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

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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 studies 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

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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 (((((((((((adolescence*[Title/Abstract]) OR pre-adolescence*[Title/Abstract]) OR teenage*[Title/Abstract]) OR preadolescence*[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 younger*[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 telephone*[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 I² 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 standards 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.
Interventions
Cameron et al.,[13] Cullen et al.,[14] Doyle et al.,[18] Chen et al.,[15] Abraham et al.,[24] Whitemore 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 Whitemore 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 Whitemore 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

| Study ID          | Number of participants allocated to each group | Participants | Gender distribution (male/female) | Intervention                                                                                      | Type of intervention |
|-------------------|-----------------------------------------------|--------------|-----------------------------------|---------------------------------------------------------------------------------------------------|----------------------|
| Cameron et al.[13] (UK) | Total: n=213                                 | Age mean±SD  | Male/female (%)                   | IG: Repeated sessions of self-affirmation manipulation                      | IG: | Repeated sessions of self-affirmation manipulation |
|                   | IG: n=90                                     | IG: 18.73    | IG: 44.19/55.81                   | CG: Assessment only                                                           | CG: Assessment only  |
|                   | CG: n=123                                    | CG: 18.89    | IG: 45.13/54.87                   |                                                                                   |                      |
| Cullen et al.[14] (UK) | Total: n=390                                  | Mean age     | Male/female (%)                   | IG: 2-10 sessions of an online ‘Teen Choice: Food and Fitness program        | IG: 2-10 sessions of an online ‘Teen Choice: Food and Fitness program |
|                   | IG: n=288                                    | IG           | IG: 47.9/41.32                   |                                                                                   |                      |
|                   | CG: n=102                                    | 12-13 Y: 29.4| CG: 52.1/58.8                    |                                                                                   |                      |
|                   |                                              | 14-15 Y: 38.4|                                                                                   |                                                                                   |                      |
|                   |                                              | 16+Y: 32.22  |                                                                                   |                                                                                   |                      |
|                   |                                              | 2-13 Y: 33.8 |                                                                                   |                                                                                   |                      |
|                   |                                              | 14-15 Y: 42.5|                                                                                   |                                                                                   |                      |
|                   |                                              | 16+ Y: 24    |                                                                                   |                                                                                   |                      |
| Doyle et al.[18] (Chicago) | Total: n=80                                 | Age Mean±SD  | Male/female (%)                   | IG: Adolescent and parents received orientation                             | IG: | Adolescent and parents received orientation |
|                   | IG: n=40                                     | IG: 14.9±1.7 | IG: 35/65                          | to Internet program, a pedometer, and a calorie/fat                            | CG: Assessment only  |
|                   | CG: n=40                                     | CG: 14.1±1.6 | CG: 40/60                          | guide                                                                         |                      |
| Simons et al.[21] (The Netherlands) | Total: n=270                                | Age mean±SD  | Male/female (%)                   | IG: AVGs at least 1 h/week                                                    | IG: | AVGs at least 1 h/week |
|                   | IG: n=140                                    | IG: 13.7±1.3 | IG: 90/10                          |                                                                                   | CG: Assessment only  |
|                   | CG: n=130                                    | CG: 14.1±1.3 | CG: 92/8                           |                                                                                   |                      |
| Chen et al.[13] (UK) | Total: n=54                                  | Age mean±SD  | Male/female (%)                   | IG: Web-based behavioral program                                               | IG: | Web-based behavioral program |
|                   | IG: n=27                                     | IG: 12.52±3.15| IG: 59/41                          |                                                                                   | CG: Assessment only  |
|                   | CG: n=27                                     | CG: 12.35±3.15| CG: 48/52                          |                                                                                   |                      |
