

# Internet Use in Relation to Overweight and Obesity: A Systematic Review and Meta-Analysis of Cross-Sectional Studies

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## ABSTRACT

Although several studies have investigated the association between Internet use and odds of overweight and obesity, results are inconsistent. This systematic review and meta-analysis was performed to summarize evidence on the association between Internet use and odds of overweight and obesity. A systematic literature search was conducted in PubMed/Medline, Web of Science, Scopus, and Google Scholar up to February 2019 to identify relevant publications. Finally, 9 cross-sectional studies were considered in this systematic review and meta-analysis. Combining 11 effect sizes from 9 studies, we found a significant, positive association between the highest Internet use, compared to the lowest (ranged from  $\geq 5$  h/d to no use among studies), and odds of overweight and obesity (OR: 1.47; 95% CI: 1.21–1.78;  $I^2$ , 69.6%;  $P < 0.001$ ), such that Internet users had 47% greater odds of being overweight or obese. We also observed a significant, positive association between the highest Internet use, compared to the lowest (ranged from  $\geq 5$  h/d to no use among studies), and overweight/obesity (OR: 1.15; 95% CI: 1.06–1.25;  $I^2$ , 0.0%;  $P = 0.426$ ), obesity (OR: 2.58; 95% CI: 1.88–3.54;  $I^2$ , 0.0%;  $P = 0.637$ ), and overweight (OR: 1.38; 95% CI: 1.16–1.64;  $I^2$ , 13.1%;  $P = 0.330$ ). A linear dose-response meta-analysis revealed that each additional 1 h/d of Internet use was associated with 8% increased odds of overweight and obesity (OR: 1.08; 95% CI: 1.05–1.11;  $I^2$ , 3.8%;  $P = 0.403$ ). Findings of this systematic review and meta-analysis indicated that Internet use was positively associated with increased odds of being overweight and obese. *Adv Nutr* 2020;11:349–356.

**Keywords:** Internet use, Internet addiction, overweight, obesity, body weight

## Introduction

The Internet offers a modern technology for accessing information and a way of communication that has become part of the lives of teens and young people (1). Based on the recent evidence, on 30 June 2018, the number of active Internet users globally was  $>4$  billion (2). Internet use can facilitate many human life activities. Healthy Internet use has been defined as Internet use over a reasonable amount of time to achieve a specific goal (3).

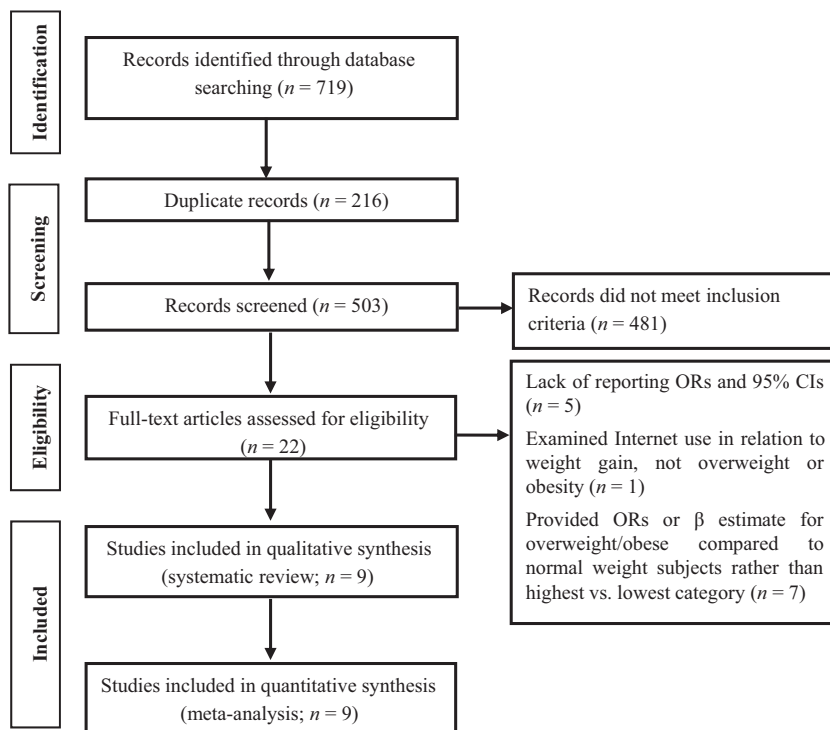
However, inappropriate Internet use can lead to some health problems that disrupt social activity and general health (1). This state may convert to “Internet addiction,” in the sense of moving out of “healthy” use (3). Internet-related problems include a wide range of mental health problems, such as anxiety, depression, stress, and

