH, Roemmich JN, Robinson JL, Paluch RA, Winiewicz DD, Fuerch JH, et al. A randomized trial of the effects of reducing television viewing and computer use on body mass index in young children. Arch Pediatr Adolesc Med. 2008;162(3):239-45.
14. Pagani LS, Fitzpatrick C, Barnett TA, Dubow E. Prospective associations between early childhood television exposure and academic, psychosocial, and physical well-being by middle childhood. Arch Pediatr Adolesc Med. 2010;164(5):425-31.
15. Ross ST, Dowda M, Saunders RP, Pate RR. Double dose: The cumulative effect of TV viewing at home and in preschool on children's activity patterns and weight status. Pediatr Exerc Sci. 2013;25(2):262.
16. 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):1-3.
17. Duch H, Fisher EM, Ensari I, Harrington A. Screen time use in children under 3 years old: a systematic review of correlates. Int J Behav Nutr Phys Act. 2013;10(1):1-10.
18. Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. Int J Behav Nutr Phys Act. 2010;7(66):10.
19. Cillero IH, Jago R. Systematic review of correlates of screen-viewing among young children. Preventive Medicine. 2010;51(1):3-10.
20. Vanderloo LM. Screen-viewing among preschoolers in childcare: A systematic review. BMC Pediatr. 2014;14(1):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(6):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. Systematic reviews. 2016;5(1):1.
23. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. International Journal of Surgery. 2010;8(5):336-41.
24. Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. Journal of Cranio-Maxillofacial Surgery. 2011;39(2):91-2.
25. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of Clinical Epidemiology. 2009;62(10):e1-e34.
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. Journal of Epidemiology and Community Health. 1998;52(6):377-84.
27. Asplund KM, Kair LR, Arain YH, Cervantes M, Oreskovic NM, Zuckerman KE. 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. 2015;11(5):590-9.
28. Jago R, Wood L, Zahra J, Thompson JL, Sebire SJ. Parental control, nurturance, self-efficacy, and screen viewing among 5-to 6-year-old children: a cross-sectional mediation analysis to inform potential behavior change strategies. Child. 2015;11(2):139-47.
29. Kesten JM, Sebire SJ, Turner KM, Stewart-Brown S, Bentley G, Jago R. Associations between rule-based parenting practices and child screen viewing: a cross-sectional study. Preventive Medicine Reports. 2015;2:84-9.
30. Nikken P, Schols M. How and Why Parents Guide the Media Use of Young Children. Journal of Child and Family Studies. 2015;24(11):3423-35.
31. Lauricella AR, Wartella E, Rideout VJ. Young children's screen time: The complex role of parent and child factors. Journal of Applied Developmental Psychology. 2015;36:11-7.
32. Wu CST, Fowler C, Lam WYY, Wong HT, Wong CHM, Loke AY. Parenting approaches and digital technology use of preschool age children in a Chinese community. Ital. 2014;40(1):1-8.
33. Jago R, Sebire SJ, Lucas PJ, Turner KM, Bentley GF, Goodred JK, et al. Parental modelling, media equipment and screen-viewing among young children: Cross-sectional study. BMJ Open. 2013;3(4).
34. Bronfenbrenner U, Evans GW. Developmental Science in the 21st Century: Emerging Questions, Theoretical Models, Research Designs and Empirical Findings. Social Development. 2000;9(1):115-25.
35. Warren R. Parental mediation of preschool children's television viewing. J Broadcast Electron Media. 2003;47(3):394-417.
36. Australian Communications and Media Authority (ACMA). Access to the internet, broadband and mobile phones in family households. Australia: 2008.
37. 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(3):261-71.
38. Draxten M, Fulkerson JA, Friend S, Flattum CF, Schow R. Parental role modeling of fruits and vegetables at meals and snacks is associated with children's adequate consumption. Appetite. 2014;78:1-7.
39. 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.

40. Birken CS, Maguire J, Mekky M, Manlhiot C, Beck CE, Jacobson S, et al. Parental factors associated with screen time in pre-school children in primary-care practice: a TARGet Kids! study. Public Health Nutrition. 2011;14(12):2134-38.
41. Jago R, Thompson JL, Sebire SJ, Wood L, Pool L, Zahra J, 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(1):54-64.
42. Schoeppe S, Rebar AL, Short CE, Alley S, Van Lippevelde W, Vandelanotte C. How is adults' screen time behaviour influencing their views on screen time restrictions for children? A cross-sectional study. BMC Public Health. 2016;16(1):201.
43. Ey LA., Culpit C.G. Exploring young children's understanding of risks associated with Internet usage and their concepts of mangement strategies. Journal of Early Childhood Research. 2011;9:53-65.
44. Vandewater EA, Rideout VJ, Wartella EA, Huang X, Lee JH, Shim M-s. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. Pediatrics. 2007;119(5):e1006-15.
45. Chiong C., Shuler C. Learning: Is there an app for that? Investigations of young children's usage and learning with mobile devices and apps. Sesame Workshop; The Joan Ganz Cooney Centre, New York 2010.
46. Kim J-K, Kang Y-S. The Effects of Young Children's Smartphone Use Experience on Their Parents' Perceptions and Needs and Their Self-Regulation. International Journal of Applied Engineering Research. 2016;11(2):1208-11.
47. Hinkley T, Salmon J, Okely AD, Crawford D, Hesketh K. Preschoolers' physical activity, screen time, and compliance with recommendations. Medicine and Science in Sports and Exercise. 2012;44(3):458-65.

Figure 1: PRISMA flow chart for study selection

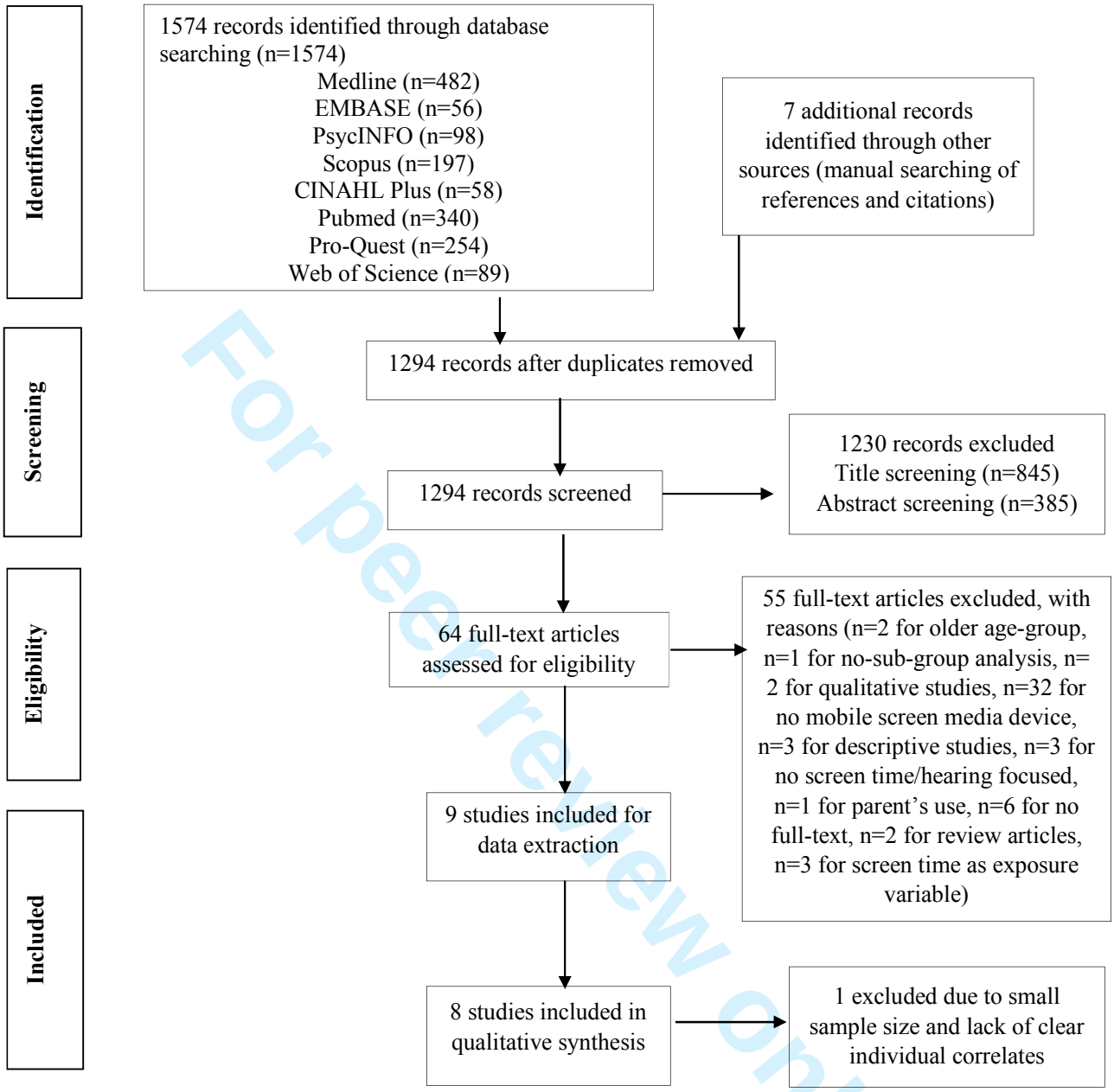

Figure 1: PRISMA flow chart for study selection

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3,4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	6,7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	7,8
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	8
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	9
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	10
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	10,11
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	10
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	10,11
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7,8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12,13

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12,13
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13-21
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	22-25
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	25-26
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	26
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014585.R1
Article Type:	Research
Date Submitted by the Author:	13-Apr-2017
Complete List of Authors:	Paudel, Susan; Curtin University School of Public Health, Jancey, Jonine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health Subedi, Narayan; Maharajgunj Medical Campus, Institute of Medicine, Department of Community Medicine and Public Health Leavy, Justine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Research methods
Keywords:	Children, Mobile media use, Screen time, Correlates, Systematic review

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

Authors:

Susan Paudel

School of Public Health, Curtin University, Western Australia

replysusan@gmail.com

Dr. Jonine Jancey

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.jancey@curtin.edu.au

Narayan Subedi

Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University

subedi.narayan@gmail.com

Dr. Justine Leavy

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.leavy@curtin.edu.au

Corresponding author:

Susan Paudel

School of Public Health, Curtin University, Western Australia

Email: replysusan@gmail.com

Contact no: 977-9843061616

Abstract

Background

Young children (0-8years) are increasingly exposed to mobile screen media devices such as smartphones and electronic tablets. Furthermore, the mobile screen devices are replacing traditional fixed screen devices such as television and desktop computers. This study is a systematic review of the peer-reviewed literature to identify the correlates of mobile screen media use among children aged eight years and less.

