Review Article

A Systematic Review on Effect of Electronic Media on Diet, Exercise, and Sexual Activity among Adolescents

Abhay M. Gaidhane[1,2], Anju Sinha[3], Mahalaqua Nazli Khatib[1,4], Padam Simkhada[5], Prakash B. Behere[6], Deepak Saxena[7], Bhaskaran Unnikrishnan[8,9], Mahafroz Khatib[2], Mahjabeen Ahmed[2], Zahiruddin Quazi Syed[2]

[1]Division of Evidence Synthesis, School of Epidemiology and Public Health, [2]Department of Community Medicine, Datta Meghe Institute of Medical Sciences (Deemed to be University), [3]Division of Reproductive, Maternal and Child Health, Indian Council of Medical Research Hqrs, New Delhi, [4]Department of Physiology, Datta Meghe Institute of Medical Sciences (Deemed to be University), Wardha, Maharashtra, India, [5]Centre for Public Health Institute, Liverpool John Moores University, Liverpool, England, [6]Department of Psychiatry, DY Patil University, Kolhapur, Maharashtra, [7]Department of Epidemiology, Indian Institute of Public Health, Gandhinagar, Gujarat, [8]Kasturba Medical College, Mangalore, [9]Manipal Academy of Higher Education, Manipal, Karnataka, India

Abstract

Context: Electronic media has become a part of day-to-day life for all, and particularly more so for children and adolescents. Exposure to electronic media may be beneficial as well as harmful. **Aim:** The aim of the study is to systematically synthesize existing published and non-published empirical evidence on the effect of exposure to electronic media on diet, exercise, and sexual activity. **Methodology:** Two reviewers independently searched online databases such as MEDLINE, CENTRAL, and EMBASE. We applied no language, date, or publication restrictions. **Selection Criteria:** We included randomized control trials that assessed the effect of exposure of electronic media on diet, exercise, and sexual activity in participants between 5 and 19 years. **Study Selection, Data Extraction:** Two reviewers independently screened studies identified in electronic search and independently extracted data and assessed the risk of bias of included studies. **Data Analysis:** We had planned to use the risk ratio or odds ratio for dichotomous data, and mean difference (MD) or standardized MD for continuous data. However, as included studied differed in types of intervention and reporting of outcomes, we did not undertake meta-analysis. **Main Results:** All included trials were parallel randomized controlled trials except for one that was a crossover trial. Eight studies reported the effect of electronic media on diet and exercise, two on diet, two on exercise, and one on sexual activity. Quality of evidence was rated as "very low" for all outcomes due to too little information or too few data to be able to reach to any conclusions. **Conclusions:** There is a little body of evidence that limits conclusions. We need to comprehend as to how to swap undesirable effects of electronic media and make it more desirable.

Registration of Systematic Review: This systematic review has been registered at PROSPERO International prospective register of systematic reviews (Registration number: PROSPERO 2018 CRD42018086935) available at https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=86935.

Keywords: Adolescents, children, diet, electronic media, exercise, gaming, internet, mobile phones and radio, physical activity, sexual activity, systematic review, television

Introduction

Currently, electronic media in the form of television, mobiles, video games, and computers are completely amalgamated into the fabric of life. Adolescents have unprecedented access to new media and use them in expected and unexpected ways. Unhealthy habits, which are strengthened through adolescence, often continue into later life and result in long-term undesirable health outcomes.[1] The National Kaiser Family Foundation (US) Survey found that children aged 8–18 years had an average media usage time of 6 h and 21 min daily.[2] Research by the pew internet and American life project revealed that 93% of youth aged 12–17 are online, and 71% have a cell

Access this article online

Quick Response Code:

Website: www.ijcm.org.in

DOI: 10.4103/ijcm.IJCM_143_18

Address for correspondence: Dr. Zahiruddin Quazi Syed, Division of Evidence Synthesis, School of Epidemiology and Public Health, Department of Community Medicine, Datta Meghe Institute of Medical Sciences, Sawangi Meghe, Wardha - 442 004, Maharashtra State, India. E-mail: zahirquazi@gmail.com

How to cite this article: Gaidhane AM, Sinha A, Khatib MN, Simkhada P, Behere PB, Saxena D, *et al*. A systematic review on effect of electronic media on diet, exercise, and sexual activity among adolescents. Indian J Community Med 2018;43:S56-65.

Received: 21-05-18, **Accepted:** 25-09-18

phone and report watching videos (57%), creating and visiting social networking sites (65%), making online purchases (38%), and getting health information (28%).[3] Although data from India are limited, a significant portion of our children also has considerable TV viewing per day, i.e., >2 h/day.[4] The research has shown that increasing numbers of teenagers are going online to find health information.[5] The matter of increasing use of electronic media among adolescents is of grave worry not only to parents, but also to teachers, health-care workers, policymakers, and activists alike. We have to know better how to inverse the adverse effects of electronic media and turn it more fruitful.

Exposure to electronic media may be beneficial as well as harmful.[6] Exploiting electronic media to encourage health behavior change has numerous benefits.[7] Electronic media may also be used to promote the healthy lifestyle, thereby preventing obesity in children and adolescent. In precise, an electronic media intervention can be provided to a greater number of people at a low cost.[8,9]

The efficacy of mass media drives in changing behavior and improving health-care delivery practices in young people have been evaluated previously in reviews of the literature.[8,9] However, a review dealing with the effects of electronic media on behaviors related to diet, exercise, and sexual activity are less known. Hence, we have undertaken a comprehensive systematic review to assess (both the positive and negative) the impact of electronic media (such as television, internet, gaming, mobile phones, and radio) on diet, exercise, and sexual activity.

Methods

Criteria for considering studies for this review

Types of studies

We included randomized control trials that assessed the effect of exposure of electronic media (defined as television, internet, gaming, mobile phones, and radio) amongst adolescents on diet, exercise, and sexual activity. In case of multiple reports of the same study, we linked it together as a single study. We considered studies published in languages other than English for inclusion in this review.

Types of participants

We included studies with participants in the age range of 5–19 years. Both male and female participants from rural as well as urban areas were considered for inclusion in this review.