attention-deficit/hyperactivity disorder (4, 5). Internet use can also be associated with some negative changes in body fat distribution and body weight (5, 6). Based on previous studies on the association between Internet use and body weight, adolescents with Internet addiction disorder are more likely to be overweight or obese (7–10). However, some studies have failed to find any such associations. For instance, Belanger et al. (11) reported no association between Internet use and overweight among girls. In contrast, Peltzer et al. (12) showed that being overweight or obese, and even underweight, was associated with heavy Internet use. There are some reviews on the association between screen time and health-related outcomes (13–17); however, these studies considered screen time mainly in terms of TV viewing, computer use, and video games, and not Internet use particularly. In addition, previous reviews on the association between screen time and obesity did not report any effect sizes. Given the increasing number of Internet users and

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**FIGURE 1** Flowchart of study selection process.

lack of any previous studies summarizing available data on the association between Internet use and odds of overweight and obesity, it therefore seemed reasonable to design a meta-analysis to investigate the relationship between Internet use and body weight.

## Materials and Methods

### Search strategy

We searched for relevant publications published until February 2019 using online databases, including PubMed/Medline, Scopus, Web of Science, and Google Scholar. Keywords used in our search strategy were: (“Internet addiction” OR “Internet dependence” OR “pathologic use of Internet” OR “Internet behavioral addiction” OR “Internet use” OR “Internet abuse” OR “problematic Internet use” OR “pathological Internet use” OR “Internet addictive disorder” OR “Internet overuse” OR “problematic computer use” OR “compulsive Internet use” OR “harmful use of the Internet” OR “Internet dependency”) AND (“weight” OR “obesity” OR “BMI” OR “body mass index” OR “overweight” OR “body weight”). Unpublished studies and gray literature were not included in our review. No time limitations were applied; however, we limited our search to English papers. In addition, a manual search was done on references of included studies to avoid missing any relevant publications.

### Inclusion criteria

Included studies were independently assessed by 2 investigators (MA and SE-K) and publications that fulfilled the following criteria were included in this systematic review

and meta-analysis: 1) original studies that were of an observational design; 2) studies that considered Internet or social networking site use as the exposure variable and overweight or obesity as the main outcome or as 1 of the outcomes; 3) studies that reported ORs and 95% CIs for the associations between Internet use and odds of overweight and obesity.

### Exclusion criteria

We excluded editorials, letters, comments, and ecological studies. Duplicate citations were excluded. Following our search strategy, 719 published articles were identified. After removing 216 duplicates, 503 abstracts were selected for a more detailed review; 481 papers were excluded after screening for title and abstracts. Finally, 22 relevant papers remained for further assessment. Of those, 13 papers were excluded for the following reasons: 5 studies were excluded because they did not report ORs and 95% CIs (18–22), 1 study examined Internet use in relation to weight gain, not overweight or obesity (23), and 7 studies provided ORs or  $\beta$  estimates for overweight/obese subjects compared with normal weight subjects, rather than highest versus lowest category of Internet use (1, 5, 6, 12, 24–26). After these exclusions, 9 cross-sectional studies remained for inclusion in this systematic review and meta-analysis (10, 11, 27–33). **Figure 1** illustrates the study selection process for this systematic review and meta-analysis.