Methods

Eight electronic databases were searched for relevant peer-reviewed English language primary research articles published or in press between January 2009 and March 2017. The systematic review was guided by PRISMA criteria and registered with PROSPERO.A manual search of reference lists and citation was also carried out for potential papers.

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.

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

Keywords

Children, mobile screen media, screen time, correlates, systematic review

Strengths

- This review summarises current peer-reviewed literature on correlates of mobile screen media use among children aged eight years and less.
- The review used a robust research strategy underpinned by a published protocol, identified up-to-date key words with the assistance of public health librarian; searched eight databases based on a comprehensive selection criterion.
- It has summarised the findings, gaps and limitation of the literature and highlighted areas for future research.

Limitations

- All the reviewed studies were cross-sectional in design.
- Association and consistency could not be determined in this review because the study findings were segregated across different mobile screen media types and hence the findings are 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 handheld 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 while the time spent on the former has drastically increased (4). This increasing exposure and accessibility to mobile screen media devices has public health implications, for children's sedentary behaviour and play opportunities, especially considering the evidence that indicates childhood habits usually track into adulthood (6). Furthermore, the pleasure a child derives from interacting with these touchscreens may lead to increased and habitual use (7). Nevertheless, there are benefits associated with interactive mobile screen media devices use, such as learning opportunities and face-to face connections with distant family and friends (8, 9).

Health guidelines recommend that children aged less than two should be exposed to a limited amount of educational mobile screen media use, while for those aged two-to-five, the daily screen time should be less than one hour (8, 10-12). 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 one-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 four (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, 13).

Despite the increase in the use of mobile screen media devices such as smartphones, electronic tablets, handheld computers and Personal Digital Assistants (PDAs) 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 (8). Systematic reviews to identify the correlates of mobile screen media use among young children are almost non-existent with previous reviews focussing on sedentary behaviours or television viewing (14-16).

Considering the increasing availability, ownership and use of mobile screen media devices (smartphones, electronic tablets, handheld computers, personal digital assistants (PDAs) among young children, identification of the correlates of mobile screen media use specific to children eight 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 eight years and less. Correlates are classified into proximal and distal factors using a bio-ecological model to facilitate comparison with the existing literature (14, 17). The model provides a strong theoretical basis to understand human behaviour (18) and has been described in detail elsewhere (19).

METHODS

This systematic review is based on Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (20-22) and is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028). The study used already published, de-identified data and hence is exempt from the ethics approval process. A detailed description of the methods is available in

the protocol article (19). As discussed in the protocol article, initially the database search was planned for articles published between 2009 and 2015 (19). 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 bio-ecological model (14, 15). The five categories are:

- *Child biological and demographic factors* includes age, sex and body mass index (BMI).
- *Family biological and demographic factors* includes demographic and biological characteristics of the family members (particularly parents) and their education, occupation and income.
- *Family structure factors* includes the number of siblings, family size and family type.
- *Behavioural factors* includes the child's behavioural characteristics and their skills and attitudes.
- *Sociocultural/ environmental factors* includes 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) touchscreens; 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, that investigated the correlates of mobile screen media use among children aged eight and less; based in home or community setting; and published, or in press in English language journals between January 2009 to March 2017. The full description of the alignment of the research question to the Population, Exposure, Comparison and Outcome (PECO) format along with the exclusion criteria is presented in table 1

Table 1: Research question using PECO format

Criteria	Description
P: Population	Children aged eight years and less
E: Exposure	Correlates of mobile screen media use
C: Comparison	With vs. without the correlates
O: Outcome	Use of mobile screen media (e.g. 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 sub-group analysis for the target group
	Papers published before 2009 and after March 2017
	Papers published in language other than English
	Non-peer reviewed articles
	Studies involving children older than 8 years

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-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 (version 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 abstract 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.

Table 2: Search strategy used in Medline database

Database: Ovid Medline (R) 1946 to 20th October 2015		
SN	Search strategy	Results
1	Only Child/ or Child/ or child.mp. or Child, Preschool/	1767004
2	Infant/ or infant.mp.	1030660
3	Kid.mp.	1251
4	Toddler.mp.	2240
5	1 or 2 or 3 or 4	2242988
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.	16724
15	Tablets/ or Tablets.mp.	34967
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	64324
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

* Sign denotes for any character(s), SN= Serial number, 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

Assessment of included papers

A modified version of the checklist by Downs and Black (23) 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 re-assessed 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 Odds Ratio (AOR) and Standardised Coefficients (SC) 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.

RESULTS

Study characteristics

Thirteen studies published between 2013 and 2017 were included in the review. Six were published in 2015 (1, 24-28), four in 2016 (29-32) and one in 2014 (33), 2013 (34) and 2017 (35). The majority of the eligible studies were conducted in high-income countries with four

from the USA (1, 24, 28, 30), three from the United Kingdom (25, 26, 34), two from Canada (31, 35) and one from the Netherlands (27), Hong Kong (33), Malaysia (29) and Czech Republic (32). 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, 28), two studies used random sampling (31, 32), one used stratified random sampling (29), while all other studies used non-representative techniques (24-27, 30, 33-35). The mean age of participants was clearly stated in eight studies (25, 27-32, 35) while four provided frequencies in different age-groups (24, 26, 33, 34). 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 (25-35), one reported adherence to the American Academy of Paediatrics (AAP) screen time guidelines (24) 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 (33) and five of the research questionnaires had been used in previous studies (1, 24, 28, 29, 35). Three studies stated parental-proxy reports as having reasonable reliability and validity to measure children's mobile screen media use (25, 26, 34). Whilst, the other studies did not report on the reliability and validity of their instrument (27, 30-32). Overall, the mean duration of mobile screen media use could not be determined as only five studies reported the

average duration (24, 27-29, 32), while all other studies categorised participants into groups, such as less than 2 hours and more than 2 hours (1, 25, 26, 30, 31, 33-35).

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 table 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 smart phones (1, 26, 28, 34) and electronic tablets (1, 25, 28, 30). Nikken et. al. (27) reported combined results for touchscreens (smartphones and electronic tablets) while the other six studies reported correlates for electronic media, that included both traditional (e.g. televisions, computers) and new devices (e.g. mobile phones and electronic tablets) (24, 29, 31-33, 35). Use of a PDA was not studied.

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 (24, 28, 30, 31, 33, 35) (Table 4). Older children were more likely to use smartphones, tablets or any media compared to younger children (24, 28, 30, 31, 33, 35). Carson and colleagues concluded that for every one month increase in age, the use of any media increased by 9.3 minutes per day (95% CI: 2.8-15.8) (35). 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 et. al. (27) concluded that the child's age had no significant association with the use of touchscreens. Females were more likely to use any media for a longer duration than their male counterparts (29, 35) but there was no any association with sex specifically in regard to touchscreen use (1, 27) . No association was found between the use of any media and child body mass index (BMI) (24).

Table 3: Description of included studies

S.N	Author	Year	Country	Study design	Sample size	Age group	Outcome measure	Screen studied	Independent variables	Measure of association	Quality score
1	Carson et. al (35).	2017	Canada	Cross-sectional	149	12–35 months	Children's screen-time	Television, videos, or DVDs on a television, computer, or portable device.	Parental and child demographics	unstandardized beta coefficients and 95% confidence interval	8
2	Lee et. al. (29)	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	Parental and child demographics, places for play, barriers and motivators for active play	P-value from chi-square test	7
3	Pempek et. al. (30)	2016	US	Cross-sectional	358	12-48 months	Children and mother's tablet use	Tablets	Child age, Mother's tablet use, income, education, personal well-being and age	Standardised coefficients	7
4	Pyper et. al. (31)	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	Different types of parental support behaviours (motivational, instrumental, regulatory and conditional), parental and child demographics	Odds ratio and 95% Confidence interval	10
5	Sigmund et. al. (32)	2016	Czech Republic	Cross-sectional	197	4-7 years	Children's screen-time	watching TV (DVD, video) and PC (notebook, tablet, smartphone)	Days of week, parental step count and screen time	Pearson correlations with 95% confidence intervals	8

6	Nikken et al. (27)	2015	Netherlands	Cross-sectional	896	0-7 years	Media ownership and use	TV, game consoles, computers and touchscreens	Parent and child characteristics (age, access, concerns about media use)	Standardised coefficients	6
7	Lauricella et al. (28)	2015	US	Cross-sectional	2300	0-8 years	Children's screen time	Television, computers, smartphones, and tablets	Parental media use, parental attitudes, child's age	Standardised coefficients	8
8	Connell et. al. (1)	2015	US	Cross-sectional	2326	0-8 years	Parent-child co-use of media	Books, TV, computers, video games, tablets, and smartphones	Parent's time with child, parent's media use, parental and child demographics	Standardised coefficients	7
9	Kesten etal. (26)	2015	UK	Cross-sectional	735	6-8 years	Children's screen-time	TV, computer, smartphone, game-console and multi-SV	Parent's employment, education, number and sex of children, screen related limits	Odds ratio and 95% Confidence interval	8
10	Jago et al. (25)	2015	UK	Cross-sectional	954	5-6 years	Children's screen-time	TV, computer/laptop use including tablets	Parenting styles and parental self-efficacy to limit screen time	Odds ratio and 95% Confidence interval	8
11	Asplund et al.(24)	2015	US	Cross-sectional	314	0-5 years	Adherence to AAP guidelines for screen time	TV, video games, computers, cell phones and other electronic devices	Child BMI, child/parent demographics, and household media environment, parental attitudes towards TV viewing	Odds ratio and 95% Confidence interval	9
12	Wu et al. (33)	2014	Hong Kong	Cross-sectional	202	3-6 years	Use of digital products	Television, digital tablets, smart phones, etc	Participants' demographics, parenting approach (restrictive, instructive and co-using)	P-value from chi-square test	8
13	Jago et al. (34)	2013	UK	Cross-sectional	750	6-8 years	Children's screen-time	TV, game console, smart-phone and multiscreen-viewing	Parental media use, parental attitudes and access to media equipment	Odds ratio and 95% Confidence interval	8