Types of outcomes

Outcomes in terms of the beneficial effect of interventions/exposure were as follows:

1. Promoting healthy dietary/eating habits
2. Promoting physical exercise
3. Promoting healthy sexual behavior such as condom use, delaying the sexual debut, and single partner.

Outcomes in terms of the harmful effect of interventions/exposure were as follows:

1. Sedentary lifestyle
2. Obesity
3. Sexual risk-taking behavior – Initiation of sexual activities at younger age, multiple sexual partners.

We assessed variation with respect to sociodemographic characteristics such as age group, sex, and sociocultural factors on effect on electronic media on the health outcome of interest. We had also planned to assess magnitude and content of media exposure according to duration (in hours), type, and content of the exposure. With regards to the timing of outcome measurement, we considered all time frames and had planned to compare with the duration of exposure as a subgroup analysis.

Search methods for identification of studies

We conducted electronic as well as nonelectronic searches. Review authors (AG, PS, PBB, and DS) formulated a search strategy and searched databases such as MEDLINE, EMBASE, and CENTRAL for pertinent studies. Ongoing clinical trials and unpublished studies were searched for this review.

For searching, we used Medical Subject Headings (MeSH) and text word terms. We did not apply any language or date restrictions. We tailored searches to individual databases. The search strategy for MEDLINE is as follows: Search ((((((((((((((((adolescen*[Title/Abstract]) OR pre-adolescen*[Title/Abstract]) OR teenage*[Title/Abstract]) OR teen*[Title/Abstract]) OR preadolescen*[Title/Abstract]) OR pre-teen*[Title/Abstract]) OR child[Title/Abstract]) OR childhood[Title/Abstract]) OR children[Title/Abstract]) OR boy*[Title/Abstract]) OR girl*[Title/Abstract]) OR young[Title/Abstract]) OR youngster*[Title/Abstract]) OR youth*[Title/Abstract]) OR minor*[Title/Abstract]) OR "Adolescent"[MeSH])) AND ((((((((((((((((((((((((((((("electronic media"[Title/Abstract]) OR electronic based[Title/Abstract]) OR cyber*[Title/Abstract]) OR web-based[Title/Abstract]) OR computer-based[Title/Abstract]) OR "internet-based"[Title/Abstract]) OR internet[Title/Abstract]) OR internet-delivered[Title/Abstract]) OR online*[Title/Abstract]) OR "computer game*"[Title/Abstract]) OR "video game*"[Title/Abstract]) OR "mobile game*"[Title/Abstract]) OR "online game*"[Title/Abstract]) OR apps[Title/Abstract]) OR "mobile app*"[Title/Abstract]) OR "short message service"[Title/Abstract]) OR SMS-based [Title/Abstract]) OR "text message*"[Title/Abstract]) OR "text messaging*"[Title/Abstract]) OR telecounselling[Title/Abstract]) OR e-health[Title/Abstract]) OR facebook[Title/Abstract]) OR whatsapp[Title/Abstract]) OR twitter[Title/Abstract]) OR social media*[Title/Abstract]) OR television*[Title/Abstract]) OR laptop*[Title/Abstract]) OR phone*[Title/Abstract]) OR smartphone*[Title/Abstract]) OR mobile*[Title/Abstract]) OR telephon*[Title/Abstract]) OR desktop*[Title/Abstract]) OR computer*[Title/Abstract]) Filters: Randomized Controlled Trial (RCT).

We also searched for conference proceedings that were likely to contain relevant material. We hand-searched journals are

not available online for finding relevant studies. We contacted investigators and experts in the field to seek information on unpublished or incomplete trials.

Selection of studies

We employed systematic review methods developed by Cochrane Handbook of Systematic Reviews.[10] Reviewers (AG, MNK, and MA) pre-screened studies identified in the electronic search using an online software Rayyan.[11] We initially screened studies on the basis of title and abstract and excluded studies and subsequently screened full-texts of potentially eligible studies. We resolved any discrepancies by a discussion with a fourth reviewer (ZQS).

Data extraction and management

Once the study was included in the review, two reviewers (MK and MA) independently extracted data using a predesigned data extraction form, and the third reviewer (UB) cross-checked these data.

Assessment of risk of bias in included studies

Biases in the included studies were graded as a low risk, high risk, or unclear risk as per the criteria proposed by Cochrane Collaboration for judging the risk of bias (RoB) in the "RoB" assessment tools. Two reviewers (MK and MA) assessed the RoB under domains of selection bias, performance bias, detection bias, attrition bias, reporting bias, and other sources of bias. A third reviewer (UB) resolved discrepancies among the primary reviewers in the assessment of RoB.

Measures of treatment effect and data synthesis

We had planned to undertake meta-analysis only if participants, interventions, comparisons, and outcomes were suitably comparable to guarantee a meaningful answer. For meta-analysis, we had planned to use RevMan 2014 statistical package adopted by Cochrane Collaboration. We had planned to use effective measures as odds ratio, risk ratio, or risk difference for dichotomous data, and mean difference (MD) or standardized MD for continuous data. We had planned to measure the extent of heterogeneity by Chi-square statistics and use I^2 statistics for quantifying inconsistency across studies. We had planned to use Funnel plots (plots of the effect estimate from each study against the standard error) to assess the potential for bias related to the size of the trials, which would have indicated possible publication bias. We had planned to perform stratified meta-analysis to assess the differential effect of electronic media based on different theoretical approaches. The impact of a media may be mediated by the subcultural environment and, in particular, by the attitude in a given culture. Therefore, we had planned to analyze, where possible, subsets of studies by characteristics of target participants (regional locations and users vs. non-users). We had planned to compare studies by type of media, duration, timing, and content of exposure to electronic media as well as different forms of electronic media such as internet, television, gaming, mobile phones, and radio. If we would have found ten or more than ten studies for an outcome, we had planned to conduct a funnel plot test for asymmetry to assess for any evidence of reporting bias. In addition, we had planned to explore the possible sources of asymmetry in a funnel plot. Where needed, we contacted authors for providing of any possible missing data. We had planned to undertake sensitivity analyses to evaluate how sensitive scores are to rational variations. However, due to due to variations in methods, intervention, and outcomes reported, we did not perform meta-analysis with subgroup and sensitivity analysis.

