

Public Health Implications of Image-Based Social Media: A Systematic Review of Instagram, Pinterest, Tumblr, and Flickr

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ABSTRACT

Introduction: Image-based social media Instagram, Pinterest, Tumblr, and Flickr have become sources of health-related information and tools for health communication. No known systematic review exists that summarizes the existing research and its health implications.

Methods: We searched EBSCOhost Academic Search Complete, PubMed, and Web of Science in January 2016, April 2017, and November 2017, with the following keywords: *Pinterest, Instagram, Tumblr, or Flickr*. Only public health-related, peer-reviewed research articles were included (excluding surveys of self-reported social media use).

Results: Sixty-six research articles were included. All 12 experimental studies used Instagram. Of the 54 observational studies, 38 studied Instagram; 12, Pinterest; 7, Tumblr; and 6, Flickr; some studies investigated more than 1 platform. More than half of the included articles were related to mental health and substance abuse (n = 39, 59%). Other topics included chronic diseases, infectious diseases, surgery, injury prevention, pharmacovigilance, sexual and reproductive health, and adolescent psychology with functional magnetic resonance imaging.

Discussion: Public health-oriented research on Instagram, Pinterest, Tumblr, and Flickr is increasing. Most observational studies investigated questions ranging from public perception of diseases or interventions (vaccination) and undesirable media exposure (“echo chamber,” distorted body image, underage substance use, and pro-suicide messages) to information dissemination and online engagement (likes and comments). A few studies attempted to use image-based social media as intervention tools, but the results were mainly exploratory.

Conclusion: More research is needed to study how social media users discuss health through sharing images online, and how public health professionals can communicate effectively using image-sharing social media.

INTRODUCTION

Images, such as photos, pictograms, and infographics, are powerful tools of health communication^{1,2} because of their potential impact on people’s knowledge, attitudes, and perceptions regarding health-related issues.^{1,3} Health agencies use billboards and photos to promote healthy behavior visually and infographics to present summarized data to the general public.³ Images are important in communicating health-related information to the targeted demographic.¹ Images reduce the complexity of the message while creating an appealing visual for the audience.³

The applications of social media in public health have attracted increasing attention, with relevant systematic reviews published focusing on specific health conditions and interventions⁴⁻⁸ and specific areas of health-related research.^{9,10}

Instagram, Pinterest, Tumblr, and Flickr are examples of social media platforms that emphasize their image-sharing capacities by positioning the image at a prominent location when sharing. (See Sidebar: Origins of Flickr, Tumblr, Pinterest, and Instagram for an overview of the origin of these platforms.) The number of global monthly active users reached 800 million for Instagram and 200 million for Pinterest by 2017.^{11,12} In January 2017, 1.3 billion Tumblr posts were published.¹³ As of March 2019, there were 90 million monthly users of Flickr.¹⁴

However, the role of these image-based social media platforms in health communication and public health remains underexplored. A systematic review is essential to better understand the current literature and guide future directions for researchers interested in developing new tools or instruments to explore health communication using such platforms.

This systematic review provides a descriptive overview by health topic of public health-related research on Instagram, Pinterest, Tumblr, and Flickr. Gaps in the literature are identified for future research. The methods to sample and capture images used among the observational studies are summarized to contribute to developing best practices in social media health-related research. We summarize the research literature up to November 2017.

The scope of this systematic review is a priori limited to Instagram, Pinterest, Tumblr, and Flickr. The 4 chosen platforms are examples that the authors considered as having a major presence of still images and where image sharing is an important, if not the most important, feature of the “platform-specific subculture.” There is a need to summarize health-related research conducted on these platforms. Although each of these platforms shares certain functions with Facebook, Twitter, and YouTube, such as video-sharing functions and allowing users to post text, readers may refer to published systematic reviews on platform-specific health research pertinent to Facebook,^{10,15} Twitter,¹⁶ and YouTube.¹⁷ Also out of scope are instant messenger apps such as WhatsApp (WhatsApp Inc, Menlo Park, CA) and Snapchat (Snap Inc, Venice, CA), and linguocultural-specific platforms

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such as Sina Weibo (Weibo Corporation, Beijing) and WeChat (Tencent Holdings Limited, Shenzhen).

METHODS

The literature search strategy, inclusion and exclusion criteria, and how we assessed the quality of articles were defined a priori. Records were kept for the process for literature search and screening as well as data extraction and quality assessment. We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)¹⁸ recommendations and completed the PRISMA checklist (Appendix A^a).

Figure 1 presents the schematic of our literature search and screening process. We searched EBSCOhost Academic Search Complete, PubMed, and Web of Science with the following

keywords: *Pinterest, Instagram, Tumblr, or Flickr*. For Web of Science, our search was restricted to document types of research articles and clinical trials.

We performed 3 rounds of searches. In January 2016, a total of 861 abstracts were retrieved (batch A). In April 2017, restricting to the 2016 and 2017 literature, we retrieved 591 abstracts (batch B). In November 2017, searching the 2017 literature only, we retrieved 633 abstracts (batch C). After removing duplicates and screening abstracts on the basis of the inclusion and exclusion criteria listed in Table 1, we downloaded the full text of the remaining documents for detailed screening (batch A, 46 articles; batch B, 42; and batch C, 41). Each article was given a unique identifier. After removing duplicates and applying the inclusion and exclusion criteria, 66 articles were

Origins of Flickr, Tumblr, Pinterest, and Instagram

Flickr was a pioneer in online photo sharing when the Web site was founded in 2004 and saw its heyday when Yahoo! bought it in 2005. Flickr evolved and found its niche among photography enthusiasts. It was acquired by SmugMug, a paid photo-sharing service, in 2018.¹²

Tumblr was founded in 2007 as a microblog that allows users to post multimedia and was acquired by Yahoo! in 2016.³ In 2012, Tumblr prohibited self-harm materials, including “pro-ana” contents.⁴ In 2018, Tumblr banned pornographic contents and triggered a debate on the line between pornography and the arts as well as backlash from certain members of the lesbian, gay, bisexual, transgender (LGBT) communities who feared that certain expressions of their identities were being censored.⁵⁻⁷

Pinterest was launched in 2010 as a Web site where users can save an image (known as a “pin”) that they upload or find on a Web page onto their “boards,” which is a collection of these pins. Other users can “re-pin” these images onto their own boards. Pinterest launched its iPhone (Apple, Cupertino, CA) application (app) in 2011, and quickly became one of the major social media sites.⁸

Instagram was launched in 2010 as an iPhone app, through which users upload and share photos.⁹ Instagram became popular for its image filters that enhanced the users’ experience. In 2012, Facebook acquired Instagram for \$1 billion.¹⁰