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Association	Study	Association	Study	Association	Study	Association	Study
Child biological and demographic factors	Child age	+	(28)	+	(28, 30)	0	(27)	+	(24, 31, 33, 35)
		- (co-use)	(1)	- (co-use)	(1)				
	Child sex (0= boy)	0	(1)	0	(1)	0	(27)	+	(29, 35)
	BMI							0	(24)
Family biological and demographic factors	Parental age	0	(1)	0	(1, 30)			0	(24)
								-	(33)
	Parent's sex (0 = father)	0	(1)	0	(1)	0	(27)		
	Family income			0	(30)	+	(27)	0	(29)
								+	(35)
								-	(33)
	Parent's occupation (0= unemployed)							-	(33)
	Parent's education	0	(1)	0	(1, 30)	0	(27)	0	(29)
	Language							0	(24)
	Race/Ethnicity	+ (Non-Hispanic)	(1)	+ (Hispanic)	(1)			0	(24)
								- (European-Canadian-Caucasian)	(29)
	Country of birth							0	(29, 35)
Family structure factors	Family size					0	(27)		
	Number of children in the family							+	(33)

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$), Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

Family biological and demographic factors

Four studies reported an association between parental age and their children's mobile screen media use (1, 24, 30, 33) (see Table 4). Of these, three reported no statistically significant association (1, 24), 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 (33).

Mixed associations were found between family income and children's mobile screen media use (see Table 4). Two studies (27, 35) reported a positive association, indicating that children from high-income families were using touchscreens or any media device longer than those from low-income families. Conversely, studies by Pempek et. al.(30) and Lee et. al.(29) found no association with family income, and Wu et. al. (33) reported a negative association. Wu also found a negative association between parent's occupational status and children's mobile screen media use (33). Furthermore children of stay-at-home parents used screen devices more frequently than those whose parents were employed (33).

No association was identified between young children's smartphone, electronic tablet or any touchscreen use and parent's sex (1, 27). Similarly, parent's educational status (1, 27, 29, 30), country of birth (35) and language (24) 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 (27, 33) (Table 4). A positive association was reported between the number of children and use of televisions, computers, tablets and mobile phones (33), 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 to those families with one child (33).

Behavioural factors

Children's ability or skill 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 (27) (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 (27).

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, 24, 27, 28, 30, 32, 34). Two studies concluded that there was no statistically significant association between parental smartphone use and their children's use (1, 34). Positive associations have also been reported for parental screen time and children's use of tablets, touchscreen devices or any media (1, 24, 27, 28, 30, 32). Sigmund et. al. concluded that the association between parental and children any media use was stronger during weekends than on weekdays (32).

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) (28). More positive parental attitudes towards these devices resulted in greater use by the children (28). Similarly, parental belief in the negative effects of mobile screen media screen devices, was not associated with children's use of these devices (27). However, children

were more likely to use mobile screen media devices when parents believed that these devices were helpful as a behavioural regulation tool (27), while parental nurturing and self-efficacy to limit mobile media use were negatively associated with electronic tablet use (25).

Children in parental care were more likely to have higher any media use than children in child care (35). Similarly, any media use was higher during weekends than weekdays (32).The number of media devices at home, and in the child's bedroom were positively associated with increased smartphone use (34). Jago et. al. (34) concluded that the greater the number of devices, the greater the use, while Asplund et. al. (24) reported no such association.

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Assoc	Study	Assoc	Study	Assoc	Study	Assoc	Study
Behavioural factors	Child media skills					+	(27)		
Sociocultural/ environmental factors	Parental media use/screen time	+ (>2 yrs)	(28)	+	(1, 28, 30)	+	(27)	+	(24) (≥2 yrs) (32)
		0	(1, 34)						
	Parent attitudes on effects of media on children	+ (>6 yrs)	(28)	+ (>2 yrs)	(28)				
	Parental belief that media has positive effects on children	0	(34)			0	(27)		
	Parental belief that media has negative effects on children					0	(27)		
	Parents belief on pacifying nature of media					+	(27)		
	Parents belief that media are too complicated for young children to use					0	(27)		
	Parent's time with child	0	(1)	0	(1)				
	Parental limit setting on media use	0	(26) (boys)						
		+ (always)	(26) (girls)						
	Collaborative rule setting	0	(26)						
	Parental control on media use			0	(25)				
	Parental nurturance			-	(25)				
	Parental self-efficacy			-	(25)				
	Type of child care (0= parental care)							-	(35)
	Mother's relational well-being			0	(30)				
	Mother's personal well-being			0	(30)				
	Days of week (0=Weekdays)							+	(32)
	Parental step count/physical activity							-	(32)
	TV on during dinner							+	(24) (≥2

									yrs)
	Number of TVs/screens at home	+	(34)					0	(24)
	Computer's outside children's bedroom							+	(33)
	Screen viewing items in child's bedroom	+	(34)						

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$),
Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

DISCUSSION

This systematic review identified 36 reported correlates of mobile screen media use among children aged eight years or less from thirteen 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 this area.

This review found that children aged between four and eight 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 were more likely to have higher mobile screen media use. The bio-ecological model posits that human behaviour is affected by intrapersonal factors, inter-personal factors and distal factors which interact to shape our behaviour (18, 36), however, the findings of this review suggest that in the case of children aged eight 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 to their younger counterparts. This finding is consistent with a systematic review of traditional screen time use among children three years and younger (14). 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 (37, 38). Studies have found that parents tend to set more rules regarding screen time for younger children (37), suggesting childhood

screen habits are reflected in adolescence and adulthood (6), and highlighting the importance of managing mobile screen media use with younger children.

Higher mobile screen media use by older children in the family has implications for younger siblings. One study in the review reported households with more than one child used screen devices (both fixed and mobile screens) more frequently (33), 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 (39, 40), and could be an important strategy to decrease young children's mobile media use.

Mixed results in regards to parental age and children's mobile screen media use were reported. Consistent with this review, previous systematic reviews on traditional media have reported an unclear association with their use and parental age (14-16). Parents who used mobile screen media were more likely to have children who used these devices and for a longer time (1, 24, 27, 28). Furthermore, children of families who watch more TV are more likely to engage in higher screen-viewing (14, 16, 41-43). 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' (44).

Parent-child co-use of mobile screen media was highest for children younger than two 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, children of stay-at-home parents had higher mobile screen media use (33). This suggests parents could be more engaged in screen-viewing, providing a supportive environment for mobile screen media use. 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 (14, 15). 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.

Use of mobile screen media devices was higher among children whose parents believed in the pacifying effects of these devices. Parents are at times using these devices as behavioural regulation tools to secure free time or when busy with household chores or shopping (4, 8, 13, 45). Parents may not be aware that they are contributing to the development of their children's mobile screen media use behaviours or the possible impacts (33) that these devices and their unmonitored use may have (46).

Methodological limitations of studies reviewed

A strength of this study was the protocol paper that guided the methodology of the review (19), 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 (6). In addition, only one study tested reliability and validity of their instrument (33) 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 American Academy of Paediatrics (12) recommendations for children screen media uses the aged 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 targets group's age when undertaking analysis. This made interpretation of findings challenging and should be addressed in any future studies in this area.

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 the maintaining a healthy media intake. 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, 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.

List of abbreviations used

PDA: Personal Digital Assistants

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

Declarations:

Ethics approval and consent to participate

Since this systematic review uses already published, de-identified data, it is hence exempt from the ethics approval process. It does not involve any contact with the human participants and has not collected any primary data.

Consent for publication

This is "Not applicable" for this study as it does not report any individual level data.

Availability of data and material

The findings of this review rely on the data presented on the papers that are already published and are easily accessible on public domains.

Competing interests

The authors declare that they have no financial and non-financial competing interests.

Funding

This study has not received any funding from any source.

Data sharing statement

The findings of this review rely on the data presented on the papers that are already published and are easily accessible on public domains.

Author's contribution

SP, JL and JJ jointly conceived and designed the study. SP was responsible for searching the literature, screening the papers, working on design, critically reviewing the papers and drafting the manuscript. JJ provided overall supervision for the study, finalised methodology, screening of full text, quality assessment, and edited the manuscript. NS was involved in searching the database, initial screening of title and abstracts and revised the manuscript. JL contributed to design, screening of full text, quality assessment, and organised and revised the manuscript. All authors have read and approved the final version of manuscript.

Acknowledgements

We would like to acknowledge the support of Public health faculty librarian of Curtin University, Ms. Diana Blackwood for her guidance during the database searching stage.