Grading of studies

We undertook grading of the evidence using GradePro software (GRADEpro GDT: GRADEpro Guideline Development Tool [Software]. McMaster University, 2015 (developed by Evidence Prime, Inc.)). After extracting data from studies, quality of studies and the weight of evidence, they present in relation to the review question was assessed. Two reviewers (AG and DS) reviewed the data on each health outcome.

Studies were graded as per the quality standard s provided by GRADE Pro[12] as follows:

- High quality if further research is very unlikely to change our confidence in the estimate of effect
- Moderate quality if further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
- Low quality if it is found that the further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate, and
- Very low quality when we are very uncertain about the estimate.

Results

Results of search

We searched various electronic databases and other resources as listed in methods section and retrieved 5983 studies after removing duplicates. We excluded 5921 studies on the basis of title and abstracts and screened full texts of 62 articles for eligibility. We found 14 studies (including one ongoing study) that fulfilled our inclusion criteria. However, none of the studies could be included in quantitative synthesis as they differed in settings, duration, type, content and intensity of intervention, length of follow-up, methods of evaluation and also in definitions and measures of outcomes. The details of the search strategy have been outlined in the PRISMA flow diagram [Figure 1].

Details of included studies [Table 1]

Study details

We have described 19 included trials in detail in the characteristics of included studies [Table 1]. The trials were undertaken in the UK,[13-18] Pennsylvania,[19] the Netherlands,[20,21] New Zealand,[22] Canada,[23] and China.[24] We did not find any studies done in low-middle income countries (LMICs) or studies in Indian setting.

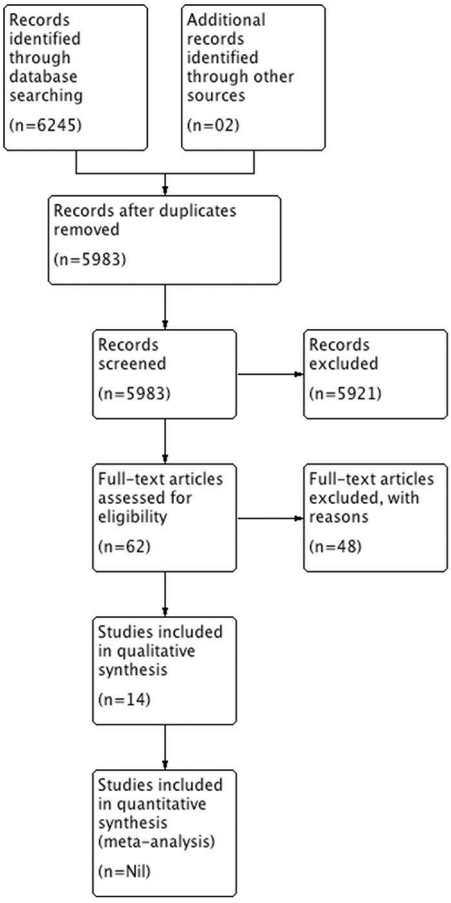

Figure 1: PRISMA flow diagram for the inclusion of studies

Types of studies

All included trials are parallel RCTs except one[23] crossover trial and one cluster RCT.[19]

Participants

The age of the participants ranged between 9 and 19 years. Studies by Simons *et al*.,[21] Abraham *et al*.,[24] and Marsch *et al*.[17] comprised predominantly male participants while studies by Doyle *et al*.,[18] Whittemore *et al*.,[19] and Slootmaker *et al*.,[20] comprised predominantly female participants. Gribbon *et al*.[23] included only males while Marks *et al*.[16] included only females in their studies. Maddison *et al*.,[22] and Chaput *et al*.[25] Other studies did not had significant differences between male and female participants.

Simons *et al*.[21] included only Dutch participants, while Chen *et al*.[15] and Abraham *et al*.[24] included only Chinese Participants. Maddison *et al*.[22] Chaput *et al*.[25] and Gribbon *et al*.[23] did not report about the race or ethnicity of the included participants. All remaining studies included mixed participants of different races/ethnicities.

Except for Doyle *et al*.,[18] Maddison *et al*.,[22] and Abraham *et al*.[24] that included overweight or obese adolescents and Simons *et al*.,[21] that recruited excessive non-active video gamers, all the other studies included healthy adolescents.

Interventions

Cameron *et al*.[13] Cullen *et al*.[14] Doyle *et al*.[18] Chen *et al*.[15] Abraham *et al*.[24] Whittemore *et al*.[19] Marks *et al*.[16] and Marsch *et al*.[17] delivered web-based/internet-based interventions while Simons *et al*.[21] Maddison *et al*.[22] Chaput *et al*.[25] and Gribbon *et al*.[23] exposed the participants to video games.

Funding

All included studies were funded/supported by funding agencies/institutes.

Outcomes

Cameron *et al*.[13] Cullen *et al*.[14] Chen *et al*.[23] Maddison *et al*.[22] Chaput *et al*.[25] Gribbon *et al*.[23] Abraham *et al*.[24] and Whittemore *et al*.[19] studied the effect of electronic media on diet and exercise. Marsch *et al*.[17] reported on outcomes related to sexual activity.

Risk of bias in included studies

Since we included only RCTs; all studies were at low risk of selection bias. Except for Simons *et al*.,[21] none of the included studies reported the blinding status of participants and personnel involved in the delivery of intervention and hence were at unclear risk of performance bias. Doyle *et al*.[18] Simons *et al*.[21] and Abraham *et al*.[24] blinded outcome assessors and hence were at low risk of detection bias. Other included studies were at unclear risk of detection bias, as they did not mention the blinding status of outcome assessors.

Findings from included studies

Since included studies differed in settings, duration, type, content and intensity of intervention, length of follow-up, methods of evaluation and also in definitions and measures of outcomes [Table 1], we did not undertake meta-analysis. However, we have provided narrative findings of the included studies [Tables 2-5].