Understanding the historical context of these platforms is important. Flickr was launched in 2004, at a time when the digital camera became popular, gradually replacing traditional cameras that used film. Flickr served the purpose of providing a free platform through which users might organize digital photos as albums and shared them with family and friends. Tumblr was launched in 2007, a year after Twitter was launched, at a time when the idea of a microblog was getting traction. Whereas Twitter’s characteristic feature was its brief text message of 140 characters, Tumblr was launched as a microblog that features images. The exponential increase of popularity of Instagram and Pinterest when their iPhone apps were launched in 2010 and 2011, respectively, coincided with the rise of the smart phone and the changing habit of photography by the average nonprofessional user. By mid-2010, smart phones (both iOS and Android operating systems) had become very popular. With a camera on every smart phone, the smart phone had become the camera that everyone carried and used daily. Instead of taking photos with digital cameras and then transferring them to a personal computer or laptop for upload, most smart phone users started taking photos with their smart phone cameras and then uploading them directly from the phone. The iPhone apps of Instagram and Pinterest came onto the market at the right moment in the history of technology and became the dominant image-sharing social media in the second decade of the 21st century.

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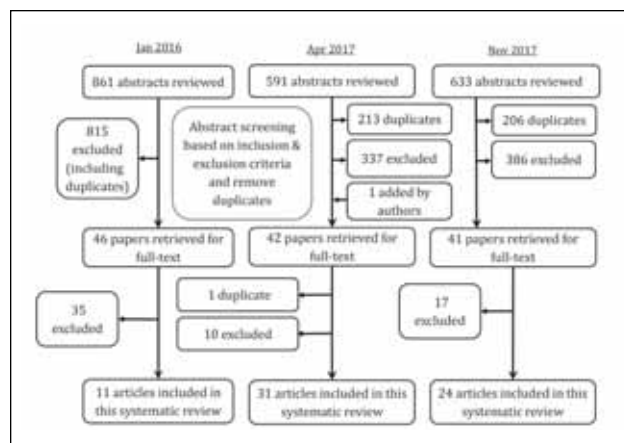


Figure 1. Flowchart of article retrieval process.

included (batch A, 11; batch B, 31; and batch C, 24). For each included article, 2 coauthors extracted the data and assessed the quality of the article independently. In this review, articles are categorized by health topic and study design (observational vs experimental). Extracted data were summarized in Appendix B^a. Articles excluded after full text retrieval were listed with their exclusion reasons in Appendix C^a. Details of data extraction and quality assessment methods are in Appendixes D and E^a.

To assess the quality of the articles, including their risk of bias, we followed the approach of a published systematic review on social media use in chronic diseases.⁶ We applied the Downs and Black Checklist (excluding question 27) for articles in which the authors performed analysis beyond the basic descriptive statistics¹⁹ (eg, regression analyses), and the Critical Appraisal Skills Programme (CASP) qualitative research checklist²⁰ (excluding question 10) for articles in which the authors performed basic descriptive statistics only. High scores indicated high quality. To be conservative in our quality assessment, if there were disagreements between the 2 reviewers regarding the scores, we took the lower scores between the 2 for each section in the Downs and Black Checklist and for the total score in the CASP qualitative research checklist.

Given the inherent limitations in the application of these 2 checklists, especially the Downs and Black Checklist, to the literature of social media content analyses, the corresponding

author (ICHF) decided to design his own checklist and apply it in this review. The new checklist (Appendix E, Table S16)^a is designed for assessing the quality of observational studies of public health image-sharing social media studies and is not applied to experimental (intervention) studies. In the new checklist that the corresponding author created, the reporting of social media data retrieval methods was emphasized (5 questions out of 10): Keyword/hashtag (question [Q] 5), tool/method (Q6), specification/limits set (Q7), date/timeframe (Q8) used to retrieve social media data, and whether the sampling method was representative (probability sampling or full dataset; Q9). This was to ensure that published studies can be repeated at least in theory.

We calculated the Cohen κ (Appendix E)^a for each item in the new checklist using the results of the 2 coders, coding all the observational articles (except the one in Portuguese) for which we used the new checklist.

RESULTS

Fifty-four observational and 12 experimental studies were included (Tables 2 and 3). Among the 54 observational studies, Instagram was studied in 38 articles,²¹⁻⁵⁸ Pinterest in 12,^{22,49,57,59-67} Tumblr in 7,^{31,50,68-72} and Flickr in 6.^{21,24,57,68,73,74} Some covered 2 or more platforms, with combinations of Instagram and Pinterest,^{22,49} Instagram and Tumblr,^{31,50} Instagram and Flickr,^{21,24} and Tumblr and Flickr,⁶⁸ as well as Instagram, Pinterest, and Flickr.⁵⁷ In all 12 experimental studies, only Instagram was used.⁷⁵⁻⁸⁶

Elements of Social Media Covered

Among the 54 observational studies, contents of social media posts were studied in 47 articles, meta-data of social media posts were studied in 28 articles, and users were studied in 24.^b All 3 elements (contents, metadata, users) were studied in 11 articles, 2 of 3 elements were studied in 24 articles, and only 1 element was studied in 18 articles.^c One article reported only frequency of Instagram posts with specific hashtags.³⁴

Sampling and Data Capture Among Observational Studies

Methods of image sampling varied among the observational studies and included the following: 1) attempts to capture all posts that met inclusion criteria; 2) random sampling; a) simple random sample of images, b) random sample of images, stratified by time, c) random sample of images but replacing images

Table 1. Inclusion and exclusion criteria		
Criteria	Inclusion ^a	Exclusion ^b
1	The article is about the public health implications of the use of Instagram, Pinterest, Tumblr, or Flickr, or the use of these platforms as tools for public health interventions or health communication.	The article is not related to the public health implications of the use of Instagram, Pinterest, Tumblr, or Flickr, or the use of these platforms as tools for public health interventions or health communication. The article is not about Instagram, Pinterest, Tumblr, or Flickr (eg, a public health research article presenting Twitter data only).
2	The document is an original research article (including a brief report) published in a peer-reviewed journal.	The article is not an original research article (eg, letters to the editor, perspectives, and reviews).
3	The article contains social media data (including meta-data of the posts or the users).	The article reports only self-reported use of image-sharing social media (eg, from surveys or interviews).

^a Articles were included in this systematic review, if they met all 3 of the criteria.

^b Articles were excluded if they met any of the criteria.