### Data extraction

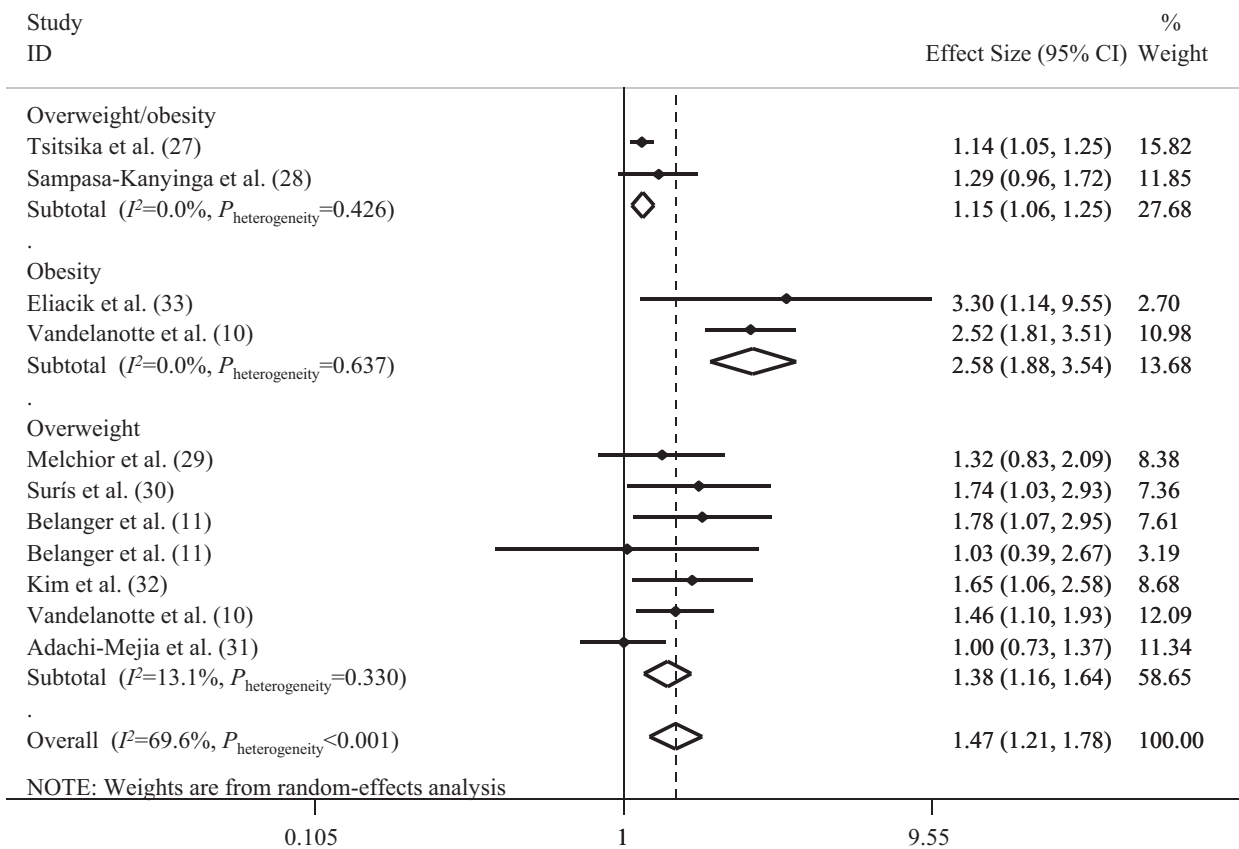
Data were extracted by 2 reviewers (MA and AS-M) and included first author’s last name, country, mean age or

**TABLE 1** Main characteristics of studies examined the association between Internet use and overweight and obesity<sup>1</sup>