Author's information

Susan Paudel (BPH, MPH, MHlthProm): School of Public Health, Curtin University, Western Australia, Email: replysusan@gmail.com

Dr. Jonine Jancey (BSc (Hons) PhD) : Associate Professor, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.jancey@curtin.edu.au

Narayan Subedi (BPH, MPH, PGDPHN): Assistant Professor, Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University, Nepal, Email: subedi.narayan@gmail.com

Dr. Justine Leavy (BSc, MPH, PhD): Senior Lecturer, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.leavy@curtin.edu.au

1

References

1. Connell SL, Lauricella AR, Wartella E. Parental Co-Use of Media Technology with their Young Children in the USA. Journal of Children and Media. 2015;9(1):5-21.
2. Holloway D, Green L, Livingstone S. Zero to eight: Young children and their internet use. London: LSE, EU Kids Online; 2013.
3. Rideout V. Zero to eight: Children's media use in America 2013. United States of America: Common Sense Media, 2013.
4. Kabali HK, Irigoyen MM, Nunez-Davis R, Budacki JG, Mohanty SH, Leister KP, et al. Exposure and use of mobile media devices by young children. Pediatrics. 2015:2015-151.
5. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. BMC Public Health. 2015;15(1):1.
6. Downing KL, Hnatiuk J, Hesketh KD. Prevalence of sedentary behavior in children under 2years: A systematic review. Preventive Medicine. 2015;78:105-14.
7. Christakis DA. Interactive media use at younger than the age of 2 years: time to rethink the American Academy of Pediatrics guideline? JAMA pediatrics. 2014;168(5):399-400.
8. 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):1-3.
9. Troseth GL, Russo CE, Strouse GA. What's next for research on young children's interactive media? Journal of Children and Media. 2016;10(1):54-62.
10. Strasburger V., Hogan M. Policy Statement: children, adolescents and the media. Pediatrics. 2013;132:958-61.
11. Department of Health. Australia's Physical Activity and Sedentary Behaviour Guidelines: Australian Government; 2015 [Available from: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#npa05.
12. American Academy of Pediatrics. American Academy of Pediatrics Announces New Recommendations for Children's Media Use USA: American Academy of Pediatrics; 2017 [Available from: 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.
13. Radesky JS, Peacock-Chambers E, Zuckerman B, Silverstein M. Use of Mobile Technology to Calm Upset Children: Associations With Social-Emotional Development. JAMA Pediatrics. 2016;170(4):397-9.
14. Duch H, Fisher EM, Ensari I, Harrington A. Screen time use in children under 3 years old: a systematic review of correlates. Int J Behav Nutr Phys Act. 2013;10(1):1-10.
15. Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. Int J Behav Nutr Phys Act. 2010;7(66):10.
16. Cillero IH, Jago R. Systematic review of correlates of screen-viewing among young children. Preventive Medicine. 2010;51(1):3-10.
17. Vanderloo LM. Screen-viewing among preschoolers in childcare: A systematic review. BMC Pediatrics. 2014;14(1):205.
18. Lawman HG, Wilson DK. A review of family and environmental correlates of health behaviors in high-risk youth. Obesity. 2012;20(6):1142-57.
19. Paudel S, Leavy J, Jancey J. Correlates of mobile screen media use among children aged 0–8: protocol for a systematic review. Systematic reviews. 2016;5(1):1.
20. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. International Journal of Surgery. 2010;8(5):336-41.
21. Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. Journal of Cranio-Maxillofacial Surgery. 2011;39(2):91-2.

22. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of Clinical Epidemiology. 2009;62(10):e1-e34.
23. 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. Journal of Epidemiology and Community Health. 1998;52(6):377-84.
24. Asplund KM, Kair LR, Arain YH, Cervantes M, Oreskovic NM, Zuckerman KE. 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. Childhood Obesity. 2015;11(5):590-9.
25. Jago R, Wood L, Zahra J, Thompson JL, Sebire SJ. Parental control, nurturance, self-efficacy, and screen viewing among 5-to 6-year-old children: a cross-sectional mediation analysis to inform potential behavior change strategies. Childhood Obesity. 2015;11(2):139-47.
26. Kesten JM, Sebire SJ, Turner KM, Stewart-Brown S, Bentley G, Jago R. Associations between rule-based parenting practices and child screen viewing: a cross-sectional study. Preventive Medicine Reports. 2015;2:84-9.
27. Nikken P, Schols M. How and Why Parents Guide the Media Use of Young Children. Journal of Child and Family Studies. 2015;24(11):3423-35.
28. Lauricella AR, Wartella E, Rideout VJ. Young children's screen time: The complex role of parent and child factors. Journal of Applied Developmental Psychology. 2015;36:11-7.
29. Lee ST, Wong JE, Ong WW, Ismail MN, Deurenberg P, Poh BK. Physical activity pattern of Malaysian preschoolers: Environment, barriers, and motivators for active play. Asia-Pacific Journal of Public Health. 2016;28(5, Suppl):21S-34S.
30. Pempek T, McDaniel B. Young Children's Tablet Use and Associations with Maternal Well-Being. Journal of Child & Family Studies. 2016;25(8):2636-47.
31. 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.
32. Sigmund E, Badura P, Vokacova J, Sigmundova D. Parent-Child Relationship of Pedometer-Assessed Physical Activity and Proxy-Reported Screen Time in Czech Families with Preschoolers. International Journal of Environmental Research and Public Health. 2016;13(7).
33. Wu CST, Fowler C, Lam WYY, Wong HT, Wong CHM, Loke AY. Parenting approaches and digital technology use of preschool age children in a Chinese community. Italian Journal of Pediatrics. 2014;40(1):1-8.
34. Jago R, Sebire SJ, Lucas PJ, Turner KM, Bentley GF, Goodred JK, et al. Parental modelling, media equipment and screen-viewing among young children: Cross-sectional study. BMJ Open. 2013;3(4).
35. 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.
36. Bronfenbrenner U, Evans GW. Developmental Science in the 21st Century: Emerging Questions, Theoretical Models, Research Designs and Empirical Findings. Social Development. 2000;9(1):115-25.
37. Warren R. Parental mediation of preschool children's television viewing. J Broadcast Electron Media. 2003;47(3):394-417.
38. Australian Communications and Media Authority (ACMA). Access to the internet, broadband and mobile phones in family households. Australia: 2008.
39. Brown R, Ogden J. Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. Health education research. 2004;19(3):261-71.

40. Draxten M, Fulkerson JA, Friend S, Flattum CF, Schow R. Parental role modeling of fruits and vegetables at meals and snacks is associated with children's adequate consumption. Appetite. 2014;78:1-7.
41. Xu H, Wen LM, Rissel C. Associations of parental influences with physical activity and screen time among young children: a systematic review. Journal of Obesity. 2015;2015.
42. Birken CS, Maguire J, Mekky M, Manlhiot C, Beck CE, Jacobson S, et al. Parental factors associated with screen time in pre-school children in primary-care practice: a TARGet Kids! study. Public Health Nutrition. 2011;14(12):2134-38.
43. Jago R, Thompson JL, Sebire SJ, Wood L, Pool L, Zahra J, 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(1):54-64.
44. Schoeppe S, Rebar AL, Short CE, Alley S, Van Lippevelde W, Vandelanotte C. How is adults' screen time behaviour influencing their views on screen time restrictions for children? A cross-sectional study. BMC public health. 2016;16(1):201.
45. Chiong C., Shuler C. Learning: Is there an app for that? Investigations of young children's usage and learning with mobile devices and apps. Sesame Workshop; The Joan Ganz Cooney Centre, New York 2010.
46. Kim J-K, Kang Y-S. The Effects of Young Children's Smartphone Use Experience on Their Parents' Perceptions and Needs and Their Self-Regulation. International Journal of Applied Engineering Research. 2016;11(2):1208-11.

1

Figure 1: PRISMA flow chart for study selection

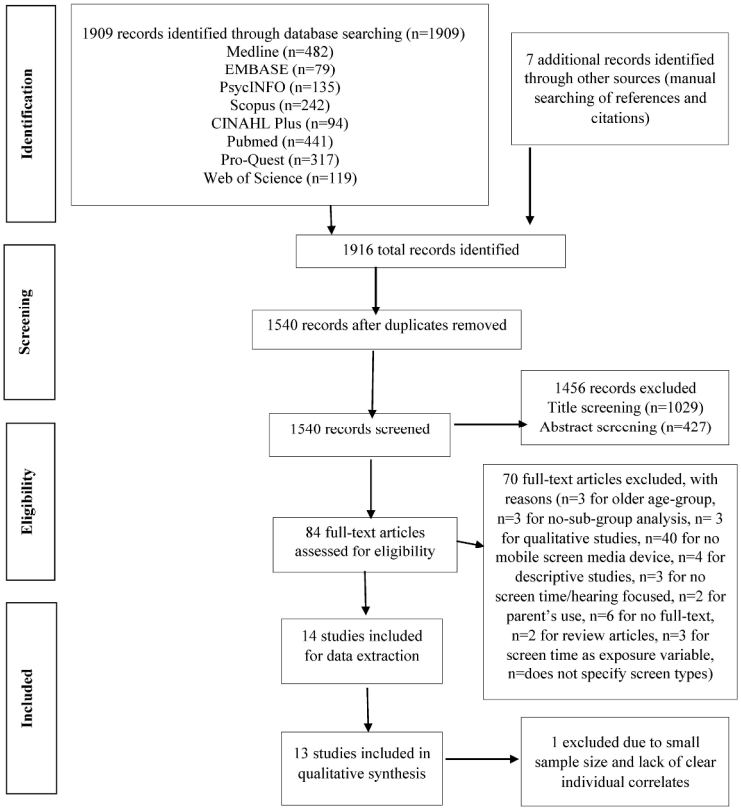

Figure 1: PRISMA flow chart for study selection

Figure 1: PRISMA flowchart for study selection

297x420mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3,4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5,6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6,7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	11
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	9,12
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8,9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12,13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12,13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13,14
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13-23
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	24-26
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	26-27
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	27
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014585.R2
Article Type:	Research
Date Submitted by the Author:	20-Jun-2017
Complete List of Authors:	Paudel, Susan; Curtin University School of Public Health, Jancey, Jonine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health Subedi, Narayan; Maharajgunj Medical Campus, Institute of Medicine, Department of Community Medicine and Public Health Leavy, Justine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Research methods
Keywords:	Children, Mobile media use, Screen time, Correlates, Systematic review

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

Authors:

Susan Paudel

School of Public Health, Curtin University, Western Australia

replysusan@gmail.com

Dr. Jonine Jancey

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.jancey@curtin.edu.au

Narayan Subedi

Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University

subedi.narayan@gmail.com

Dr. Justine Leavy

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.leavy@curtin.edu.au

Corresponding author:

Susan Paudel

School of Public Health, Curtin University, Western Australia

Email: replysusan@gmail.com

Contact no: 977-9843061616

Keywords: Mobile screen media, children, systematic review, screen time, correlates

Word Count: 5169

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 eight 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 eight years or less were the study population. Studies that included larger age-groups without sub-group analysis specific to the 0-8 year's 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 PDAs.