Table 2. Social media platforms and elements of social media posts studied in 54 observational studies reviewed

Parameter	No. of studies
Social media platforms studied ^a	
Instagram	38
Pinterest	12
Tumblr	7
Flickr	6
Elements of social media covered	
Contents of social media posts	47
Meta-data of social media posts	28
Users of social media	24
All 3 elements	11
Two of 3 elements	24
Only 1 element	18
None ^b	1

^a Some observational studies covered more than 1 of these 4 platforms, with combinations of Instagram and Pinterest,^{22,49} Instagram and Tumblr,^{31,50} and Instagram and Flickr,^{21,24} Tumblr and Flickr⁸⁸ as well as Instagram, Pinterest, and Flickr.⁵⁷
^b One article reported only frequency of Instagram posts with specific hashtags.³⁴

from the same users with the next images, and d) random sample of time slots to capture images; and 3) nonrandom sampling methods: a) a convenience sample of posts that shown up first, b) posts in the most popular group, c) posts posted by the most popular users, d) the most recent posts, e) the posts showing up, f) every “fifth” post, and g) a small sample over time. Likewise, methods of data capture varied and included: 1) application programming interface (API; see Sidebar: Glossary), 2) firehose (see Sidebar: Glossary), 3) proprietary platforms, 4) screenshots, and 5) recruiting participants who are willing to share their Instagram photos with the researchers. For details, see Appendix D.⁴

Articles by Health Topics

Table 3 summarizes the 66 included articles by health topic and study design. The categories of mental health,⁴ and substance abuse^{41-51,66,72,82,83} together comprised 39 articles (59%).

Infectious Diseases

Three-quarters of vaccine-related Pinterest images were found to be antivaccine.⁵⁹ Two studies categorized Ebola virus-related images, and 2 were on the Zika virus. Among them, 2 were simple thematic content analysis between platforms.^{21,22} On top of content analysis, 1 categorized sentiment of the images²⁵; another compared between the Instagram images and tweets posted by the Centers for Disease Control and Prevention, the World Health Organization, and Médecins Sans Frontières (Doctors Without Borders) and included engagement analysis (likes and comments).²³

A correlation ($r = 0.798$) was identified between the dengue incidence in Santa Catarina, Brazil, and social media posts originated from the same state that were specific to mentions of dengue, chikungunya, and Zika. Instagram and Flickr were among the platforms monitored.²⁴

Chronic Diseases

Researchers analyzed images related to various chronic diseases: Chronic obstructive pulmonary disease,⁶⁰ chronic pain,⁶⁸ skin cancer,⁶⁷ scoliosis,²⁷ status epilepticus,⁶¹ and young adulthood cancer.²⁸ In a pilot photovoice project for adolescents with type 1 diabetes, the 20 participants found using Instagram a positive experience.²⁶

Three experimental studies explored Instagram as an intervention tool. As part of a larger intervention in a cluster-randomized experimental study, parents of 50 children in the intervention arm were given mobile phones with preconfigured Instagram accounts. Parents were asked to take photos of the food their children consumed and upload them to the Instagram account; only 50% (25/50) complied. Of the 937 images uploaded, 70% were uploaded by the 3 most active participants’ parents.⁷⁵

In another study, participants were exposed to an Instagram image of a black bean veggie burger. The image was experimentally manipulated to have either 105 likes and many positive comments or no likes or comments. Participants were randomly assigned to each group. Individuals with a higher body mass index were found to express a higher behavioral intention to like, share, or comment on the image.⁸⁰

Table 3. Number of included articles by topics and study design (N = 66)^a

Topic	Observational			Experimental			All, no. (%)
	Number	Summary Table	References	Number	Summary Table	References	
Infectious diseases	6	S1	21-25, 59	0	None	None	6 (9)
Chronic diseases	7	S2	26-28, 60, 61, 67, 68	3	S3	74, 76, 79	10 (15)
Mental health (excluding substance abuse)	22	S4	29-40, 48, 50, 62-65, 69-71, 73	4	S5	75, 77, 78, 80	26 (39)
Substance abuse	11	S6	41-47, 49, 51, 66, 72	2	S7	81, 82	13 (20)
Sexual and reproductive health	1	S8	74	1	S9	83	2 (3)
Pharmacovigilance	1	S10	52	0	None	None	1 (2)
Surgery	4	S11	53-56	0	None	None	4 (6)
Injury prevention	2	S12	57, 58	0	None	None	2 (3)
Adolescent psychology with functional magnetic resonance imaging	0	None	None	2	S13	84, 85	2 (3)
Total	54	Not applied	Not applied	12	Not applied	Not applied	66 (100)

^a Details of articles of each category can be found in the supplementary tables listed in Appendix B (available at: www.thepermanentejournal.org/files/2020/18-307-App.pdf).

A third study evaluated Instagram as a channel to encourage adherence to a home exercise program. Participants in the intervention group received reminders and health education materials via Instagram and reported a higher adherence to the home exercise program, compared with the control group.⁷⁷

Mental Health (Excluding Substance Abuse)

This category included studies on body image and healthy eating, depression, self-harm, and psychogenic nonepileptic seizures.

Body Image and Healthy Eating: Thinspiration (pro-anorexia). A study identified 9 categories of anorexic Instagram images.³⁸ Pro-anorexic #thinspiration content was found to be prevalent on Pinterest.⁶² A network analysis of the interaction within and between pro-anorexia and pro-recovery Flickr communities identified an “echo chamber” (see Sidebar: Glossary) effect, with like-minded individuals communicating more frequently with each other.⁷³ Importantly, it was found to be counterproductive for pro-recovery users to post comments to pro-anorexia photos because this would make the pro-anorexia individuals continue posting pro-anorexia photos for a longer time. Similarly, the “echo” chamber effect was identified on Instagram, among both the fat acceptance community and the pro-anorexia community.³³ A study found that there were more pro-ana (see Sidebar: Glossary) posts on Twitter than Tumblr, whereas there were more anti-ana (see Sidebar: Glossary) posts on Tumblr than Twitter.⁷⁰ Another study found that pro-ana Tumblr posts were more likely to be reblogged at a higher rate than anti-ana posts; users generally did not like to repost a post with a noticeable affective tone, but they did so if the post identified someone as having an eating disorder.⁷¹

Body Image and Healthy Eating: Fitspiration (see Sidebar: Glossary). An analysis of 50 #fitspiration Instagram images found that these images replicated and extended the contemporary notion of the ideal female body of slenderness.³⁰ A study found that on Instagram, Tumblr, Facebook, and Twitter, men were featured almost as often as women in #fitspo imagery and men were just as likely to be objectified as women.³¹ Two studies on Instagram identified some degree of objectification in most #fitspo³⁶ and #fitspiration images³⁷; their negative side effects on the viewers’ body image were suggested.³⁷ Fitspiration messages were found to include a comparable amount of “fit praise” and “thin praise”⁶⁴; however, these images may create peer support online.³⁶