Study (ref)	Country	Mean age/age range	Sex	Sample size	Exposure	Exposure assessment	Outcome	Outcome assessment	Comparison	OR (95% CI)
Tsitsika et al. (27)	European countries <sup>2</sup>	15.8 (14–17)	M/F	Total: 10,287; M: 5140; F: 5147	Problematic Internet use/social networking sites	Questionnaire	Overweight/obesity	Self-reported weight and height	≥2 h/d vs. <2 h/d	1.14 (1.05–1.25)
Eliacik et al. (33)	Turkey	(13–18)	M/F	Total: 135; M: 52; F: 83	Internet addiction	Internet addiction scale	Obesity	Self-reported weight and height	≥5 h/d vs. <5 h/d	3.30 (1.14–9.55)
Sampasa-Kanyinga et al. (28)	Canada	15.2	M/F	Total: 9858; M: 4428; F: 5430	Social networking sites	Questionnaire	Overweight/obesity	Self-reported weight and height	≥5 h/d vs. no use	1.29 (0.96–1.72)
Melchior et al. (29)	France	(22–35)	M/F	Total: 674; M: 268; F: 406	Internet use	Questionnaire	Overweight	Self-reported weight and height	>2 h/d vs. ≤2 h/d	1.32 (0.83–2.09)
Suris et al. (30)	Switzerland	14.2	M/F	Total: 3067; M: 1525; F: 1542	Problematic Internet use	Internet addiction test	Overweight	Self-reported weight and height	IAT ≥50 vs. IAT <50	1.74 (1.03–2.93)
Belanger et al. (11)	Switzerland	(16–20)	M	3906	Heavy Internet use	Questionnaire	Overweight	Self-reported weight and height	≥2 h/d vs. <2 h/d	1.78 (1.07–2.95)
Kim et al. (32)	China	(16–20)	F	3305	Heavy Internet use	Questionnaire	Overweight	Self-reported weight and height	≥2 h/d vs. <2 h/d	1.03 (0.39–2.67)
Vandelanotte et al. (10)	Australia	18.9	M/F	Total: 2430	Heavy Internet use	Questionnaire	Overweight	Self-reported weight and height	≥4 h/wk vs. <4 h/wk	1.65 (1.06–2.58)
Adachi-Mejia et al. (31)	USA	(20–65)	M/F	Total: 2532; M: 978; F: 1554	Leisure-time Internet and computer use	Questionnaire	Obesity	Self-reported weight and height	≥3 h/wk vs. no use	2.52 (1.81–3.51)
		(20–65)	M/F	Total: 2532; M: 978; F: 1554	Leisure-time Internet and computer use	Questionnaire	Overweight	Self-reported weight and height	≥3 h/wk vs. no use	1.46 (1.10–1.93)
		(9–12)	M/F	Total: 2343; M: 1174; F: 1169	Internet use	Questionnaire	Overweight	Self-reported weight and height	A few times a week or more vs. no use	1.00 (0.73–1.37)

<sup>1</sup> Age values are means (ranges), IAT, Internet addiction test; ref, reference.

<sup>2</sup> including Germany, Greece, Iceland, the Netherlands, Poland, Romania, and Spain.



**FIGURE 2** Forest plot for the association between Internet use and odds of overweight and obesity.

age range of study participants, sex of participants, sample size, exposure, methods of exposure assessment, outcomes, methods of outcome assessments, comparisons, and ORs with corresponding 95% CIs. Data extraction was done independently and cross-checked by 2 reviewers. Disagreements between the 2 reviewers were solved by consultation with another investigator (MG).

### Quality assessment

The quality of observational studies included in this systematic review and meta-analysis was examined with use of the Newcastle-Ottawa Scale (34). Based on this scale, a maximum score of 9 can be awarded to each study. In the current analysis, we considered studies with quality scores >6 to be high-quality studies.