| Maddison[22] (New Zealand) | Total: n=322                                | Age 10-14 years | Not reported                      | IG: An AVG                                                                    | IG: | An AVG |
|                   | IG: n=160                                    | Not reported |                                                                                   |                                                                                   | CG: Assessment only  |
|                   | CG: n=162                                    | Not reported |                                                                                   |                                                                                   |                      |
| Chapat et al.[23] (Canada) | Total: n=22                                 | Age mean±SD  | Not reported                      | IG: Video game                                                                 | IG: | Video game |
|                   | IG: n=11                                     | IG: 16.7±1.1 |                                                                                   |                                                                                   | CG: Assessment only  |
|                   | CG: n=11                                     | CG: 15.6±1.1 |                                                                                   |                                                                                   |                      |
| 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)                  | IG: | Playing Xbox 360 and Kinect for Xbox360 |
|                   | IG: n=140                                    | IG: 14.5±1.4 years | Male participants only |                                                                                   | IG1 (IT group): | Usual care plus internet-based curriculum with cell phone calls/texts |
|                   | CG: n=160                                    | CG: 14.5±1.4 years | only | IG1: (IT group): | Usual care plus internet-based curriculum with cell phone calls/texts |
| Abraham et al.[20] (China) | Total: n=48                                 | Age median (years) | Male/female%IG1: 56/44%IG2: 62/38% | IG2 (sLM group): | Usual care visits plus nutritional |
|                   | IG1: n=16                                    | IQR          | IG1: 64/36%IG2: 62/38%            | IG2 (sLM group): | Usual care visits plus nutritional |
|                   | IG 2: n=16                                   | IG 1: 14.9 (13.7-16.2) | CG: 62/38%            | IG2: 60/40% | counseling sessions |
|                   | CG: n=16                                    | IG 2: 14.1 (13.5-15.3) | CG: 62/38%            | IG2: 60/40% | counseling sessions |
| Whittemore et al.[19] (Philadelphia) | Total: n=384                                | Age (%)      | Male/female (%)                   | IG: Health-e-Teen + CST                                                        | IG: | Health-e-Teen + CST |
|                   | IG: n=207                                    | IG: 14-15 (67.2%)  | IG: 37.2/62.8                     |                                                                                   | CG: Assessment only  |
|                   | CG: n=177                                    | CG: 16-17 (32.8%)  | CG: 39/61                          |                                                                                   |                      |
|                   |                                              | 14-15 (70.6%)  |                                                                                   |                                                                                   |                      |
|                   |                                              | 16-17 (29.4%)  |                                                                                   |                                                                                   |                      |
| Marks et al.[16] (USA) | Total: n=319                                | Age mean±SD  | Adolescent girls only             | IG: PA Website                                                                  | IG: | PA Website |
|                   | IG: n=158                                    | IG: 12.2±1.0 |                                                                                   |                                                                                   | CG: Assessment only  |
|                   | CG: n=161                                    | CG: 12.1±0.9 |                                                                                   |                                                                                   |                      |
| Slootmaker et al.[20] (Netherlands) | Total: n=87                                 | Mean±SD age  | Male/female (%)                   | IG: Adolescents were provided with a PAM accelerometer, coupled to a web-based tailored PA | IG: | Adolescents were provided with a PAM |
|                   | IG: n=41                                     | IG: 15.3 (1.1) | 37/63%                           | advice (PAM COACH)                                                             | CG: Assessment only  |
|                   | CG: n=46                                     | CG: 14.8 (1.4) |                                                                                   |                                                                                   |                      |
| Marsch et al.[17] New York | Total: n=141                                | Age mean±SD  | Male/female (%)                   | IG: Web-delivered TES intervention                                             | IG: | Web-delivered TES intervention |
|                   | IG: n=69                                     | IG: 15.85 (1.10)| IG: 78.26/21.74                  |                                                                                   | CG: Assessment only  |
|                   | CG: n=72                                     | CG: 15.76 (1.08)| CG: 76.39/23.61                  |                                                                                   |                      |