Cameron *et al*.,[13] Cullen *et al*.,[14] Chen *et al*.,[15] Maddison *et al*.,[22] Chaput *et al*.,[25] Gribbon *et al*.,[23] Abraham *et al*.,[24] and Whittemore *et al*.[19] studied the effect of electronic media on diet and exercise. Doyle *et al*.,[18] and Simons *et al*.[21] assessed outcomes related to diet. Marks *et al*.,[16] and Marsch *et al*.[17] reported on outcomes related to exercise while Marsch *et al*.[17] reported on outcomes related to sexual activity.

Effect of video games on diet, body weight, body composition, and exercise

Simons *et al*.,[21] Maddison *et al*.,[22] Chaput *et al*.,[25] and Gribbon *et al*.[23] studied the effect of video games on diet, body composition, and exercise. A study by Simons *et al*.,[21] concluded that active video game (AVG) intervention is an inappropriate tool for the prevention of excessive weight gain among gaming adolescents [Table 2].[21] It did not reduce anthropometric values in a group of "excessive" non-active video gamers who mostly were of normal weight as compared to a control group. However, the control group showed a lower body mass index and skin folds than the intervention group.[21] Maddison *et al*.[22] demonstrated that playing AVGs can have

Table 1: Characteristics of studies Table

Study ID	Participants			Intervention
	Number of participants allocated to each group	Age range/ mean (years)	Gender distribution (male/female)	Type of intervention
Cameron *et al*.[13] (UK)	Total: *n*=213 IG: *n*=90 CG: *n*=123	Mean age group IG: 18.73 CG: 18.89	Male/female (%) IG: 44.19/55.81 CG: 45.13/54.87	IG: Repeated sessions of self-affirmation manipulation CG: Assessment only
Cullen *et al*.[14] (UK)	Total: *n*=390 IG: *n*=288 CG: *n*=102	Mean age IG 12-13 Y: 29.4 14-15 Y: 38.4 16+Y: 32.22 CG 2-13 Y: 33.8 14-15 Y: 42.5 16 + Y: 24	Male/female (%) IG: 47.9/41.32 CG: 52.1/58.8	IG: 2-10 sessions of an online 'Teen Choice: Food and Fitness program CG: Participants were asked to set and print a goal sheet
Doyle *et al*.[18] (Chicago)	Total: *n*=80 IG: *n*=40 CG: *n*=40	Age Mean±SD IG: 14.9±1.7 CG: 14.1±1.6	Male/female (%) IG: 35/65 CG: 40/60	IG: Adolescent and parents received orientation to Internet program, a pedometer, and a calorie/fat guide CG: Parents received basic information on nutrition and PA
Simons *et al*.[21] (The Netherlands)	Total: *n*=270 IG: *n*=140 CG: *n*=130	Age mean±SD IG: 13.7±1.3 CG: 14.1±1.3	Male/female (%) IG: 90/10 CG: 92/8	IG: AVGs at least 1 h/week CG: Participants continue their normal (nonactive) gaming behavior
Chen *et al*.[15] (UK)	Total: *n*=54 IG: *n*=27 CG: *n*=27	Age mean±SD 12.52±3.15	Male/female (%) IG: 59/41 CG: 48/52	IG: Web-based behavioral program CG: General health information and not tailored as intervention group
Maddison[22] (New Zealand)	Total: *n*=322 IG: *n*=160 CG: *n*=162	Age 10-14 years	Not reported	IG: An AVG CG: No change
Chaput *et al*.[25] (Canada)	Total: *n*=22 IG: *n*=11 CG: *n*=11	Age mean±SD 16.7±1.1	Not reported	IG: Video game CG: Rest on a comfortable chair
Gribbon *et al*.[23] (Canada)	Total: *n*=30	Age 14.5±1.4 years	Male participants only	IG: Playing Xbox 360 and Kinect for Xbox360 (AVG condition)
Abraham *et al*.[24] (China)	Total: *n*=48 IG1: *n*=16 IG 2: *n*=16 CG: *n*=16	Age median (years) IQR IG1: 14.9 (13.7-16.2) IG2: 14.1 (13.5-15.3) CG: 14.3 (13.5-15.8)	Male/female%IG1: 56/44% IG2: 62/38% CG: 62/38%	IG1 (IT group): Usual care plus internet-based curriculum with cell phone calls/texts reminders IG2 (sLMP group): Usual care visits plus nutritional counseling sessions CG: Usual care visits in obesity clinic
Whittemore *et al*.[19] (Philadelphia)	Total: *n*=384 IG: *n*=207 CG: *n*=177	Age (%) IG 14-15 (67.2%) 16-17 (32.8%) CG 14-15 (70.6%) 16-17 (29.4%)	Male/female (%) IG: 37.2/62.8 CG: 39/61	IG: Health-e-Teen + CST CG: Health-e-Teen
Marks *et al*.[16] (USA)	Total: *n*=319 IG: *n*=158 CG: *n*=161	Age mean±SD IG: 12.2±1.0 CG: 12.1±0.9	Adolescent girls only	IG: PA Website CG: Print "workbook" containing identical content and graphics from website
Slootmaker *et al*.[20] (Netherland)	Total: *n*=87 IG: *n*=41 CG: *n*=46	Mean±SD age IG: 15.3 (1.1) CG: 14.8 (1.4)	Male/female (%) 37/63%	IG: Adolescents were provided with a PAM accelerometer, coupled to a web-based tailored PA advice (PAM COACH)
Marsch *et al*.[17] New York	Total: *n*=141 IG: *n*=69 CG: *n*=72	Age mean±SD IG: 15.85 (1.10) CG: 15.76 (1.08)	Male/female (%) IG: 78.26/21.74 CG: 76.39/23.61	IG: Web-delivered TES intervention CG: Tradition educator-based intervention

PAM: Personal activity monitor, PA: Physical activity, TES: Therapeutic Education System, CST: Communication Skills Training, PAM COACH: PAM accelerometer, coupled to a web-based tailored physical activity advice, SD: Standard deviation, AVG: Active video game