### Statistical methods

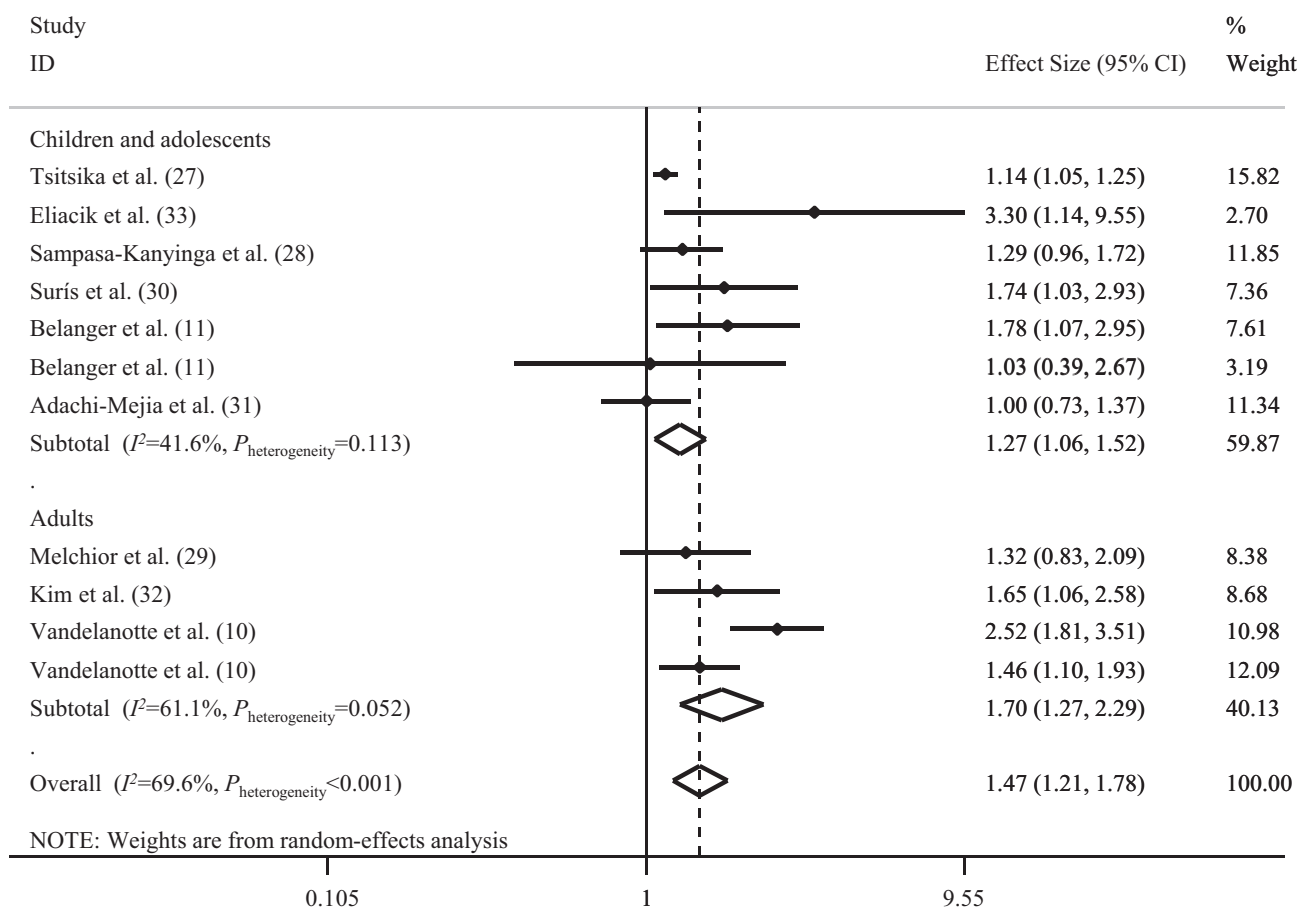
All reported ORs and their 95% CIs for the odds of overweight and obesity were used to calculate the log OR and its SE. We conducted a random-effects model that took between-study heterogeneity into account to calculate the overall summary effect. Between-study heterogeneity was examined using Cochran's Q test and the I-squared test ( $I^2$ ). We also performed a linear dose-response meta-analysis per 1 h/d increment of Internet use with a generalized

least squares trend estimation. A sensitivity analysis was conducted in which each study was excluded to evaluate the influence of that individual study on the overall results. We evaluated any publication bias by a visual inspection of funnel plots. A formal statistical assessment of funnel plot asymmetry was done with use of Egger's regression asymmetry test. Stata version 11.2 (StataCorp) was used for all statistical analysis.  $P$  values < 0.05 were considered statistically significant.