Four experimental studies investigated the relationship between Instagram images and women’s body images. In a study, participants who were exposed to fitspiration images reported greater body dissatisfaction and lower state appearance self-esteem than those who were exposed to control stimuli (travel-related images).⁷⁶ In a sequel, researchers found that participants who were exposed to celebrity and peer images experienced increased negative mood and body dissatisfaction relative to those who saw travel-related images, whereas the difference between exposure to celebrity vs peer images was insignificant.⁷⁸ In a third study, comparing with controls who posted travel-related images, participants who posted “fitspiration” images reported higher scores on bulimia, compulsive exercise, drive for thinness, and drive for muscularity, and had a higher proportion at risk of diagnosis of a clinical eating disorder.⁷⁹ In a 3-group

comparison study, relative to the control group of neutral images, participants who viewed “fitspiration” images reported poorer self-compassion, whereas participants exposed to self-compassion quotes reported greater body satisfaction, body appreciation, self-compassion, and reduced negative mood.⁸¹ Interestingly, exposure to a combination of “fitspiration” images and self-compassion quotes showed a more positive outcome than those who were exposed to fitspiration images.⁸¹

Body Image and Healthy Eating: Fatspiration (see Sidebar: Glossary). Images with hashtags #fatspiration or #fatspo were found to more often endorse the theme of fat acceptance than those with hashtags #healthateverysize or #haes. Overall, images with these hashtags often displayed the whole body rather than just the face.⁴⁰ A study noted that the fat acceptance community is also an echo chamber.³³

Body Image and Healthy Eating: Healthy Eating. A study on Scandinavians who had turned 14 years old found that food images were prevalent on their accounts and that it was difficult to monitor adolescents’ exposure to marketing of unhealthy food.³² Infographics about nutrition and healthy eating on Pinterest were found to contain few health behavior theory constructs; recommendations were made for more health behavior theory elements to be included therein to influence healthy eating behaviors.⁶⁵ A study characterizing Instagram #cheatmeal images found that

Glossary

Age gate: A Web page or an interface that requires the user to verify positively that s/he is of a certain age or older. This is to prevent underage individuals from gaining access to online materials that they should otherwise not access.

Anti-ana: Discouragement of anorexic behaviors. This is the opposite of *pro-ana*.

Application programming interface (API): A set of computer codes that allows communication between computers and/or servers. Developers use API to automate the retrieval of social media data from the platforms. However, most social media companies set limits to the amount of data that developers can freely retrieve.

Echo chamber: The phenomenon that social media users interact with other users who share their own viewpoints (eg, regarding politics) and avoid individuals with whom they disagree. These networks of individuals reinforce each other’s views.

Fatspiration: A combination of the words *fat* and *inspiration*. This is also known as “fatspo.” This term is used by the community who encourages “fat acceptance” (being happy with the fact that individuals are overweight), and this is the opposite of “fitspiration.”

Firehose: A firehose API allows developers who pay for the service to download a large volume of social media data from social media platforms that go beyond the free limit set by social media companies for free API download.

Fitspiration: A combination of the words *fit* and *inspiration*. This is also known as “fitspo.” This term is used by the community that promotes a slender body shape, but not anorexic.

Pro-ana: Promotion of anorexia nervosa. This is also known as “ana.”

Thinspiration: A combination of the words *thin* and *inspiration*. This term is used by the pro-anorexic community.

cheat meals were shown as a goal-oriented dietary practice in pursuit of physique-ideals.³⁵

Depression. Depression-focused Pinterest images were found to attract more attention (re-pins, likes, and comments), and half of those images expressed perception of depression as a severe disorder.⁶³ In a study in which 2 groups of participants, with and without depression, provided consent to the researchers for a 1-time download of all their Instagram images from their accounts, prediction models based on computational features of the images actually made a good prediction if the image was uploaded by someone with depression.³⁹ Human ratings of photo attributes being “happy” or “sad” also distinguished depressed participants from healthy participants.³⁹ Nevertheless, the computational features and human ratings did not correlate.³⁹

Self-Harm. Images pertinent to depression, suicide, or self-harm were found to be prevalent on Tumblr.⁶⁹ Nonsuicidal self-injury content was found by another study to be popular on Instagram.²⁹ A study on Instagram images with German-language hashtags for nonsuicidal self-injury content found that 8.8% of such images directly depicted wounds, and such images generated around twice as many comments than images that did not directly depict wounds.⁴⁸

Psychogenic Nonepileptic Seizures (PNES). A study found that among PNES hashtags on Instagram, #nead (n = 4331) was the most common, but only one-fourth were related to nonepileptic attack disorder; of #pnes images (n = 1273), three-fourths were related to PNES.³⁴

Substance Abuse

This category included alcohol, tobacco, and marijuana and other restricted substances.

Alcohol. Using fictitious Instagram user profiles, a study found that the “age gate” (see Sidebar: Glossary) was not employed on Instagram, and therefore all profiles on Instagram, regardless of age, could be exposed to alcohol industry advertisements.⁴¹ In a survey, researchers created vignettes that described situations in which college students might post images related to alcohol consumption and developed photo stimuli associated with those vignettes. They asked participants to tell whether such photos are more likely to be seen on Facebook, Instagram, or Snapchat. Instagram was found to be the most probable platform for images depicting alcohol use as attractive and glamorous.⁸²

Tobacco. Waterpipe-related images were prevalent on Pinterest, Instagram, and Tumblr,^{42,66,72} portraying waterpipe smoking positively⁶⁶ and becoming part of advertisement campaigns by bars, restaurants, and nightclubs.⁴² Policy exemptions were recommended to be removed so that waterpipe use cannot be used as part of commercial advertisement for nightlife businesses.⁴² Men were found to post waterpipe-related images more frequently than women did.⁷²

Likewise, e-cigarette commercial advertisements are common on Instagram and Pinterest,^{44,45,49} where users characterized e-cigarettes as novel devices rather than equivalent to traditional cigarettes.⁴⁵ Activity and product-themed images had more likes than advertisements or text-themed images.⁴⁴ Customization of e-cigarettes were found among 38% of e-cigarette images on Instagram and in 64% of e-cigarette Pinterest images.⁴⁹ In an

experimental study, e-cigarette Instagram pages featuring celebrities were found to significantly increase positive attitudes toward e-cigarettes and smoking intentions, compared with those featuring noncelebrities and “products only.”⁸³ Celebrities were rated by participants with a higher trustworthiness, expertise, goodwill, and attractiveness compared with noncelebrities.⁸³

A study on Swisher little cigar- and cigarillo-related posts found that one-fourth of the images coded by the authors were also marijuana-related.⁴⁶

Marijuana and Other Restricted Substances. Marijuana images were found to be common on Instagram, including explicit marketing of marijuana that might have the potential to influence social norms surrounding marijuana.⁴³ Researchers analyzed 2249 Instagram followers of Weedmaps, a Web site for marijuana retail; of these users, 63% were male; 61% were white; 19% were black; 20% were Hispanic; 51% were Californians; and 45% were 20 to 24 years old.⁴⁷