Table 2: Findings from included studies on effect of electronic media on diet

Study ID	Outcome	Participants in intervention arm	Total no in control arm	Continuous data		Other comment
				Mean of intervention±SD/SE or Median (IQR)	Mean of control±SD/SE or median (IQR)	
Cameron *et al*.[13]	Fruit and vegetable intake Portions per day (%)	495	512	BL: 5.61±4.89 Post: 4.11±1.84	BL: 5.72±4.98 Post: 3.89±1.97	*P*=0.024 Post: 6 months follow-up
Cullen *et al*.[14]	Diet-related 1. Self-efficacy (availability in past 7 days) 2. Fruit and juice 3. Vegetables 4. Sweetened beverages 5. Diet beverages 6. Whole milk	211	80	Means±SE 1. BL: 33.27±0.01 Post: 33.79±0.01 2. BL: 1.19±0.04 Post: 1.14 0.04 3. BL: 1.15±0.04 Post: 1.08±0.04 4. BL: 2.05±0.03 Post: 2.09±0.03 5. BL: 0.28±0.03 Post: 0.34±0.03 6. BL: 0.42±0.02 Post: 0.32±0.02	Means±SE 1. BL: 33.79±0.02 Post1:33.30±0.02 2. BL: 0.93±0.05 Post 1: 1.40±0.05 3. BL: 1.02±0.06 Post 1:1.07±0.06 4. BL: 2.15±0.04 Post 1:2.05±0.04 5. BL: 0.37±0.04 Post 1:0.35±0.04 6. BL: 0.29±0.03 Post 1:0.31±0.03	Significant increase in food intake (*P*<0.05)
Doyle *et al*.[18]	EDE-Q (eating disorder examination-questionnaire)	33	33	Mean±SD BL: 2.24±1.35 Post: 1.63±1.17 4M FU: 1.95±1.32	Mean±SD BL: 2.56±1.12 Post: 1.99±1.34 4M FU: 1.94±1.55	
Simons *et al*.[21]	Consumption of sugar sweetened beverages (% >1400 ml/week) (yes=1; no=0)	BL: 138 10M: 131	BL: 124 10M: 121			Overall effect OR (95%CI): 0.62 (0.40; 0.96)
	Consumption of snacks (pieces/portions per week)	BL: 138 10M: 131	BL: 124 1M: 111 4M: 119 10M: 121	Median (IQR) BL: 10.0 (12.25) 10M: 9.0 (11.0)	Median (IQR) BL: 12.0 (13.0) 10M: 11.0 (10.5)	Overall effect β (95%CI): −1.07 (−2.66;0.50)
Chen *et al*.,[15]	Vegetables and fruit, servings per day	27	27	Mean±SD BL: 2.19±0.48 8M: 2.63±0.71	Mean±SD BL: 2.28±0.61 8M: 2.34±0.66	Effect size=0.14 *P*=0.001
	Nutrition knowledge (14-item survey on dietary knowledge)	27	27	Mean±SD BL: 2.74±0.81 8M: 3.04±0.71	Mean±SD BL: 2.59±0.89 8M: 2.76±0.78	Effect size=0.18 *P*=0.001
	Nutrition self-efficacy (15-item self-report questionnaire scored on a Likert scale)	27	27	Mean±SD BL: 2.59±0.29 8M: 2.59±0.27	Mean±SD BL: 2.54±0.32 8M: 2.52±0.29	
Abraham *et al*.[24]	Dietary Knowledge score (maximum score: 75)	IG1: 16 IG2: 16	16	Median (IQR) IG1 (IT group) BL: 48.0 (47.0-49.0) 6M: 48.5 (47.0-50.5) IG2 (sLMP group) BL: 51.0 (48.0-52.0) 6M: M-47.5 (44.0-54.0)	Median (IQR) BL: 48.0 (47.0-49.06) 6M: 47.5 (44.5-49.5)	
Gribbon *et al*.[23]	Energy intake	No differences between conditions in energy intake immediately after the intervention (*P*=0.94; or 24 h (*P*=0.63); or 3 d (*P*=0.53); postintervention				
	Appetite sensations (VASs)	No differences all time points between conditions				
Chaput *et al*.[25]	Increase in food intake (regardless of appetite sensations)					

SD: Standard deviation, VAS: Visual analog scales, IQR: Interquartile range, CI: Confidence interval, OR: Odds ratio

a positive effect on body composition in overweight or obese children that is most likely mediated through improved aerobic fitness [Table 4]. However, a study by Chaput *et al*.,[25] involving healthy male adolescents found significantly higher energy expenditure ($P < 0.01$), daily energy surplus of 682 kJ (163 kcal) over resting ($P < 0.01$) and an increase in food intake regardless of appetite sensations in a single session of video game play condition than during rest [Tables 2 and 3].

Table 3: Findings from included studies on effect of electronic media on physical exercise