## Results

### Findings from the systematic review

Overall, 9 cross-sectional studies (10, 11, 27–33) were included in this systematic review (Table 1). These studies, including 38,537 participants aged  $\geq 9$  y, were published between 2007 and 2016. There were 2 studies from Switzerland (11, 30); 1 each from Australia (10), Canada (28), France (29), the United States (31), China (32), Turkey (33); and another 1 with data from 7 European countries, including Germany, Greece, Iceland, the Netherlands, Poland, Romania, and Spain (27). There were 6 studies that examined the association between Internet use and overweight (10, 11, 29–32), 2 studies that examined Internet use in relation to obesity (10, 33), and 2 studies that considered Internet use in



**FIGURE 3** Forest plot for the association between Internet use and odds of overweight and obesity based on age group.

relation to overweight/obesity (27, 28). All included studies involved both genders. For exposure assessments, 1 study used the Internet addiction test (30), 1 study used the Internet addiction scale (33), and 7 studies used a questionnaire (10, 11, 27–29, 31, 32). For BMI assessments, all studies used self-reported data.

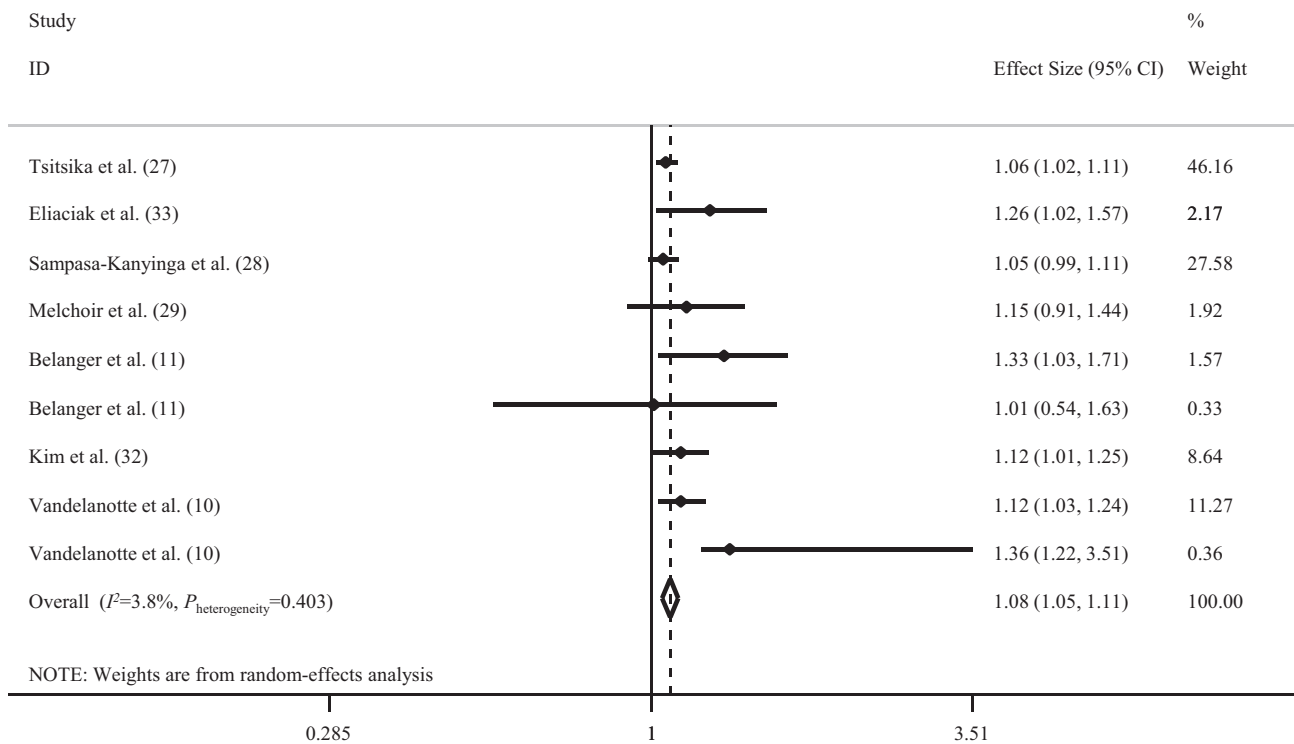
Among studies that examined the association between Internet use and overweight, 3 studies reported a significant, positive association between Internet use and odds of overweight (10, 30, 32); however, 2 other studies showed no significant association (29, 31). In addition, Belanger et al. (11) reported a significant, positive association between Internet use and overweight among boys, but not girls. With regard to obesity, 2 studies reported a significant, positive association between Internet use and odds of obesity (10, 33). There was 1 study that found a significant, direct association between Internet use and overweight/obesity (27); however, another study observed no significant association (28).