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
Gaidhane, et al.: Systematic review on effect of electronic media on diet, exercise, and sexual activity

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) | P             |
|            |                                                                          |                                 |                         |                 |               | Significant increase in food intake (P<0.05) |
| Cameron et al.[13] | Fruit and vegetable intake Portions per day (%) | 495                             | 512                     | BL: 5.61±4.89 | BL: 5.72±4.98 | 0.024         |
|            |                                                                          |                                 |                         | Post: 4.11±1.84 | Post: 3.89±1.97 |               |
| Cullen et al.[14] | Diet-related                                                            | 211                             | 80                      | Mean±SD         | Mean±SD       | 0.001         |
|            | 1. Self-efficacy (availability in past 7 days)                           |                                 |                         |                 |               | Overall effect OR (95%CI): 0.62 (0.40; 0.96) |
|            | 2. Fruit and juice                                                       |                                 |                         |                 |               | Overall effect β (95%CI): −1.07 (−2.66;0.50) |
|            | 3. Vegetables                                                            |                                 |                         |                 |               |               |
|            | 4. Sweetened beverages                                                   |                                 |                         |                 |               |               |
|            | 5. Diet beverages                                                        |                                 |                         |                 |               |               |
|            | 6. Whole milk                                                            |                                 |                         |                 |               |               |
| Doyle et al.[16] | EDE-Q (eating disorder examination-questionnaire)                      | 33                              | 33                      | Mean±SD         | Mean±SD       | 0.001         |
|            |                                                                          |                                 |                         |                 |               | Effect size=0.14 |
|            |                                                                          |                                 |                         |                 | Mean±SD       | P=0.001       |
|            |                                                                          |                                 |                         |                 |               | Effect size=0.18 |
|            |                                                                          |                                 |                         |                 | Mean±SD       | P=0.001       |
| Simons et al.[21] | Consumption of sugar sweetened beverages (% >1400 ml/week) (yes=1; no=0) | 138                             | 124                     | Median (IQR)    | Median (IQR)  | 0.001         |
|            |                                                                          | 10M: 131                        | 10M: 121                |                 |               | Overall effect |
|            |                                                                          |                                 |                         |                 |               | SD: Standard deviation, VAS: Visual analog scales, IQR: Interquartile range, CI: Confidence interval, OR: Odds ratio |
| Chen et al.[23] | Vegetables and fruit, servings per day                                   | 27                              | 27                      | Mean±SD         | Mean±SD       | 0.001         |
|            |                                                                          |                                 |                         |                 |               | Effort size=0.14 |
|            |                                                                          |                                 |                         |                 | Mean±SD       | P=0.001       |
|            |                                                                          |                                 |                         |                 | Mean±SD       | P=0.001       |
|            |                                                                          |                                 |                         |                 | Mean±SD       | P=0.001       |
| Abraham et al.[24] | Dietary Knowledge score (maximum score: 75)                            | IG1: 16                         | IG2: 16                 | Median (IQR)    | Median (IQR)  | 0.001         |
|            |                                                                          |                                 |                         |                 |               | Overall effect |
|            |                                                                          |                                 |                         |                 | Mean±SD       | OR (95%CI): 0.62 (0.40; 0.96) |
|            |                                                                          |                                 |                         |                 | Mean±SD       | Overall effect β (95%CI): −1.07 (−2.66;0.50) |
| Gribbon et al.[25] | 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 |
|            |                                                                          |                                 |                         |                 | Mean±SD       | 0.001         |
|            |                                                                          |                                 |                         |                 | Mean±SD       | 0.001         |
| Chaput et al.[25] | Appetite sensations (VASs)                                               |                                 |                         | No differences all time points between conditions |
|            |                                                                          |                                 |                         |                 | Mean±SD       | 0.001         |
|            |                                                                          |                                 |                         |                 | Mean±SD       | 0.001         |

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].
Gaidhane, et al.: Systematic review on effect of electronic media on diet, exercise, and sexual activity