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.

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

Keywords

Children, mobile screen media, screen time, correlates, systematic review

Strengths

- This review summarises current peer-reviewed literature on correlates of mobile screen media use among children aged eight years and less.
- A peer reviewed and published protocol paper guided the systematic review.
- The review incorporated aa robust research strategy, that identified up-to-date key words with the assistance of public health librarian; and searched eight relevant databases
- A comprehensive inclusion and exclusion criteria was established and used.

Limitations

- 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.

1

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, children are increasingly using mobile screen media devices for focused solitary viewing (7). This increasing exposure and accessibility to mobile screen media devices has public health implications, for children's sedentary behaviour and play opportunities, especially considering the evidence that indicates childhood habits usually track into adulthood (8). Furthermore, the pleasure a child derives from interacting with these touchscreens 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 connections with distant family and friends and play opportunities (10, 11). Similarly , engagement with active video games have been reported to promote light to moderate physical activity (12).

Health guidelines recommend that children aged less than two should be exposed to a limited amount of educational mobile screen media use, while for those aged two-to-five, the daily screen time should be less than one 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 one-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 four (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 (PDAs) 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 focussing 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, personal digital assistants (PDAs) among young children, identification of the correlates of mobile screen media use specific to children eight 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 eight years and less. Correlates are classified into proximal and distal factors using a bio-ecological 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 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (23-25) and is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028). The study used already published, de-identified 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 bio-ecological model (17, 18). The five categories are:

- *Child biological and demographic factors* includes age, sex and body mass index (BMI).
- *Family biological and demographic factors* includes demographic and biological characteristics of the family members (particularly parents) and their education, occupation and income.
- *Family structure factors* includes the number of siblings, family size and family type.
- *Behavioural factors* includes the child's behavioural characteristics and their skills and attitudes.
- *Sociocultural/ environmental factors* includes 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) touchscreens; 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, that investigated the correlates of mobile screen media use among children aged eight and less; based in home or community setting; and published, or in press in English language journals between January 2009 to March 2017. The full description of the alignment of the research question to the Population, Exposure,

Comparison and Outcome (PECO) format along with the exclusion criteria is presented in table 1.

Table 1: Research question using PECO format

Criteria	Description
P: Population	Children aged eight years and less
E: Exposure	Correlates of mobile screen media use
C: Comparison	With vs. without the correlates
O: Outcome	Use of mobile screen media (e.g. 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 sub-group 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

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-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 (version 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 abstract 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.

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/	1767004
2	Infant/ or infant.mp.	1030660
3	Kid.mp.	1251
4	Toddler.mp.	2240
5	1 or 2 or 3 or 4	2242988
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.	16724
15	Tablets/ or Tablets.mp.	34967
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	64324
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

* Sign denotes for any character(s), SN= Serial number, 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

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 re-assessed 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 Odds Ratio (AOR) and Standardised Coefficients (SC) 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.

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 United Kingdom (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). Whilst, 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 table 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 smart phones (1, 29, 31, 37) and electronic tablets (1, 28, 31, 33). Nikken et. al. (30) reported combined results for touchscreens (smartphones and electronic tablets) while the other six studies reported correlates for electronic media, that included both traditional (e.g. televisions, computers) and new devices (e.g. mobile phones and electronic tablets) (27, 32, 34-36, 38). Use of a PDA was not studied.

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 to younger children (27, 31, 33, 34, 36, 38). Carson and colleagues concluded that for every one month increase in age, the use of any media increased by 9.3 minutes per day (95% CI: 2.8-15.8) (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 et. al. (30) concluded that the child's age had no significant association with the use of touchscreens. Females 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 touchscreen use (1, 30) . No association was found between the use of any media and child body mass index (BMI) (27).

1

Table 3: Description of included studies

S.N	Author	Year	Country	Study design	Sample size	Age group	Outcome measure	Screen studied	Results specific to	Independent variables	Measure of association	Quality score
1	Carson et. al (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	unstandardized beta coefficients and 95% confidence interval	8
2	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 chi-square test	7
3	Pempek et. al. (33)	2016	US	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
4	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	Odds ratio and 95% Confidence interval	10
5	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 correlations with 95% confidence intervals	8
6	Nikken et al. (30)	2015	Netherlands	Cross-sectional	896	0-7 years	Media ownership and use	TV, game consoles, computers and touchscreens	Touchscreens (smartphones and electronic tablets)	Parent and child characteristics (age, access, concerns about media use)	Standardised coefficients	6
7	Lauricella et al. (31)	2015	US	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
8	Connell	2015	US	Cross-	2326	0-8 years	Parent-	Books, TV,	Smartphones	Parent's time with child,	Standardised	7

	et. al. (1)			sectional			child co-use of media	computers, video games, tablets, and smartphones	And electronic tablets	parent's media use, parental and child demographics	coefficients	
9	Kesten etal. (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	Odds ratio and 95% Confidence interval	8
10	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	Odds ratio and 95% Confidence interval	8
11	Asplund et al.(27)	2015	US	Cross-sectional	314	0-5 years	Adherence to AAP guidelines for screen time	TV, video games, computers, cell phones and other electronic devices	Electronic media (fixed and mobile screens)	Child BMI, child/parent demographics, and household media environment, parental attitudes towards TV viewing	Odds ratio and 95% Confidence interval	9
12	Wu et al. (36)	2014	Hong Kong	Cross-sectional	202	3-6 years	Use of digital products	Television, digital tablets, smart phones, etc	Electronic media (fixed and mobile screens)	Participants' demographics, parenting approach (restrictive, instructive and co-using)	P-value from chi-square test	8
13	Jago et al. (37)	2013	UK	Cross-sectional	750	6-8 years	Children's screen-time	TV, game console, smart-phone and multiscreen-viewing	Smartphones	Parental media use, parental attitudes and access to media equipment	Odds ratio and 95% Confidence interval	8

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		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)

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$), Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

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 that children from high-income families were using touchscreens or any media device longer than those from low-income families. Conversely, studies by Pempek et. al.(33) and Lee et. al.(32) found no association with family income, and Wu et. al. (36) reported a negative association. Wu 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 touchscreen 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 to 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, touchscreen 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 screen 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 were 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.

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Assoc	Study	Assoc	Study	Assoc	Study	Assoc	Study
Behavioural factors	Child media skills					+	(30)		
Sociocultural/ environmental factors	Parental media use/screen time	+ (>2 yrs)	(31)	+	(1, 31, 33)	+	(30)	+	(27) (≥2 yrs) (35)
		0	(1, 37)						
	Parent attitudes on effects of media on children	+ (>6 yrs)	(31)	+ (>2 yrs)	(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	(29) (boys)						
		+ (always)	(29) (girls)						
	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							+	(27) (≥2 yrs)
	Number of TVs/screens at home	+	(37)					0	(27)

	Computer's outside children's bedroom							+	(36)
	Screen viewing items in child's bedroom	+	(37)						

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$),
Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

DISCUSSION

This systematic review identified 36 reported correlates of mobile screen media use among children aged eight years or less from thirteen 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 four and eight 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 were more likely to have higher mobile screen media use. The bio-ecological model posits that human behaviour is affected by intrapersonal factors, inter-personal 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 eight 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 to their younger counterparts. This finding is consistent with a systematic review of traditional screen time use among children three 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 two 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 regards 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 two 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, 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 touchscreens for longer durations than those from low-income families (30), which may be due to greater ownership and access to touchscreen 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 were 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 American Academy of Paediatrics (15) recommendations for children screen media uses the aged 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 targets group's age when undertaking analysis. This made interpretation of findings challenging and should be addressed in any future studies in this area.

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 the 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.

List of abbreviations used

PDA: Personal Digital Assistants

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

Declarations:

Ethics approval and consent to participate

Since this systematic review uses already published, de-identified data, it is hence exempt from the ethics approval process. It does not involve any contact with the human participants and has not collected any primary data.

Consent for publication

This is "Not applicable" for this study as it does not report any individual level data.

Availability of data and material

The findings of this review rely on the data presented on the papers that are already published and are easily accessible on public domains.

Competing interests

The authors declare that they have no financial and non-financial competing interests.

Funding

This study has not received any funding from any source.

Author's contribution

SP, JL and JJ jointly conceived and designed the study. SP was responsible for searching the literature, screening the papers, working on design, critically reviewing the papers and

drafting the manuscript. JJ provided overall supervision for the study, finalised methodology, screening of full text, quality assessment, and edited the manuscript. NS was involved in searching the database, initial screening of title and abstracts and revised the manuscript. JL contributed to design, screening of full text, quality assessment, and organised and revised the manuscript. All authors have read and approved the final version of manuscript.

Acknowledgements

We would like to acknowledge the support of Public health faculty librarian of Curtin University, Ms. Diana Blackwood for her guidance during the database searching stage.