A new approach was developed to automate the detection of drug abuse and drug dealing through using multimodal data on social media.⁵¹ Image and text classifiers were applied to identify drug-related posts from a sample of potential drug-related posts; drug-related accounts were identified through drug-related posts. Accounts were determined if they belonged to drug dealers through timeline data. The positive predictive value (precision) and sensitivity (recall) of this new method were 83% and 68%, respectively.⁵¹

Sexual and Reproductive Health

Researchers analyzed 40 Flickr images of birthing rooms and found that the technologic birthing room was most dominant, with a focus on medical equipment and the labor bed.⁷⁴ Another study manipulated Instagram images with messages about correct and consistent condom use and randomly assigned participants to 1 of 4 groups, in which health information was 1) placed only in the caption, 2) split between the image and the caption, 3) embedded solely in the image, and 4) absent from both the image and the caption. Embedding the message in the image was perceived most effective by the participants.⁸⁴

Pharmacovigilance

Researchers examined the effectiveness of using Instagram for surveillance of drug-drug interactions and adverse drug reactions, using dictionaries on drugs, symptoms, and natural products, and focusing on drugs popular for treating depression.⁵² They used the dictionary-based method to categorize Instagram images under different themes, on the basis of the text associated with the images.⁵² They used Instagram to perform a population-level behavior analysis of users, using drug, symptom, and natural product dictionaries to tag timelines that discussed common antidepressant drugs.⁵²

Surgery

Three descriptive studies of Instagram images related to anterior cruciate ligament surgery,⁵³ cellular therapy for musculoskeletal conditions,⁵⁵ and total joint arthroplasty⁵⁶ identified the prevalence of personal recovery stories,⁵³ advertisements,⁵⁵ and tone-positive, postoperative, patient-generated images.⁵⁶

Injury Prevention

Researchers analyzed 176 concussion-related Instagram, Pinterest, and Flickr images, of which 91% reflected the Sports

Concussion Assessment Tool 3 guidelines.⁵⁷ In an educational campaign to increase adolescent seatbelt use, images with celebrities wearing seat belts were most liked, whereas postings made at the high school health fair were least liked.⁵⁸

Adolescent Psychology

Two studies found that Instagram images with more likes were more apt to be liked by adolescents⁸⁵ and college students⁸⁶ than those with fewer likes.

Quality Assessment

Twenty articles were evaluated using the Downs and Black checklist¹⁹ (excluding question 27; maximum possible score of 26), with an average score of 10.65 (standard deviation = 4.37; first quartile = 7.5; median = 11; third quartile = 12.25; range = 4-22). Forty-six articles were evaluated using the CASP checklist²⁰ (excluding question 10; maximum possible score of 9), with an average score of 7.83 (standard deviation = 0.76; first quartile = 7; median = 8; third quartile = 8; range = 5-9). Fifty-four observational studies were evaluated using the new quality assessment tool (maximum possible score of 10), with an average score of 6.05 (standard deviation = 1.66; first quartile = 5; median = 6; third quartile = 8; range = 1-9). For all 3 checklists, a high score reflects a high quality. See Appendix E^a for details.

For data pertinent to the ethics statement and funding statements of the reviewed study, see Tables 4 and 5 and Appendix D.^a

Table 4. Summary of results on ethics, funding of articles reviewed		
Parameter	Denominator	Number (%)
Ethics		
Mentioned obtaining approval or exemption from institutional review board or equivalent	66 included articles	28 (42)
Explicitly mentioned participants' written consent ^a	12 experimental studies	6 (50)
Funding ^b		
Reported that their project was funded by specific sources	66 included articles	28 (42)

^a In addition, 1 observational Photovoice project with human participants mentioned institutional review board approval and participants' consent.²⁶

^b See Table S14 in Appendix B for details and see Appendix D for discussion (available at: www.thepermanentejournal.org/files/2020/18-307-App.pdf).

Table 5. Summary of results on quality assessment of articles reviewed		
Quality assessment	No. of articles assessed	Range of scores (maximum score possible)
Scores received using Downs and Black Checklist ^{a,19}	20	4-22 (26)
Scores received using CASP Checklist ^{b,20}	46	5-9 (9)
Scores received using the new checklist for observational studies of image-sharing social media	54	1-9 (10)

^a Question 27 excluded.

^b Question 10 excluded.

CASP = Critical Appraisal Skills Programme.

DISCUSSION

This systematic review analyzed 66 articles pertinent to the public health applications of Instagram, Pinterest, Tumblr, and Flickr. Instagram was the most studied among the 4 platforms. Mental health and substance abuse were the most studied public health areas among the articles reviewed. Although image-based social media are considered as effective visual communication tools to reach out, concerns have been raised about lack of information diversity in “echo chamber” and exposure to undesirable information (eg, self-harm). For example, the evidence accumulated draws our attention to the effect on teenagers and young adults' body images given the peer comparison in social media when one is exposed to distorted images of peers and celebrities.

The experimental studies reviewed were exploratory in nature. It will take more studies to elucidate the causal relationship between exposures and outcomes, and to identify interventions that work.

Most content analysis studies applied manual categorization of images. A few applied machine learning methods, including Reece and Danforth.³⁹ These researchers recruited 2 groups of participants who were different in their externally verified clinical status (eg, depression), and they applied both machine learning and manual coding to compare the participants' social media images.³⁹

Sampling remains a challenge for content analysis of these platforms. Recent restrictions on API access to Instagram,⁸⁷ among others, significantly limit how researchers can download and sample images therein. Notwithstanding privacy concerns, restricted API access is a serious yet underreported collateral damage of the 2018 Cambridge Analytica incident that affected social media research.⁸⁸ (Facebook reported that the Facebook information of up to 87 million people may have been improperly shared with Cambridge Analytica, a data analysis company in London, UK.⁸⁹) Importantly, this means that some of the research reviewed here may not be replicable, especially those that downloaded all posts pertinent to a search term and then performed a random sampling. If the research goal is to estimate the prevalence of pieces of (mis)information on a platform, then random sampling of time slots in which a small number of images were captured may offer a solution. An alternative approach is to randomly sample users who posted images pertinent to a search term. For example, among users who posted images pertinent to disease X, how many of them posted misinformation? Given the skewed distribution of number of images posted per user, this would not bias the sample toward the images posted by a tiny group of highly active users. Randomly sampling users ascertains a well-defined sampling frame,⁹⁰ and is thus methodologically better than the practice of randomly sampling images and then replacing images from the same users with the next images by users otherwise not selected.