| Study ID       | Outcome                                                                 | Participants in intervention arm | Participants in control arm | Continuous data | Other comment |
|----------------|--------------------------------------------------------------------------|----------------------------------|----------------------------|-----------------|--------------|
| Cameron et al. | PA (metabolic equivalent of task in percentage)                          | 513                              | 526                        | BL: 3350.52±5144.16 |              |
|                |                                                                          |                                  |                            | Post: 3627.94±2578.97 |              |
|                |                                                                          |                                  |                            | Mean±SD          |              |
| Cullen et al.  | PA-related Self-efficacy                                                 | 211                              | 80                         | BL: 28.22±0.01   | Significant increase in PA (P=0.001) |
|                |                                                                          |                                  |                            | Post: 29.17±0.01  |              |
| Simons et al.  | PA (hours per week)                                                      | BL: 138                          | 10M: 131                   | Median (IQR)     | Overall effect β (95%CI) =−0.12 (−1.04−0.80) |
|                | Fleming PA Computerized Questionnaire                                     | 10M: 124                         |                            | Mean of intervention±SD/SE |              |
| Chen et al.    | Actigraphy (count/min, assessed by actigraphy)                           | 27                               | 27                         | Mean±SD          | Effect size=12.46 (P=0.001) |
|                |                                                                          |                                  |                            | 8M: 674.37±76.52 |              |
|                | PA knowledge (a five-item questionnaire to assess subject’s knowledge about PA) | 27                               | 27                         | Mean±SD          | Effect size=0.16 (P=0.008) |
|                | PA self-efficacy (subscale of the Health Behavior Questionnaire)          | 27                               | 27                         | Mean±SD          |              |
|                |                                                                          |                                  |                            | BL: 2.70±0.78    |              |
|                |                                                                          |                                  |                            | 8M: 3.29±0.82    |              |
| Chaput et al.  | Total energy (kJ)                                                        | 11                               | 11                         | Mean±SD          |              |
|                |                                                                          |                                  |                            | BL: 6493±2223    |              |
| Abraham et al. | PA score (maximum score: 10)                                             | IG1: 16                          | IG2: 16                    | Mean±SD          |              |
|                |                                                                          |                                  |                            | Kj: 605±2368     |              |
| Whittmore et al.| Exercise                                                                | 207                              | 177                        | Mean±SD          |               |
|                | Vigorous (days/week of 20 min)                                           |                                  |                            | BL: 3.4±2.4      | Time Effect (a) |
|                |                                                                          |                                  |                            | 6M: 4.1±2.1      | Intervention ≤0.01 |
|                | Exercise                                                                 | 207                              | 177                        | Mean±SD          |               |
|                | Moderate (days/week of 30 min)                                           |                                  |                            | BL: 3.8±2.4      | Time effect (a) |
|                |                                                                          |                                  |                            | 6M: 4.4±2.1      | Intervention =0.01 |
| Griibbon et al.| Energy expenditure                                                       |                                  |                            | Mean±SD          |               |
| Marks et al.   | PA                                                                       | IG1 (IT Group)                   | IG2 (sLMP Group)           | Mean±SD          |               |
| Slootmaker et al.| Physical activity                                                       |                                  |                            | BL: 4.5 (2.0-4.5)|               |
|                | Sedentary time                                                           |                                  |                            | BL: 6.0 (4.5-7.0)|               |

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. 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., Cullen et al., Doyle et al., Chen et al., Abraham et al., Whittemore et al., Marks et al., and Marsch et al. observed the effect of web-based/internet-based interventions on diet, body weight, body composition, and exercise. A pre-protocol analysis of Cameron et al. 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. 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/m²)              | 160/CG, 162/CG                   | 160/CG, 162/CG              | Treatment effects with mediator variable VO₂, maximum                                |                                                   |
|                    |                          | Mean=SE 0.13±0.11                | Mean=SE 0.43±0.11           |                                                                                      |                                                   |
|                    |                          | Percentage body fat             |                            |                                                                                      |                                                   |
|                    |                          | Mean=SE −0.93±0.32               | Mean=SE −0.52±0.33          |                                                                                      |                                                   |
|                    |                          | Treatment effects with mediator variable VO₂, maximum |                            |                                                                                      |                                                   |
| Abraham et al.[24] | BMI                      | IG1: 16/CG, 16/CG                 | 16                     |                                                                                      |                                                   |
|                    |                          | IG2: 16/CG, 16/CG                 |                           |                                                                                      |                                                   |
| 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 Whitemore 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.[18] 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 ≤ 0.001). The print group demonstrated significantly greater increases in intentions (P ≤ 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)
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 LMICs 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 LMICs including India being available for inclusion in future updates of this review.

We identified one recently published Cochrane systematic review by Bala et al.\(^ \text{[26]} \) 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.\(^ \text{[10]} \) The authors of this review are from diverse specialties 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.
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