Author's information

Susan Paudel (BPH, MPH, MHlthProm): School of Public Health, Curtin University, Western Australia, Email: replysusan@gmail.com

Dr. Jonine Jancey (BSc (Hons) PhD) : Associate Professor, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.jancey@curtin.edu.au

Narayan Subedi (BPH, MPH, PGDPHN): Assistant Professor, Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University, Nepal, Email: subedi.narayan@gmail.com

Dr. Justine Leavy (BSc, MPH, PhD): Senior Lecturer, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.leavy@curtin.edu.au

References

1. Connell SL, Lauricella AR, Wartella E. Parental Co-Use of Media Technology with their Young Children in the USA. Journal of Children and Media. 2015;9(1):5-21.
2. Holloway D, Green L, Livingstone S. Zero to eight: Young children and their internet use. London: LSE, EU Kids Online; 2013.
3. Rideout V. Zero to eight: Children's media use in America 2013. United States of America: Common Sense Media, 2013.
4. Kabali HK, Irigoyen MM, Nunez-Davis R, Budacki JG, Mohanty SH, Leister KP, et al. Exposure and use of mobile media devices by young children. Pediatrics. 2015:2015-151.
5. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. BMC Public Health. 2015;15(1):1.
6. Ofcom. Communications Market Report Bite-sized. 2016.
7. Ofcom. Children and parents: media use and attitudes report. Ofcom, 2016.
8. Downing KL, Hnatiuk J, Hesketh KD. Prevalence of sedentary behavior in children under 2years: A systematic review. Preventive Medicine. 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 pediatrics. 2014;168(5):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):1-3.
11. Troseth GL, Russo CE, Strouse GA. What's next for research on young children's interactive media? Journal of Children and Media. 2016;10(1):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(7):664-72.
13. Strasburger V., Hogan M. Policy Statement: children, adolescents and the media. Pediatrics. 2013;132:958-61.
14. Department of Health. Australia's Physical Activity and Sedentary Behaviour Guidelines: Australian Government; 2015 [Available from: 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: American Academy of Pediatrics; 2017 [Available from: 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, Silverstein M. Use of Mobile Technology to Calm Upset Children: Associations With Social-Emotional Development. JAMA Pediatrics. 2016;170(4):397-9.
17. Duch H, Fisher EM, Ensari I, Harrington A. Screen time use in children under 3 years old: a systematic review of correlates. Int J Behav Nutr Phys Act. 2013;10(1):1-10.
18. Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. Int J Behav Nutr Phys Act. 2010;7(66):10.
19. Cillero IH, Jago R. Systematic review of correlates of screen-viewing among young children. Preventive Medicine. 2010;51(1):3-10.
20. Vanderloo LM. Screen-viewing among preschoolers in childcare: A systematic review. BMC Pediatr. 2014;14(1):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(6):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. Systematic reviews. 2016;5(1):1.
23. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. International Journal of Surgery. 2010;8(5):336-41.
24. Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. Journal of Cranio-Maxillofacial Surgery. 2011;39(2):91-2.
25. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of Clinical Epidemiology. 2009;62(10):e1-e34.
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. Journal of Epidemiology and Community Health. 1998;52(6):377-84.
27. Asplund KM, Kair LR, Arain YH, Cervantes M, Oreskovic NM, Zuckerman KE. 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. 2015;11(5):590-9.
28. Jago R, Wood L, Zahra J, Thompson JL, Sebire SJ. Parental control, nurturance, self-efficacy, and screen viewing among 5-to 6-year-old children: a cross-sectional mediation analysis to inform potential behavior change strategies. Child. 2015;11(2):139-47.
29. Kesten JM, Sebire SJ, Turner KM, Stewart-Brown S, Bentley G, Jago R. Associations between rule-based parenting practices and child screen viewing: a cross-sectional study. Preventive Medicine Reports. 2015;2:84-9.
30. Nikken P, Schols M. How and Why Parents Guide the Media Use of Young Children. Journal of Child and Family Studies. 2015;24(11):3423-35.
31. Lauricella AR, Wartella E, Rideout VJ. Young children's screen time: The complex role of parent and child factors. Journal of Applied Developmental Psychology. 2015;36:11-7.
32. Lee ST, Wong JE, Ong WW, Ismail MN, Deurenberg P, Poh BK. Physical activity pattern of Malaysian preschoolers: Environment, barriers, and motivators for active play. Asia-Pacific Journal of Public Health. 2016;28(5, Suppl):21S-34S.
33. Pempek T, McDaniel B. Young Children's Tablet Use and Associations with Maternal Well-Being. Journal of Child & Family Studies. 2016;25(8):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.
35. Sigmund E, Badura P, Vokacova J, Sigmundova D. Parent-Child Relationship of Pedometer-Assessed Physical Activity and Proxy-Reported Screen Time in Czech Families with Preschoolers. International Journal of Environmental Research and Public Health. 2016;13(7).
36. Wu CST, Fowler C, Lam WYY, Wong HT, Wong CHM, Loke AY. Parenting approaches and digital technology use of preschool age children in a Chinese community. Ital. 2014;40(1):1-8.
37. Jago R, Sebire SJ, Lucas PJ, Turner KM, Bentley GF, Goodred JK, et al. Parental modelling, media equipment and screen-viewing among young children: Cross-sectional study. BMJ Open. 2013;3(4).
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.
39. Bronfenbrenner U, Evans GW. Developmental Science in the 21st Century: Emerging Questions, Theoretical Models, Research Designs and Empirical Findings. Social Development. 2000;9(1):115-25.

40. Warren R. Parental mediation of preschool children's television viewing. J Broadcast Electron Media. 2003;47(3):394-417.
41. Australian Communications and Media Authority (ACMA). Access to the internet, 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(3):261-71.
43. Draxten M, Fulkerson JA, Friend S, Flattum CF, Schow R. 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, Lagström H. The factors associated with toddlers' screen time change in the STEPS Study: A two-year follow-up. Preventive medicine. 2016;84:27-33.
45. De Jong E, Visscher T, HiraSing R, Heymans M, Seidell J, Renders C. 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 (Lond). 2013;37(1):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. Journal of Obesity. 2015;2015.
47. Birken CS, Maguire J, Mekky M, Manlhiot C, Beck CE, Jacobson S, et al. Parental factors associated with screen time in pre-school children in primary-care practice: a TARGet Kids! study. Public Health Nutrition. 2011;14(12):2134-38.
48. Jago R, Thompson JL, Sebire SJ, Wood L, Pool L, Zahra J, 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(1):54-64.
49. Schoeppe S, Rebar AL, Short CE, Alley S, Van Lippevelde W, Vandelanotte C. How is adults' screen time behaviour influencing their views on screen time restrictions for children? A cross-sectional study. BMC public health. 2016;16(1):201.
50. Vandewater EA, Rideout VJ, Wartella EA, Huang X, Lee JH, Shim M-s. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. Pediatrics. 2007;119(5):e1006-15.
51. Veldhuis L, van Grieken A, Renders CM, HiraSing RA, Raat H. Parenting Style, the home environment, and screen time of 5-year-old children; The 'Be Active, Eat Right'Study. PLoS ONE. 2014;9(2):e88486.
52. Dumuid D, Olds TS, Lewis LK, Maher C. Does home equipment contribute to socioeconomic gradients in Australian children's physical activity, sedentary time and screen time? BMC public health. 2016;16(1):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. Sesame Workshop; The Joan Ganz Cooney Centre, New York 2010.
54. Carson V, Tremblay MS, Spence JC, Timmons BW, Janssen I. The Canadian Sedentary Behaviour Guidelines for the Early Years (zero to four years of age) and screen time among children from Kingston, Ontario. Paediatrics & child health. 2013;18(1):25-8.
55. He M, Piché L, Beynon C, Harris S. Screen-related Sedentary Behaviors: Children's and Parents' Attitudes, Motivations, and Practices. Journal of Nutrition Education and Behavior. 2010;42(1):17-25.
56. Christensen MA, Bettencourt L, Kaye L, Moturu ST, Nguyen KT, Olgin JE, et al. Direct Measurements of Smartphone Screen-Time: Relationships with Demographics and Sleep. PLoS ONE. 2016;11(11):e0165331.

Figure 1: PRISMA flow chart for study selection

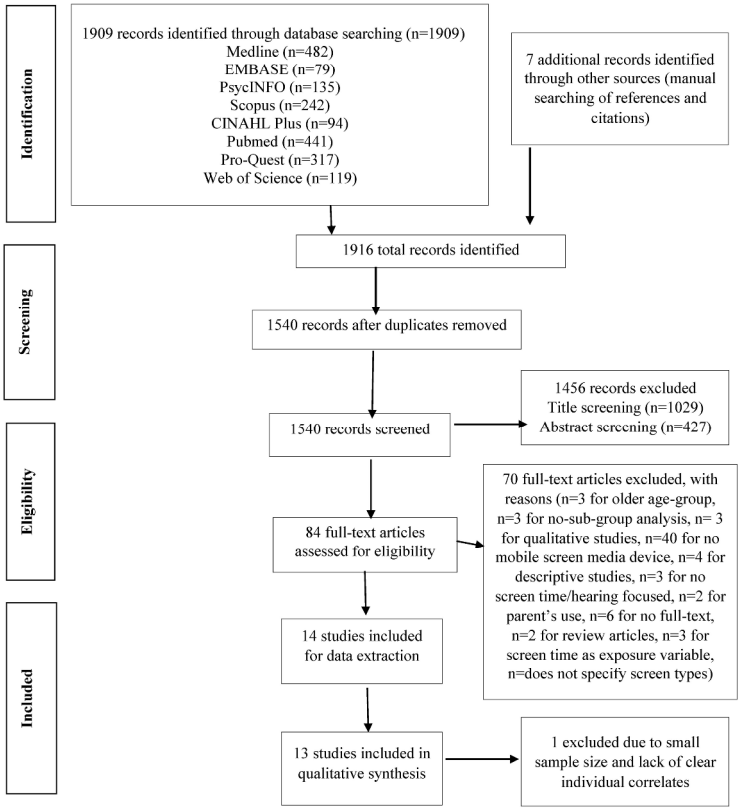

Figure 1: PRISMA flow chart for study selection

Figure 1: PRISMA flowchart for study selection

297x420mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3,4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5,6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6,7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	11
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	9,12
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8,9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12,13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12,13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13,14
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13-23
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	24-26
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	26-27
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	27
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

BMJ Open

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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014585.R3
Article Type:	Research
Date Submitted by the Author:	15-Aug-2017
Complete List of Authors:	Paudel, Susan; Curtin University School of Public Health, Jancey, Jonine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health Subedi, Narayan; Maharajgunj Medical Campus, Institute of Medicine, Department of Community Medicine and Public Health Leavy, Justine; Curtin University, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Research methods
Keywords:	Children, Mobile media use, Screen time, Correlates, Systematic review

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

Authors:

Susan Paudel

School of Public Health, Curtin University, Western Australia

replysusan@gmail.com

Dr. Jonine Jancey

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.jancey@curtin.edu.au

Narayan Subedi

Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University

subedi.narayan@gmail.com

Dr. Justine Leavy

Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Western Australia

j.leavy@curtin.edu.au

Corresponding author:

Susan Paudel

School of Public Health, Curtin University, Western Australia

Email: replysusan@gmail.com

Contact no: 977-9843061616

Keywords: Mobile screen media, children, systematic review, screen time, correlates

Word Count: 5201

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 eight 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 eight years or less were the study population. Studies that included larger age-groups without sub-group analysis specific to the 0-8 year's 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 PDAs.