### Findings from the meta-analysis

The study of Tsitsika et al. (27) provided ORs separately for problematic Internet use, as well as social networking site use. Therefore, we pooled these 2 ORs and reported the

pooled effect size as the final effect size for that study. In addition, Eliacik et al. (33) conducted cross-sectional and case-control studies. We used the cross-sectional phase data of that article in our analysis. The study of Vandelanotte et al. (10) examined Internet use in relation to both overweight and obesity; therefore, we considered this data as 2 separate studies in our review. This was also done for the study of Belanger et al. (11), which reported ORs separately for men and women. Therefore, we had 11 effect sizes from 9 studies.

Combining 11 effect sizes, we found a significant, positive association between the highest Internet use, compared to the lowest (ranged from  $\geq 5$  h/d to no use among studies), and odds of overweight and obesity (OR: 1.47; 95% CI: 1.21–1.78), such that Internet users had 47% greater odds of being overweight or obese (Figure 2). We found evidence of significant between-study heterogeneity ( $I^2$ , 69.6%;  $P < 0.001$ ). Because of the limited number of studies in each subgroup, we did not perform subgroup analyses to find possible sources of heterogeneity. In a sensitivity analysis, we found that no particular study significantly affected the summary effects. In addition, evidence of a significant publication bias was seen using Egger’s test ( $P = 0.043$ ). We



**FIGURE 4** Linear dose-response meta-analysis for the association between Internet use and odds of overweight and obesity.

also observed a significant, positive association between the highest Internet use, compared to the lowest (ranged from  $\geq 5$  h/d to no use among studies), and overweight/obesity (OR: 1.15; 95% CI: 1.06–1.25;  $I^2$ , 0.0%;  $P = 0.426$ ), obesity (OR: 2.58; 95% CI: 1.88–3.54;  $I^2$ , 0.0%;  $P = 0.637$ ), and overweight (OR: 1.38; 95% CI: 1.16–1.64;  $I^2$ , 13.1%;  $P = 0.330$ ; [Figure 2](#)).

We also conducted an analysis based on age group. There was a significant, positive association between Internet use and overweight and obesity among children and adolescents (OR: 1.27; 95% CI: 1.06–1.52;  $I^2$ , 41.6%;  $P = 0.113$ ), as well as among adults (OR: 1.70; 95% CI: 1.27–2.29;  $I^2$ , 61.1%;  $P = 0.052$ ; [Figure 3](#)).