Social media platforms evolve constantly. For example, as of April 2019, Instagram was reported to pilot-test among some users the hiding of the total number of likes an image received in response to concerns about damage done to users' mental health and well-being.⁹¹ This echoes research reviewed here that showed that teenagers and young adults were more likely to like an image if others like it.^{85,86}

Future Directions

How and to what extent can image-based social media strengthen the efficacy of health promotion strategies and enable outreach to subpopulations who are less exposed to traditional means of health messaging are important questions to be addressed. To address these concerns, we highlight the following research directions that may fill the gaps in public health research pertinent to Instagram, Pinterest, Tumblr, and Flickr:

1. Research into health topics underrepresented in the reviewed literature (eg, many different infectious diseases other than those covered) is warranted.
2. An experimental study design will help demonstrate causal relationships that observational studies cannot.
3. Methodologic research into how data sampling and retrieval methods affect observational studies' results will help reach a consensus to promote best practice.
4. Image-based machine learning may help streamline content analysis, but this has to be tested and validated in the context of public health research.
5. Obtaining social media posts along with demographic and clinical data from consenting participants will provide new research opportunities. However, the possible bias or general representativeness of willing participants who share social media posts with researchers remains a concern.

Limitations

This systematic review contains several limitations. We limited its scope to 4 social media platforms only to maintain a sharp focus. We acknowledge that there are other social media platforms that also possess image-sharing capacities. We could not include articles published after our third literature search in November 2017; this arbitrary cut-off point was largely a pragmatic logistical decision given the availability of student coauthors to work on this review during an academic year. Articles written in Spanish or Portuguese were reviewed by EBB only given the linguistic barriers of other coauthors. Although acknowledging the potential relevance of other types of published studies (eg, conference proceedings or letters to the editor), we included only peer-reviewed articles to ensure the quality of the data. No meta-analysis was performed because of the heterogeneity of the articles' content (outcome measures, research questions, etc). We chose the Downs and Black checklist¹⁹ (excluding question 27) and CASP qualitative research checklist²⁰ (excluding question 10) following the example of a published systematic review on social media use in chronic diseases⁶; other researchers might choose to use other checklists. Acknowledging the inherent limitations of the 2 checklists, we developed and tested a new checklist for a more accurate assessment of the quality of observational, social media-based public health research. Notwithstanding its limitations, our checklist in development can be improved for future studies.

CONCLUSION

We reviewed 66 public health research articles that analyzed 1 or more image-sharing social media sites, including Instagram, Pinterest, Tumblr, and Flickr. Of these 66 articles, 59% covered

mental health or substance abuse. Data retrieval and sampling methods varied greatly across studies. Gaps remain in understanding how social media users communicate about health-related issues on these image-sharing social media sites. How health care and public health professionals can communicate effectively on such sites deserves further research. ❖

^a Available from: www.thepermanentejournal.org/files/2020/18-307-App.pdf.

^b Contents of social media posts were studied in references 21-23, 25-33, 35-38, 40, 42-46, 48-57, 59-72, and 74; meta-data of social media posts were studied in references 23-25, 27-29, 33, 38, 39, 41, 42, 44-46, 48, 54, 55, 58-60, 62-64, 65, 67, 69, 70, and 73; and "users" were studied in references 23, 28, 31-33, 36, 38, 39, 43, 45, 47, 48, 51, 52, 54, 56, 59, 61, 66, and 69-73.

^c All 3 elements were studied in references 23, 28, 33, 38, 45, 48, 54, 59, 66, 69, and 70, and 2 of 3 elements were studied in references 25, 27, 29, 31, 32, 36, 39, 42-44, 46, 51, 52, 55, 56, 60-64, 67, and 71-73. Only 1 element was studied in references 21, 22, 24, 26, 30, 35, 37, 40, 41, 47, 49, 50, 53, 57, 58, 65, 68, and 74.

^d Mental health was covered in references 29-40, 48, 50, 62-65, 69-71, 73, 76, 78, 79, and 81.

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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Kathleen Loudon, ELS, of Loudon Health Communications performed a primary copy edit.

Authors' Contributions

Isaac Chun-Hai Fung, PhD, conceived the research idea, oversaw the entire project, and wrote the first draft of the current version of the manuscript. Elizabeth B Blankenship, MPH, was heavily involved in the writing of the manuscript, before the second and third rounds of literature search. The study was codesigned by Isaac Chun-Hai Fung, PhD, and Elizabeth B Blankenship, MPH. Literature search was performed by Elizabeth B Blankenship, MPH (1st round), and Isaac Chun-Hai Fung, PhD (2nd and 3rd rounds). Literature screening was performed by Elizabeth B Blankenship, MPH, and Isaac Chun-Hai Fung, PhD, in the first and second rounds, and by Isaac Chun-Hai Fung, PhD; Jennifer O Ahweyevu, MPH; Lacey K Cooper, MPH; and Emily A Duncan, MPH, in the third round. For the first round of literature review, Carmen H Duke, MPH, trained Elizabeth B Blankenship, MPH, on the methods of conducting a systematic review. Carmen H Duke, MPH, and Elizabeth B Blankenship, MPH, provided data extraction and quality assessment training to Stacy L Carswell, MPH; Ashley M Jackson, MPH; and Jimmy C Jenkins III, MPH, under Isaac Chun-Hai Fung, PhD's supervision. Elizabeth B Blankenship, MPH, coordinated the review process. Elizabeth B Blankenship, MPH; Stacy L Carswell, MPH; Ashley M Jackson, MPH; and Jimmy C Jenkins III, MPH, screened the papers for inclusion or exclusion, extracted data, and assessed the quality of the included studies. Carmen H Duke, MPH, was the adjudicator if there were disagreements over data extraction. In the second and third rounds of literature review, Isaac Chun-Hai Fung, PhD, trained Jennifer O Ahweyevu, MPH; Lacey K Cooper, MPH; and Emily A Duncan, MPH, in data extraction and quality assessment. Data extraction was performed by Isaac Chun-Hai Fung, PhD; Jennifer O Ahweyevu, MPH; Lacey K Cooper, MPH; and Emily A Duncan, MPH. Quality assessment was performed by Jennifer O Ahweyevu, MPH, and Lacey K Cooper, MPH. Isaac Chun-Hai Fung, PhD, was the adjudicator if there were disagreements over data extraction. Isaac Chun-Hai Fung, PhD, and Jennifer O Ahweyevu, MPH, summarized the data and created the tables. Hai Liang, PhD; King-Wa Fu, PhD; and Zion Tsz Ho Tse, PhD, provided Isaac Chun-Hai Fung, PhD, and Elizabeth B Blankenship, MPH, with intellectual inputs and helped edit the paper. Isaac Chun-Hai Fung, PhD, and Elizabeth B Blankenship,

MPH, serve as co-first authors. Jennifer O Ahweyevu, MPH, and Lacey K Cooper, MPH, serve as co-second authors. Isaac Chun-Hai Fung, PhD, is the corresponding author of the paper and revised the manuscript after peer review.