Study ID	Outcome	Participants in intervention arm	Participants in control arm	Continuous data		Other comment
				Mean of intervention ± SD/ SE or Median (IQR)	Mean of control ± SD/SE	
Cameron *et al*.[13]	PA (metabolic equivalent of task in percentage)	513	526	BL: 3350.52±5144.16 Post: 3627.94±2578.97	BL: 3316.10±5143.79 Post: 3613.27±2578.07	*P*=0.932 Post: 6 months follow-up
Cullen *et al*.[14]	PA-related Self-efficacy	211	80	Means±SE BL: 28.22±0.01 At Post: 29.17±0.01	Means±SE BL: 29.17±0.02 At Post 1:29.30±0.02	Significant increase in PA (*P*<0.001)
Simons *et al*.[21]	PA (hours per week) Flemish PA Computerized Questionnaire	BL: 138 10M: 131	BL: 124 10M: 121	Median (IQR) BL: 10.63 (7.02) 10M: 10.0 (6.17)	Median (IQR) BL: 10.38 (6.42) 10M: 10.0 (6.96)	Overall effect β (95%CI) −0.12 (−1.04-0.80)
Chen *et al*.[15]	Actigraphy (count/min, assessed by actigraphy)	27	27	Mean±SD BL: 634.85±107.07 8M: 674.37±76.52	Mean±SD BL: 624.89±110.72 8M: 615.67±106.77	Effect size=12.46 (*P*=0.01)
	PA knowledge (a five-item questionnaire to assess subject's knowledge about PA)	27	27	Mean±SD BL: 2.70±0.78 8M: 3.29±0.82	Mean±SD BL: 2.85±0.82 8M: 2.61±0.71	Effect size=0.16 (*P*=0.008)
	PA self-efficacy (subscale of the Health Behavior Questionnaire)	27	27	Mean±SD BL: 2.55±0.46 8M: 2.72±0.27	Mean±SD BL: 2.49±0.45 8M: 2.44±0.24	
Chaput *et al*.[25]	Total energy (kj)	11	11	Mean±SD Kj: 6493±2223	Mean±SD Kj: 6057±2368	
Abraham *et al*.[24]	PA score (maximum score: 10)	IG1: 16 IG2: 16	16	Median (IQR) IG1 (IT Group) BL: 6.0 (3.5-6.5) 6M: 6.0 (4.5-7.0) IG2 (sLMP Group) BL: 4.0 (3.0-7.0) 6M: 4.0 (3.0-6.0)	Median (IQR) BL: 4.5 (2.0-6.5) 6M: 6.0 (4.5-7.0)	
Whittemore *et al*.[19]	Exercise Vigorous (days/week of 20 min)	207	177	Mean±SD BL: 3.4±2.4 6M: 4.1±2.1	Mean±SD BL: 3.4±2.3 6M: 4.1±2.1	Time Effect (a) Intervention ≤0.01 Control ≤0.01
	Exercise Moderate (days/week of 30 min)	207	177	Mean±SD BL: 3.8±2.4 6M: 4.4±2.1	Mean±SD BL: 3.9±2.4 6M: 4.3±2.0	Time effect (a) Intervention =<0.01 Control=0.06
Gribbon *et al*.[23]	Energy expenditure	Higher during AVG condition than with control and seated video game conditions (*P*=0.00)				
Marks *et al*.[16]	PA	Both Web and print groups had significant changes in physical activity self-efficacy (Web: *P*=0.01; print: *P*=0.002 and intentions (Web: *P*=0.02; print: *P*≤0.001) PA increased significantly in print group only *P*=0.002				
Slootmaker *et al*.[20]	Physical activity	Significant differences between groups in favor of intervention group in PA for girls after 3 months (411 min/week; 95% CI: 1; 824; *P*=0.04)				
	Sedentary time	Significant differences between groups in favor of intervention group in sedentary time in boys after 8 months (−1801 min/week; 95% CI: −3545; −57; *P*=0.04)				

SD: Standard deviation, VAS: Visual analogue scales, IQR: Interquartile range, CI: Confidence interval, OR: Odds ratio, SE: Standard error, AVG: Active video game

Gribbon *et al*.[23] suggested that through a single session of Kinect AVG plays promoted an increase in energy expenditure, it did not increase the food intake immediately after the intervention ($P < 0.5$) [Tables 2 and 3].

Effect of web-based/internet-based interventions on diet, body weight, body composition, and exercise

Cameron *et al*.,[13] Cullen *et al*.,[14] Doyle *et al*.,[18] Chen *et al*.,[15] Abraham *et al*.,[24] Whittemore *et al*.,[19] Marks *et al*.,[16] and Marsch *et al*.[17] observed the effect of web-based/internet-based interventions on diet, body weight, body composition, and exercise. A per-protocol analysis of Cameron *et al*.,[13] found a significant effect of theory-based online health behavior on fruit and vegetable intake ($P = 0.024$) and an insignificant effect on physical activity ($P = 0.932$) after 6 months' follow-up [Tables 2 and 3]. Cullen *et al*.[14] showed that the

Table 4: Findings from included studies on effect of electronic media on body weight, body composition

Study ID	Outcome	Participants in intervention arm	Participants in control arm	Continuous data		Other comment
				Mean of intervention±SD/ SE Or median (IQR)	Mean of control±SD/SE	
Maddison *et al*.[22]	BMI (kg/m^2) Treatment effects with mediator variable VO_2 maximum	160	162	Mean±SE 0.13±0.11	Mean±SE 0.43±0.11	*P*<0.0001
	Percentage body fat Treatment effects with mediator variable VO_2 maximum	160	162	Mean±SE −0.93±0.32	Mean±SE −0.52±0.33	*P*<0.0001
Abraham *et al*.[24]	BMI	IG1: 16 IG2: 16	16	Median (IQR) IG1(IT Group) BL: 29.3 (26.7-30.9) 6M: M -28.4 (26.7-31.9) IG2 (sLMP P group) BL: 31.5 (29.8-33.7) 6M: 31.0 (39.6-34.1)	Median (IQR) CG BL: 30.1 (28.4-32.3) 6M: 30.5 (28.7-32.0)	
Chen *et al*.[15]	More adolescents in the intervention group had decreased their waist-to-hip ratio (*P*=0.02)					

SD: Standard deviation, VAS: Visual analog scales, IQR: Interquartile range, CI: Confidence interval, OR: Odds ratio, SE: Standard error, BMI: Body mass index