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 scrtableeen 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.

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

Keywords

Children, mobile screen media, screen time, correlates, systematic review

Strengths

1. This review summarises current peer-reviewed literature on correlates of mobile screen media use among children aged eight years and less.
2. A peer reviewed and published protocol paper guided the systematic review.
3. The review incorporated a robust research strategy, that identified up-to-date key words with the assistance of public health librarian; and searched eight relevant databases
4. A comprehensive inclusion and exclusion criteria was established and used.

Limitations

1. All the reviewed studies were cross-sectional in design making it difficult to derive a casual inference.
2. Study sample sizes ranged from 149 to 3206, which may have impacted on the findings.
3. 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 touchscreens 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 connections with distant family and friends and play opportunities (10, 11). Similarly, engagement with active video games have been reported to promote light to moderate physical activity (12).

Health guidelines recommend that children aged less than two should be exposed to a limited amount of educational mobile screen media use, while for those aged two-to-five, the daily screen time should be less than one 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 one-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 four (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 (PDAs) 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 focussing 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, personal digital assistants (PDAs) among young children, identification of the correlates of mobile screen media use specific to children eight 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 eight years and less. Correlates are classified into proximal and distal factors using a bio-ecological 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 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (23-25) and is registered with PROSPERO International Prospective Register of Ongoing Systematic Reviews (registration number: CRD42015028028). The study used already published, de-identified 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 bio-ecological model (17, 18). The five categories are:

- *Child biological and demographic factors* includes age, sex and body mass index (BMI).
- *Family biological and demographic factors* includes demographic and biological characteristics of the family members (particularly parents) and their education, occupation and income.

- *Family structure factors* includes the number of siblings, family size and family type.
- *Behavioural factors* includes the child's behavioural characteristics and their skills and attitudes.
- *Sociocultural/ environmental factors* includes 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) touchscreens; 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, that investigated the correlates of mobile screen media use among children aged eight and less; based in home or community setting; and published, or in press in English language journals between January 2009 to March 2017. The full description of the alignment of the research question to the Population, Exposure, Comparison and Outcome (PECO) format along with the exclusion criteria is presented in table 1.

Table 1: Research question using PECO format

Criteria	Description
P: Population	Children aged eight years and less
E: Exposure	Correlates of mobile screen media use
C: Comparison	With vs. without the correlates

O: Outcome	Use of mobile screen media (e.g. 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 sub-group 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

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-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.

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/	1767004
2	Infant/ or infant.mp.	1030660
3	Kid.mp.	1251
4	Toddler.mp.	2240
5	1 or 2 or 3 or 4	2242988
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.	16724
15	Tablets/ or Tablets.mp.	34967
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	64324
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	482

	"all child (0 to 18 years)")

* Sign denotes for any character(s), SN= Serial number, 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

Endnote (version 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 abstract 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 re-assessed 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 Odds Ratio (AOR) and Standardised Coefficients (SC) 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.

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 United Kingdom (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.

Table 3: Description of included studies

S.N	Author	Year	Country	Study design	Sample size	Age group	Outcome measure	Screen studied	Results specific to	Independent variables	Measure of association	Quality score
1	Carson et. al (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	unstandardized beta coefficients and 95% confidence interval	8
2	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 chi-square test	7
3	Pempek et. al. (33)	2016	US	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
4	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	Odds ratio and 95% Confidence interval	10
5	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 correlations with 95% confidence intervals	8
6	Nikken et al. (30)	2015	Netherlands	Cross-sectional	896	0-7 years	Media ownership and use	TV, game consoles, computers and touchscreens	Touchscreens (smartphones and electronic tablets)	Parent and child characteristics (age, access, concerns about media use)	Standardised coefficients	6
7	Lauricella et al. (31)	2015	US	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
8	Connell et. al. (1)	2015	US	Cross-sectional	2326	0-8 years	Parent-child co-use of	Books, TV, computers, video games, tablets,	Smartphones And electronic tablets	Parent's time with child, parent's media use, parental and child	Standardised coefficients	7

							media	and smartphones		demographics		
9	Kesten etal. (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	Odds ratio and 95% Confidence interval	8
10	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	Odds ratio and 95% Confidence interval	8
11	Asplund et al.(27)	2015	US	Cross-sectional	314	0-5 years	Adherence to AAP guidelines for screen time	TV, video games, computers, cell phones and other electronic devices	Electronic media (fixed and mobile screens)	Child BMI, child/parent demographics, and household media environment, parental attitudes towards TV viewing	Odds ratio and 95% Confidence interval	9
12	Wu et al. (36)	2014	Hong Kong	Cross-sectional	202	3-6 years	Use of digital products	Television, digital tablets, smart phones, etc	Electronic media (fixed and mobile screens)	Participants' demographics, parenting approach (restrictive, instructive and co-using)	P-value from chi-square test	8
13	Jago et al. (37)	2013	UK	Cross-sectional	750	6-8 years	Children's screen-time	TV, game console, smart-phone and multiscreen-viewing	Smartphones	Parental media use, parental attitudes and access to media equipment	Odds ratio and 95% Confidence interval	8

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). Whilst, 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 table 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 smart phones (1, 29, 31, 37) and electronic tablets (1, 28, 31, 33). Nikken et. al. (30) reported combined results for touchscreens (smartphones and

electronic tablets) while the other six studies reported correlates for electronic media, that included both traditional (e.g. televisions, computers) and new devices (e.g. mobile phones and electronic tablets) (27, 32, 34-36, 38). Use of a PDA was not studied.

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 to younger children (27, 31, 33, 34, 36, 38). Carson and colleagues concluded that for every one month increase in age, the use of any media increased by 9.3 minutes per day (95% CI: 2.8-15.8) (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 et. al. (30) concluded that the child's age had no significant association with the use of touchscreens. Females 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 touchscreen use (1, 30) . No association was found between the use of any media and child body mass index (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 that children from high-income families were using touchscreens or any media device longer than those from low-income families. Conversely, studies by Pempek et. al.(33) and Lee et. al.(32) found no association with family income, and Wu et. al. (36) reported a negative association. Wu 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 touchscreen 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 to those families with one child (36).

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		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)

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$), Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

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, touchscreen 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 screen 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 were 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.

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

Variable type	Variables	Smartphones		Tablets		Touchscreens		Any media device	
		Assoc	Study	Assoc	Study	Assoc	Study	Assoc	Study
Behavioural factors	Child media skills					+	(30)		
Sociocultural/ environmental factors	Parental media use/screen time	+ (>2 yrs)	(31)	+	(1, 31, 33)	+	(30)	+	(27) (≥2 yrs) (35)
		0	(1, 37)						
	Parent attitudes on effects of media on children	+ (>6 yrs)	(31)	+ (>2 yrs)	(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	(29) (boys)						
		+ (always)	(29) (girls)						
	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							+	(27) (≥2 yrs)
	Number of TVs/screens at home	+	(37)					0	(27)

	Computer's outside children's bedroom							+	(36)
	Screen viewing items in child's bedroom	+	(37)						

Note: '+' denotes Positive association, '-' denotes Negative association, '0' denotes No association (significant at 95% confidence level, $p<0.05$),
Empty cells denote that association for that variable has not been studied, '( )' denotes reference.
Touchscreens includes combined results for smartphones and tablets while any media includes combination of traditional media with at least one form of mobile screen media devices.

DISCUSSION

This systematic review identified 36 reported correlates of mobile screen media use among children aged eight years or less from thirteen 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 four and eight 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 were more likely to have higher mobile screen media use. The bio-ecological model posits that human behaviour is affected by intrapersonal factors, inter-personal 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 eight 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 to their younger counterparts. This finding is consistent with a systematic review of traditional screen time use among children three 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 two 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 regards 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 two 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, 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 touchscreens for longer durations than those from low-income families (30), which may be due to greater ownership and access to touchscreen 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 were 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 American Academy of Paediatrics (15) recommendations for children screen media uses the aged 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 targets 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 the 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.

List of abbreviations used

PDA: Personal Digital Assistants

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

Declarations:

Ethics approval and consent to participate

Since this systematic review uses already published, de-identified data, it is hence exempt from the ethics approval process. It does not involve any contact with the human participants and has not collected any primary data.

Consent for publication

This is "Not applicable" for this study as it does not report any individual level data.

Availability of data and material

The findings of this review rely on the data presented on the papers that are already published and are easily accessible on public domains.

Competing interests

The authors declare that they have no financial and non-financial competing interests.

Funding

This study has not received any funding from any source.

Author's contribution

SP, JL and JJ jointly conceived and designed the study. SP was responsible for searching the literature, screening the papers, working on design, critically reviewing the papers and drafting the manuscript. JJ provided overall supervision for the study, finalised methodology,

screening of full text, quality assessment, and edited the manuscript. NS was involved in searching the database, initial screening of title and abstracts and revised the manuscript. JL contributed to design, screening of full text, quality assessment, and organised and revised the manuscript. All authors have read and approved the final version of manuscript.

Acknowledgements

We would like to acknowledge the support of Public health faculty librarian of Curtin University, Ms. Diana Blackwood for her guidance during the database searching stage.