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APPENDIX A – PRISMA 2009 Checklist

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

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	n/a
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6; Fig 1; Appendices B & C
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6-16; Tables 2-4; Appendices B & D
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendices D & E
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-16; Tables 2-4; Appendices B & D
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16-19
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-20
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

APPENDIX B

Public Health Implications of Image-based Social Media: A Systematic Review of Instagram, Pinterest, Tumblr and Flickr
Appendix B. Tables of extracted data from included studies

Table S1. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to Infectious diseases

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e-g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
A9. Guidry et al. (2015) ¹	Pinterest	800 images	How are vaccinations portrayed on Pinterest? How do Pinterest users engage with vaccination content on the platform? How are health belief model constructs represented in vaccination-focused Pinterest pins? To what extent do vaccination-related Pinterest pins mention issues related to conspiracy theories and civil liberties?	"vaccine" "vaccines" "vaccinate" "vaccination"	Analyzed 800 pins for content related to vaccines.	Analyzed original pins vs. re-pins.	Analyzed user's identity (individual, organization, etc.)	Majority of pins portrayed vaccines in a negative light (anti-vaccine). Pro-vaccine pins featured more statistical information and anti-vaccine pins featured more narrative information.
A21. Seltzer et al. (2015) ²	Instagram and Flickr	1217 images (Instagram, n= 609 images; Flickr, n=608 images)	To evaluate public images from Flickr and Instagram to characterize content related to Ebola, and to compare the differences between the two platforms	#ebola	Analyzed 1217 images for content and sorted into themes related to Ebola.	--	--	Popular visual and social media platforms are frequently used for information exchange about Ebola; Instagram images were often jokes, while Flickr images were more serious and literal. Nine distinct themes were identified.
B16. Fung et al. (2016) ³	Instagram and Pinterest	1232 images (Instagram, n=616 images; Pinterest, n=616 images)	To assess the differences between Pinterest and Instagram in relaying photographic information about Zika virus; Investigated whether the percentage of Zika-virus-related photos with Spanish or Portuguese text embedded on the photo was higher for Instagram	"zika " "virus" "#zikaavirus"	Analyzed 1232 images for content and relevancy, and if relevant they were sorted into themes related to Zika, manually coded for whether the	--	--	Photos with words embedded were prevalent in all 144 relevant Instagram photos. Photos with Spanish or Portuguese words embedded were more prevalent on Instagram than on Pinterest. There were

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<p>C13. Guidry et al. (2017)⁴</p>	<p>Instagram and Twitter</p>	<p>All (N=107) Instagram posts by the CDC, WHO and MSF. 779 tweets randomly selected from a larger sample (unknown N) from @CDCgov, @WHO, @MSF.</p>	<p>than Pinterest.</p> <p>1) How did three leading health-focuses organizations (CDC, WHO, MSF) communicate about Ebola using Twitter and Instagram, respectively? 2) How did publics respond to Twitter and Instagram posts about Ebola by leading health-focused organizations? 3) What are the differences, if any, between Ebola-focused posts by leading health-focused organizations on Twitter versus Instagram? 4) To what extent do Ebola-focuses tweets and Instagram posts contain risk perception variables? 5) How do publics respond to tweets and Instagram posts about Ebola and risk perception factors?</p>	<p>Search term (hashtags): #Ebola; #EbolaOutbreak</p>	<p>image had embedded words or not.</p> <p>Presence of Ebola-related variables, presence of risk perception variables</p>	<p>Engagement (likes, comments)</p>	<p>The 3 organizations (CDC, WHO and MSF who posted the posts)</p>	<p>more Zika-virus-related photos relating to prevention, pregnancy and Zika-associated deaths on Instagram compared to Pinterest.</p> <p>On Instagram, there were more Ebola and risk perceptions variables: Instagram posts were significantly more likely than tweets to contain survivor stories, tips for dealing with Ebola, and information about Ebola prevention, crisis response measures, the contagious nature of Ebola and the deadly nature of Ebola, while tweets were more likely than Instagram to contain information about a potential Ebola vaccine. Compared with Instagram, tweets had lower odds of containing a risk perception variable (OR=0.177, p<0.001). MSF had higher engagement than both WHO and CDC on Instagram; while CDC and WHO surpassed MSF regarding Twitter engagement.</p>
<p>C17. Klein et al.</p>	<p>Instagram and</p>	<p>1,993 messages</p>	<p>To analyze the relations between rumors in networks</p>	<p>Terms searched:</p>	<p>--</p>	<p>Utilized self-reported</p>	<p>--</p>	<p>In epidemiology, the monitoring of big data</p>

(2017)⁵	Flickr	(Twitter, 71.45%; Facebook, 26.29%; Instagram, 1.81%; News, 0.30%; Blogs, 0.10%; YouTube, 0.05%)	and data collected by the Board of Epidemiological Surveillance of Santa Catarina	#dengue associated with “chikungunya”, “zika”, “aedes aegypti”, “microcephaly”, “the dengue mosquito”, “mosquito”, “fever”, “virus”.		geolocation of users to limit study to Santa Catarina area.		can be a good predictive model of outbreaks or epidemics in a locality.
C32. Seltzer et al. (2017)⁶	Instagram	500 posts	To discover if Instagram could be used as a surveillance tool for tracking sentiment during the Zika virus public health emergency	#zika	Each image was assessed by topic first; sentiment, image type, Zika content, audience, geography and reliability.	Engagement (likes)	--	Instagram can be used to assess public understanding. No posts contained completely wrong data; fear was the greatest sentiment; identified lots of misinformation.