Teen Choice: Food and Fitness website was effective at aiding adolescents to increase vegetable consumption ($P < 0.05$) and daily physical activity ($P < 0.001$) and decrease sedentary habit after 2 months [Tables 2 and 3]. Doyle *et al*.[18] provided evidence to encourage the possibility of internet-delivered weight control in decreasing overweight in adolescents. Findings of Doyle *et al*.,[18] found that though an Internet-delivered intervention produced a moderate decrease in weight that persisted 4 months subsequent to treatment, eating habits were not considerably corrected [Table 2]. Results of Chen *et al*.,[15] showed noteworthy amendments in waist-to-hip ratio, fruit and vegetable consumption, and physical activity through web-based behavioral program. More adolescents in the intervention group had decreased their waist-to-hip ratio ($P = 0.02$), increased physical activity ($P = 0.01$), increased vegetable and fruit intake ($P = 0.001$), and increased knowledge related to physical activity ($P = 0.008$) and nutrition ($P = 0.001$) as compared to those in the control group [Tables 2-4].[15] An RCT by Abraham *et al*.,[24] involving obese teens receiving care at a pediatric obesity clinic showed the feasibility of internet-based curriculum and found no significant differences in weight between internet plus text intervention, usual care visits plus four nutritional counseling sessions and usual care in an obesity clinic [Table 4]. Results of study by Whittemore *et al*.,[19] indicate that both school-based obesity prevention programs: HEALTH[e] TEEN (include 8 lessons, goal setting, self-monitoring, health coaching, and social networking) and HEALTH[e] TEEN + CST (lessons such as social problem solving, stress reduction, assertive communication, and conflict resolution) are appealing to adolescents and improved adolescents' self-efficacy and health behaviors [Table 3]. The study suggested that internet education has the potential to improve health outcomes in adolescents particularly for minority and low-income populations.[19] Marks *et al*.[16] compared the effectiveness of 2 weeks of exposure to either a web-based physical activity intervention or a matching content delivered in a printed workbook among a sample of adolescent girls and found that both Web and print groups had significant changes in physical activity self-efficacy (Web: $P = 0.01$; Print: $P = 0.002$) and intentions (Web: $P = 0.02$; Print: $P \leq 0.001$. The print group demonstrated significantly greater increases in intentions ($P \leq 0.001$) and self-reported physical activity ($P = 0.002$) as compared with the Web group.[16] Results of Marks *et al*.,[16] found that a printed workbook was more efficacious than a similar website for promoting physical activity intents and habits among a section of middle school girls [Table 3]. Slootmaker *et al*.[20] found that an accelerometer, coupled to a web-based tailored physical activity advice had significant differences in moderate-intensity physical activity among girls ($P = 0.04$) and in sedentary time among boys ($P = 0.04$) [Table 3].

Effect of web-based intervention on sexual activity

Results of Marsch *et al*.,[17] indicate that web-based intervention and person-delivered interventions were equally effective in improving risk-related knowledge, skills, and behavior in terms of increase in condom use, reductions in the number of sex partners and reductions in oral sex [Table 5]. However, the frequency of unprotected sexual activity remained unaltered [Table 5].

Quality of evidence

The quality of evidence was rated as "very low' due to too little information or too few data to be able to reach to any conclusions.

Discussion

This systematic review attempted to synthesize the existing evidence on the effect of exposure to electronic media (such as television, internet, gaming, mobile phones, and radio)

Table 5: Findings from included studies on effect of electronic media on sexual activity

Study ID and country	Outcome	Total no of participants in intervention arm	Total no in control arm	Continuous data	
				Mean of intervention±SD	Mean of control±SD
Marsch *et al*.[17]	Condom Use Self-Efficacy Scale	Pre: 69	Pre: 72	Pre: 3.35/0.51	Pre: 3.26/0.57
		Post: 44	Post: 30	Post: 3.44/0.44	Post: 3.38/0.51
	Condom use skills checklist	Pre: 69	Pre: 72	Pre: 6.08/1.06	Pre: 6.09/1.16
		Post: 44	Post: 30	Post: 6.84/1.15	Post: 6.74/0.90
	Risk behavior survey (overall)	Pre: 69	Pre: 72	Pre: 1.36/1.79	Pre: 1.20/1.41
		Post: 44	Post: 30	Post: 1.07/1.08	Post: 0.81/0.98
	Risk Behavior Survey (unprotected sex)	Pre: 69	Pre: 72	Pre: 2.33/5.44	Pre: 4.31/10.16
		Post: 44	Post: 30	Post: 2.76/6.46	Post: 2.25/4.95
	Behavioral intentions scale	Pre: 69	Pre: 72	Pre: 5.10/0.93	Pre: 4.82/1.04
		Post: 44	Post: 30	Post: 5.12/0.75	Post: 4.96/0.91

SD: Standard deviation

on diet, exercise, and sexual activity. We found fourteen (including one on-going study) studies that met our inclusion criteria. Since included studies varied in settings, intervention (duration, nature, and content), length of follow-up, definitions and measures of outcomes, and methods of outcome assessment, we did not undertake meta-analysis. However, we have explicitly presented details and findings of included studies in tabular format [Tables 1-5].

Small body and diversity of evidence restrict the deductions that we can draw in this review and are insufficient for definitive evidence. We found inadequate evidence about the effectiveness of electronic media in LMIC including India. Limited data from very few included studies in this systematic review confirms the need for further large RCTs with long-term follow-up focusing on the evaluation of the effect of electronic media as well as adverse events associated with it. We look forward to such trials especially from LMIC including India being available for inclusion in future updates of this review.

We identified one recently published Cochrane systematic review by Bala *et al*.,[26] that assessed the effectiveness of mass media interventions in diet, exercise, and sexual activity among adolescents. Similar to our review, the included studies in this review differed in design, settings, duration, content and intensity of intervention, length of follow-up, and methods of evaluation.

The quality of evidence for all our outcomes was very low, as assessed by GRADE criteria. In general, the assessment of the quality of the included studies was limited by deficiencies in terms of quality of methodology and reporting of adequate data to allow reasonable conclusions to be made. This review does not provide a reliable indication of the likely effect.

We have estimated that the potential bias in this review is low. The search was as comprehensive as possible. The evaluation of trials for inclusion was done in pairs. None of the authors of this review was part in any of the included or excluded studies. Furthermore, none have any commercial or any other conflicts of interest in any type of electronic media. We are assertive that we have incorporated all pertinent studies. We have tried to reduce bias in the review process by undertaking data extraction, assessment of RoB and assessment of the quality of evidence in duplicates and resolving discrepancies by a third reviewer. Nevertheless, there is still some likelihood that we may have missed some studies, which have not been published. We undertook the review in line with the recommendations of Cochrane as specified in the Cochrane Handbook for Systematic Reviews of Interventions.[10] The authors of this review are from diverse masteries with varied focuses (e.g., public health, mental health, child health, nutrition, clinical medicine, and biostatistics). We believe this core diversity of know-how to be an asset of this review and made use of it by replicating methods during the complete review process.