Author's information

Susan Paudel (BPH, MPH, MHlthProm): School of Public Health, Curtin University, Western Australia, Email: replysusan@gmail.com

Dr. Jonine Jancey (BSc (Hons) PhD) : Associate Professor, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.jancey@curtin.edu.au

Narayan Subedi (BPH, MPH, PGDPHN): Assistant Professor, Department of Community Medicine and Public Health, Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University, Nepal, Email: subedi.narayan@gmail.com

Dr. Justine Leavy (BSc, MPH, PhD): Senior Lecturer, Collaboration for Evidence, Research and Impact in Public Health (CERIPH), School of Public Health, Curtin University, Email: j.leavy@curtin.edu.au

References

1. Connell SL, Lauricella AR, Wartella E. Parental Co-Use of Media Technology with their Young Children in the USA. Journal of Children and Media. 2015;9(1):5-21.
2. Holloway D, Green L, Livingstone S. Zero to eight: Young children and their internet use. London: LSE, EU Kids Online; 2013.
3. Rideout V. Zero to eight: Children's media use in America 2013. United States of America: Common Sense Media, 2013.
4. Kabali HK, Irigoyen MM, Nunez-Davis R, Budacki JG, Mohanty SH, Leister KP, et al. Exposure and use of mobile media devices by young children. Pediatrics. 2015:2015-151.
5. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. BMC Public Health. 2015;15(1):1.
6. Ofcom. Communications Market Report Bite-sized. 2016.
7. Ofcom. Children and parents: media use and attitudes report. Ofcom, 2016.
8. Downing KL, Hnatiuk J, Hesketh KD. Prevalence of sedentary behavior in children under 2years: A systematic review. Preventive Medicine. 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 pediatrics. 2014;168(5):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):1-3.
11. Troseth GL, Russo CE, Strouse GA. What's next for research on young children's interactive media? Journal of Children and Media. 2016;10(1):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(7):664-72.
13. Strasburger V., Hogan M. Policy Statement: children, adolescents and the media. Pediatrics. 2013;132:958-61.
14. Department of Health. Australia's Physical Activity and Sedentary Behaviour Guidelines: Australian Government; 2015 [Available from: 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: American Academy of Pediatrics; 2017 [Available from: 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, Silverstein M. Use of Mobile Technology to Calm Upset Children: Associations With Social-Emotional Development. JAMA Pediatrics. 2016;170(4):397-9.
17. Duch H, Fisher EM, Ensari I, Harrington A. Screen time use in children under 3 years old: a systematic review of correlates. Int J Behav Nutr Phys Act. 2013;10(1):1-10.
18. Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. Int J Behav Nutr Phys Act. 2010;7(66):10.
19. Cillero IH, Jago R. Systematic review of correlates of screen-viewing among young children. Preventive Medicine. 2010;51(1):3-10.
20. Vanderloo LM. Screen-viewing among preschoolers in childcare: A systematic review. BMC Pediatr. 2014;14(1):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(6):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. Systematic reviews. 2016;5(1):1.

23. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. International Journal of Surgery. 2010;8(5):336-41.
24. Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. Journal of Cranio-Maxillofacial Surgery. 2011;39(2):91-2.
25. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of Clinical Epidemiology. 2009;62(10):e1-e34.
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. Journal of Epidemiology and Community Health. 1998;52(6):377-84.
27. Asplund KM, Kair LR, Arain YH, Cervantes M, Oreskovic NM, Zuckerman KE. 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. 2015;11(5):590-9.
28. Jago R, Wood L, Zahra J, Thompson JL, Sebire SJ. Parental control, nurturance, self-efficacy, and screen viewing among 5-to 6-year-old children: a cross-sectional mediation analysis to inform potential behavior change strategies. Child. 2015;11(2):139-47.
29. Kesten JM, Sebire SJ, Turner KM, Stewart-Brown S, Bentley G, Jago R. Associations between rule-based parenting practices and child screen viewing: a cross-sectional study. Preventive Medicine Reports. 2015;2:84-9.
30. Nikken P, Schols M. How and Why Parents Guide the Media Use of Young Children. Journal of Child and Family Studies. 2015;24(11):3423-35.
31. Lauricella AR, Wartella E, Rideout VJ. Young children's screen time: The complex role of parent and child factors. Journal of Applied Developmental Psychology. 2015;36:11-7.
32. Lee ST, Wong JE, Ong WW, Ismail MN, Deurenberg P, Poh BK. Physical activity pattern of Malaysian preschoolers: Environment, barriers, and motivators for active play. Asia-Pacific Journal of Public Health. 2016;28(5, Suppl):21S-34S.
33. Pempek T, McDaniel B. Young Children's Tablet Use and Associations with Maternal Well-Being. Journal of Child & Family Studies. 2016;25(8):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.
35. Sigmund E, Badura P, Vokacova J, Sigmundova D. Parent-Child Relationship of Pedometer-Assessed Physical Activity and Proxy-Reported Screen Time in Czech Families with Preschoolers. International Journal of Environmental Research and Public Health. 2016;13(7).
36. Wu CST, Fowler C, Lam WYY, Wong HT, Wong CHM, Loke AY. Parenting approaches and digital technology use of preschool age children in a Chinese community. Ital. 2014;40(1):1-8.
37. Jago R, Sebire SJ, Lucas PJ, Turner KM, Bentley GF, Goodred JK, et al. Parental modelling, media equipment and screen-viewing among young children: Cross-sectional study. BMJ Open. 2013;3(4).
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.
39. Bronfenbrenner U, Evans GW. Developmental Science in the 21st Century: Emerging Questions, Theoretical Models, Research Designs and Empirical Findings. Social Development. 2000;9(1):115-25.
40. Warren R. Parental mediation of preschool children's television viewing. J Broadcast Electron Media. 2003;47(3):394-417.

41. Australian Communications and Media Authority (ACMA). Access to the internet, 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(3):261-71.
43. Draxten M, Fulkerson JA, Friend S, Flattum CF, Schow R. 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, Lagström H. The factors associated with toddlers' screen time change in the STEPS Study: A two-year follow-up. Preventive medicine. 2016;84:27-33.
45. De Jong E, Visscher T, HiraSing R, Heymans M, Seidell J, Renders C. 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 (Lond). 2013;37(1):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. Journal of Obesity. 2015;2015.
47. Birken CS, Maguire J, Mekky M, Manlhiot C, Beck CE, Jacobson S, et al. Parental factors associated with screen time in pre-school children in primary-care practice: a TARGet Kids! study. Public Health Nutrition. 2011;14(12):2134-38.
48. Jago R, Thompson JL, Sebire SJ, Wood L, Pool L, Zahra J, 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(1):54-64.
49. Schoeppe S, Rebar AL, Short CE, Alley S, Van Lippevelde W, Vandelanotte C. How is adults' screen time behaviour influencing their views on screen time restrictions for children? A cross-sectional study. BMC public health. 2016;16(1):201.
50. Vandewater EA, Rideout VJ, Wartella EA, Huang X, Lee JH, Shim M-s. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. Pediatrics. 2007;119(5):e1006-15.
51. Veldhuis L, van Grieken A, Renders CM, HiraSing RA, Raat H. Parenting Style, the home environment, and screen time of 5-year-old children; The 'Be Active, Eat Right'Study. PLoS ONE. 2014;9(2):e88486.
52. Dumuid D, Olds TS, Lewis LK, Maher C. Does home equipment contribute to socioeconomic gradients in Australian children's physical activity, sedentary time and screen time? BMC public health. 2016;16(1):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. Sesame Workshop; The Joan Ganz Cooney Centre, New York 2010.
54. Carson V, Tremblay MS, Spence JC, Timmons BW, Janssen I. The Canadian Sedentary Behaviour Guidelines for the Early Years (zero to four years of age) and screen time among children from Kingston, Ontario. Paediatrics & child health. 2013;18(1):25-8.
55. He M, Piché L, Beynon C, Harris S. Screen-related Sedentary Behaviors: Children's and Parents' Attitudes, Motivations, and Practices. Journal of Nutrition Education and Behavior. 2010;42(1):17-25.
56. Christensen MA, Bettencourt L, Kaye L, Moturu ST, Nguyen KT, Olgin JE, et al. Direct Measurements of Smartphone Screen-Time: Relationships with Demographics and Sleep. PLoS ONE. 2016;11(11):e0165331.

Figure 1: PRISMA flow chart for study selection

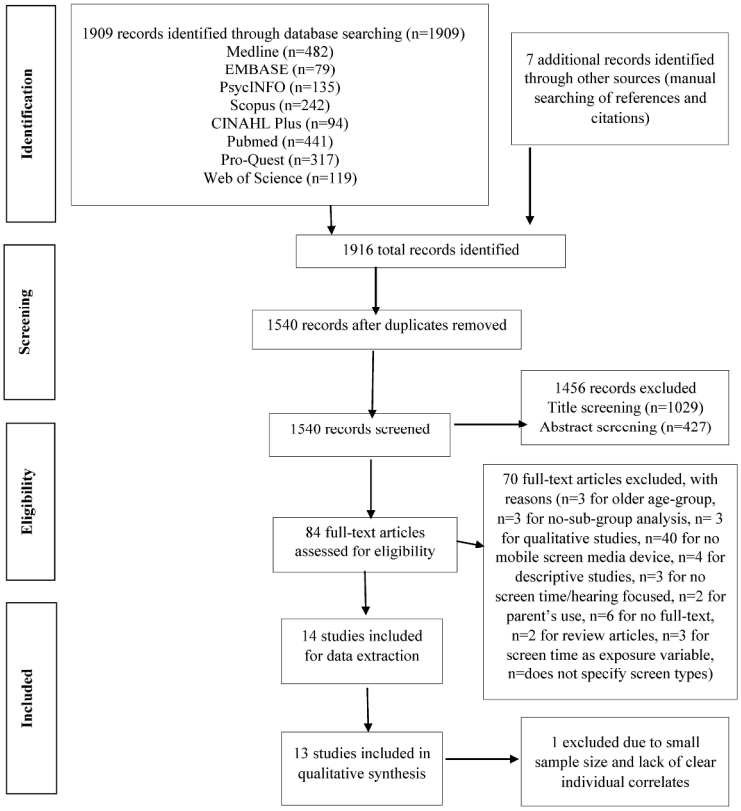

Figure 1: PRISMA flow chart for study selection

Figure 1: PRISMA flowchart for study selection

297x420mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3,4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5,6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6,7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	11
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	9,12
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8,9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12,13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12,13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13,14
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13-23
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	24-26
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	26-27
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	27
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.