To conduct a linear dose-response meta-analysis on the association between Internet use and odds of overweight and obesity, 1 study had reported the frequency of Internet use rather than Internet use in h/d ([31](#)) and 1 study had reported Internet addiction scores, not Internet use in h/d ([30](#)). Therefore, we did not include these studies in our dose-response meta-analysis. Therefore, 7 studies were included in the linear dose-response meta-analysis on the association between Internet use and odds of overweight and obesity ([10](#), [11](#), [27–29](#), [32](#), [33](#)). Combining 9 effect sizes from 7 studies, we found that each additional 1 h/d of Internet use was associated with 8% increased odds of overweight and obesity (OR: 1.08; 95% CI: 1.05–1.11;  $I^2$ , 3.8%;  $P = 0.403$ ; [Figure 4](#)).

## Discussion

In this systematic review and meta-analysis, we found a significant, positive association between Internet use and odds of overweight and obesity. We also found a significant linear dose-response relation between Internet use and odds of overweight and obesity. To the best of our knowledge, this is the first systematic review and meta-analysis summarizing available data on the association between Internet use and odds of overweight and obesity.

Internet use is associated with a sedentary lifestyle and, therefore, is a potential risk factor for overweight and obesity ([10](#)). In this study, we found that Internet use was positively associated with odds of overweight and obesity. Our findings are in agreement with previous studies reporting a significant, positive association between Internet use and overweight ([10](#), [30](#)). Belanger et al. ([11](#)) reported a significant association between Internet use and overweight among boys, but not girls. Some studies have indicated a significant relationship between Internet use and obesity ([10](#), [33](#)). However, in some publications, such an association was not observed ([19](#), [29](#)). The contradictory findings from earlier studies might be explained by heterogeneity in study populations, sex of participants, and study designs, as performing the same study but in heterogenous populations, such as in children, adolescents, or adults, can yield basic differences in results. It must be kept in mind that the cutoffs for obesity in children, adolescents, and adults are different



and may conflict the results. In addition, cohort studies are much more powerful and findings from such studies are closer to causality. However, because of a lack of studies, we could not include cohort studies in our review. Given these findings, it seems that heavy Internet use is associated with higher odds of overweight and obesity. However, further studies, especially with prospective designs, are warranted to further elucidate any associations.

The underlying mechanisms through which Internet use may influence body weight are poorly understood. However, possible explanations include inactivity because of heavy Internet use (5, 9, 23); nutritional behaviors, such as skipping meals (especially breakfast) and high snack consumption, because of Internet overuse (12, 28); and psychological disorders, including neuroticism, anxiety, and depression, which can be associated with Internet addiction and can severely affect weight control and eating disorder syndromes (5, 24, 35). However, it seems that further studies clarifying these mechanisms are needed.

Despite being the first systematic review and meta-analysis on the association between Internet use and odds of overweight and obesity, some limitations must be considered. We conducted this meta-analysis on cross-sectional studies. Therefore, it is difficult to make a conclusive determination of the association between Internet use and odds of overweight and obesity. Socioeconomic status is an important factor relating to Internet availability and use. However, it was not possible to conduct an analysis stratified by socioeconomic status, because of a lack of data. Moreover, different definitions were used for overweight and obesity across different age groups. This is inevitable when examining primary publications that mixed all age groups together, which could also have affected our findings. Another limitation is that we did not perform subgroup analyses to find possible sources of heterogeneity, because of the limited number of studies in each subgroup.

In conclusion, the findings of this systematic review and meta-analysis indicate that Internet use is significantly associated with increased odds of overweight and obesity. We also found a significant linear dose-response relation between Internet use and odds of overweight and obesity.

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The authors' responsibilities were as follows—MA: contributed to the conception, design, search, statistical analyses, data interpretation, and manuscript drafting; AM: contributed to the data interpretation and manuscript drafting; MG: contributed to the statistical analyses, data interpretation, and manuscript drafting; AS-M: contributed to the conception, design, search, statistical analyses, data interpretation, and manuscript drafting; SE-K: contributed to the search and manuscript drafting; and all authors: read and approved the final manuscript.

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