Conclusions

There is a small body of evidence that limits conclusions we can draw about the effect of electronic media on diet, exercise, sedentary behavior, and sexual activities. Too little has been done to exploit the strong prosocial aspects of electronic media and to protect children and adolescents from its detrimental effects. There is a need to find methods to improve the role of media among adolescents, taking benefit of their desirable qualities, and minimalizing their undesirable ones. We did not find any studies done in LMICs or studies in Indian setting.

Although the current evidence suggests that electronic media has mixed effects, we provide recommendations for clinicians, policymakers, and educators in partnering with caregivers and youth to support electronic media use that promotes positive outcomes in these areas. There are some vital directions for further research. Research is needed on school/college-based internet obesity prevention programs, dietary program, and sexual health programs of longer duration that include a maintenance component. Evidence from LMICs is warranted to address this issue.

Financial support and sponsorship

This study was supported by the Indian Council of Medical Research.

Conflicts of interest

There are no conflicts of interest.

References

1. Friedman HS, Martin LR, Tucker JS, Criqui MH, Kern ML, Reynolds CA, *et al.* Stability of physical activity across the lifespan. J Health Psychol 2008;13:1092-104.
2. National Kaiser Family Foundation (US) Survey. Forum in Washington, D.C.; 2010. Available from: https://www.kff.org/other/event/generation-m2-media-in-the-lives-of. [Last accessed on 2018 Feb 17].
3. Rice RE. Influences, usage, and outcomes of internet health information searching: Multivariate results from the pew surveys. Int J Med Inform 2006;75:8-28.
4. Ray M, Jat KR. Effect of electronic media on children. Indian Pediatr 2010;47:561-8.
5. Zhao S. Parental education and children's online health information seeking: Beyond the digital divide debate. Soc Sci Med 2009;69:1501-5.
6. Ševčíková A. Two sides of the same coin: Communication technology, media use, and our kids' health. Int J Public Health 2015;60:129-30.
7. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP, Gonder-Frederick LA. A behavior change model for internet interventions. Ann Behav Med 2009;38:18-27.
8. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, *et al.* The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. PLoS Med 2013;10:e1001362.
9. Free C, Phillips G, Watson L, Galli L, Felix L, Edwards P, *et al.* The effectiveness of mobile-health technologies to improve health care service delivery processes: A systematic review and meta-analysis. PLoS Med 2013;10:e1001363.
10. Julian PT, Green HS. Cochrane Handbook for Systematic Reviews of Interventions. Chichester (UK): John Wiley and Sons; 2008.
11. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev 2016;5:210.
12. Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE Handbook for Grading Quality of Evidence and Strength of Recommendations; 2013. Available from: htttp//www.guidelinedevelopment.org/handbook. [Last accessed on 2018 Jan 18].
13. Cameron D, Epton T, Norman P, Sheeran P, Harris PR, Webb TL, *et al.* A theory-based online health behaviour intervention for new university students (U@Uni: LifeGuide): Results from a repeat randomized controlled trial. Trials 2015;16:555.
14. Cullen KW, Thompson D, Boushey C, Konzelmann K, Chen TA. Evaluation of a web-based program promoting healthy eating and physical activity for adolescents: Teen choice: Food and fitness. Health Educ Res 2013;28:704-14.
15. Chen JL, Weiss S, Heyman MB, Cooper B, Lustig RH. The efficacy of the web-based childhood obesity prevention program in chinese american adolescents (Web ABC study). J Adolesc Health 2011;49:148-54.
16. Marks JT, Campbell MK, Ward DS, Ribisl KM, Wildemuth BM, Symons MJ, *et al.* A comparison of web and print media for physical activity promotion among adolescent girls. J Adolesc Health 2006;39:96-104.
17. Marsch LA, Guarino H, Grabinski MJ, Syckes C, Dillingham ET, Xie H, *et al.* Comparative effectiveness of web-based vs. Educator-delivered HIV prevention for adolescent substance users: A Randomized, controlled trial. J Subst Abuse Treat 2015;59:30-7.
18. Doyle AC, Goldschmidt A, Huang C, Winzelberg AJ, Taylor CB, Wilfley DE, *et al.* Reduction of overweight and eating disorder symptoms via the internet in adolescents: A randomized controlled trial. J Adolesc Health 2008;43:172-9.
19. Whittemore R, Jeon S, Grey M. An internet obesity prevention program for adolescents. J Adolesc Health 2013;52:439-47.
20. Slootmaker SM, Chinapaw MJ, Seidell JC, van Mechelen W, Schuit AJ. Accelerometers and internet for physical activity promotion in youth? Feasibility and effectiveness of a minimal intervention [ISRCTN93896459]. Prev Med 2010;51:31-6.
21. Simons M, Brug J, Chinapaw MJ, de Boer M, Seidell J, de Vet E, *et al.* Replacing non-active video gaming by active video gaming to prevent excessive weight gain in adolescents. PLoS One 2015;10:e0126023.
22. Maddison R, Mhurchu CN, Jull A, Prapavessis H, Foley LS, Jiang Y, *et al.* Active video games: The mediating effect of aerobic fitness on body composition. Int J Behav Nutr Phys Act 2012;9:54.
23. Gribbon A, McNeil J, Jay O, Tremblay MS, Chaput JP. Active video games and energy balance in male adolescents: A randomized crossover trial. Am J Clin Nutr 2015;101:1126-34.
24. Abraham AA, Chow WC, So HK, Yip BH, Li AM, Kumta SM, *et al.* Lifestyle intervention using an internet-based curriculum with cell phone reminders for obese Chinese teens: A randomized controlled study. PLoS One 2015;10:e0125673.
25. Chaput JP, Visby T, Nyby S, Klingenberg L, Gregersen NT, Tremblay A, *et al.* Video game playing increases food intake in adolescents: A randomized crossover study. Am J Clin Nutr 2011;93:1196-203.
26. Bala MM, Strzeszynski L, Topor-Madry R, Cahill K. Mass media interventions for smoking cessation in adults. Cochrane Database Syst Rev 2013;6:CD004704.