Table S2. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to chronic diseases

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
A23. Yi-Frazier et al. (2015) ⁷	Instagram	20 participants	The aim of the study was to test the feasibility of using Photovoice techniques through Instagram in a high risk group of youth, adolescents with type 1 diabetes, and to explore the types of photos shared in this setting.	#diabetesteenproject	Analyzed #diabetesteenproject (posted by participants) for content by sorting into themes/topics.	--	--	Engaged participants universally reported the project to be a positive experience.
A42. Paige et al. (2015) ⁸	Pinterest	514 images	How Pinterest users communicate and share health information on COPD? What categories of COPD information are presented on Pinterest COPD group pinboards? Which embedded visual communication tools are presented on Pinterest COPD group pinboards? Do embedded visual communication tools presented on Pinterest COPD group pinboards vary by categories of COPD information? Do engagement metrics of pins presenting COPD self-management information vary based on embedded visual communication tool? Does the presentation of self-efficacy information on pins presented on Pinterest COPD group pinboards vary by category of COPD information?	Chronic obstructive pulmonary disease (COPD)	Analyzed images related to COPD and sorted into themes/topics.	Analyzed number of likes and re-pins ("level of engagement").	--	Half of the pins included COPD self-management information; photographs of real people included more women than men, more patients than providers, and more self-management information than general COPD information. Infographics were re-pinned and photographs of real people were liked more than other visual communication tools. Pinterest may be a useful social networking website for COPD patient education aimed at women living with or at high risk for COPD.
B17.	Flickr,	133 images	To analyze chronic pain	chronic pain,	Analyzed the	--	--	The narratives on Flickr

Gonzalez-Polledo et al. (2016) ⁹	Tumblr	and 110 posts	narratives on Flickr and Tumblr	pain, hurt, specific ailments like 'migraine', 'arthritis', and 'fibromyalgia'	narrative of chronic pain related images and blogs		emphasize immediacy, mark chronicity, make the pain experience visible and elicit empathy. Tumblr dissolves the narratives into more networked forms of interaction through the circulation of multimodal memes, and support communities are built through humor and social criticism.
B38. Tang & Park (2016) ¹⁰	Pinterest	708 pins	RQ1: To what extent are different types of skin cancer covered on Pinterest? RQ2: How is skin cancer covered in terms of cause, treatment, and prevention? RQ3: To what extent do Pinterest pins cover the susceptibility and severity of skin cancer, benefits and barriers associate with diagnosis, prevention, or treatment, cues to action, and information that boosts readers' self-efficacy? RQ4: What are characteristics of the contents of the top 10% most repined pins on skin cancer? RQ5: What are the differences in Pinterest coverage of skin cancer in general and different types of skin cancer?	Keywords: "skin cancer", "melanoma", "squamous-cell carcinoma", and "basal-cell carcinoma".	Analyzed dermatology-related content	Number of repins of images were recorded.	Sun exposure and tanning beds were most frequently discussed as the causes of skin cancer, and alternative therapies such as herbal medicine were discussed more than traditional biomedical treatment or prevention. Highly repinned pins tend to include more information than regular pins. This study provides a comprehensive overview of the types and characteristics of information about skin cancer on Pinterest though a content analysis guided by the theory of agenda setting and the health belief model (HBM).
C14. Haeberle	Instagram	982, of which 669	To investigate the nature of the information regarding	30 different hashtags	Analyzed the tones of	Likes	88.9% (595/669) had a positive tone

<p>et al. (2017)¹¹</p>		<p>were eligible for analysis.</p> <p>49 pediatric orthopedic surgeons of the top 5 orthopedic institutions</p>	<p>scoliosis shared on Instagram, and the social media presence of scoliosis surgeons at major academic institutions</p>	<p>associated scoliosis</p>	<p>scoliosis-related Instagram posts (30 different hashtags)</p> <p>--</p>	<p>Account age; mean number of posts; mean number of followers; accounts with website linked</p> <p>--</p>	<p>--</p>	<p>4/49 surgeons using Instagram</p>
<p>C19. Mahroum et al. (2017)¹²</p>	<p>Pinterest</p>	<p>192 pins; of which 55 were eligible for analysis</p>	<p>To systematically describe and analyze the available pins related to Status epilepticus</p>	<p>“Status epilepticus”</p>	<p>Prevalence of pins with a content category or from a source</p>	<p>--</p>	<p>Provider of pins (academic, commercial, institutional, physician, medical/nursing students patient organizations or patients, epilepsy organizations and foundations); Source of pins: academic source, news, blogs and forums, search engines, encyclopedia or dictionary, social networks.</p>	<p>31/55 (56.4%) mentioned at least one cause of SE; 30/55 (54.5%) mentioned symptoms of SE; 25/55 (45.5%) mentioned diagnosis of SE; 40/55 (72.7%) mentioned treatment of SE; 22/55 (40.0%) mentioned prognosis of SE. Sources: 30/55 (54.5%) from academic sources and 25/55 (45.5%) from internet sources. Neutral tone: 46/55 (83.6%)</p>
<p>C38. Warner et al. (2018)¹³</p>	<p>Instagram</p>	<p>N=1136 public posts, of which 50</p>	<p>To use content analysis to examine textual data of Instagram posts about young</p>	<p>#youngadultcan cer.</p>	<p>Frequency of words (Tools: Yoshikoder;</p>	<p>Frequency of words, likes and</p>	<p>Users’ gender (female and male),</p>	<p>Posts made by survivors had more likes on average (54.5 vs 32.3, p</p>

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		<p>were randomly selected: the sample limited to only one post per account; if a randomly selected post belonged to a previously sampled account, the next consecutive post from a different account was collected. In total, 3244 words.</p>	<p>adults cancer to describe (1) indicators of social support, (2) valence (i.e., positive/negative terms), and (3) linguistic content (e.g., emotional terms/pronouns).</p>		<p>Linguistic Inquiry and Word Count; between groups (active treatment vs survivorship; individual vs organization)</p>	<p>comments; between groups (active treatment vs survivorship; individual vs organization)</p>	<p>treatment status (active treatment and survivorship), type of user (individual and organization) and caregiver status (yes and no)</p>	<p>=0.03). Individuals had more comments than organizations (5.3 vs 1.2, p=0.01). More positive (30%) than negative (13%) terms were used by survivors (p<0.01). Organizations used equally positive and negative terms. Survivors used more emotional terms (79.6% vs 34.9%, p<0.01) and fewer pronouns (mean: 39.5 vs 71.7, p=0.01) than those in active treatment. Organizations (71.0%) used more emotional terms than individuals (55.9%, p=0.03).</p>
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Table S3. Studies of human participants exposed to Instagram, Pinterest, Tumblr and Flickr images pertinent to chronic diseases

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
B3. Al-Eisa et al. (2016) ¹⁴	Instagram	58 participants	To investigate the efficacy of using Instagram with a home-exercise program as a motivational stimulus in improving physical activity adherence levels among female college students.	Quasi-experimental study. Participants were assigned into two groups (intervention and control) in a nonrandomized way. The intervention group had an online social network (Instagram) accounts; however, control group had no such account. An email was sent to all the participants about the date for returning the adherence sheet and only the intervention group received the study account in Instagram and was required to follow it. A variety of techniques were used in Instagram to improve motivation for adherence to PA. After the period of intervention, which was 4 weeks, a feedback questionnaire was collected to investigate the flexibility, effectiveness, and motivation level for given program activity.	Motivation to engage in physical activity assessed using the self-report Exercise Motivation Inventory-2 (EMI-2) questionnaire. Adherence was classified by the number of physical activity sessions that the individuals participated in during the program. Data on adherence was self-reported using an adherence sheet. A feedback questionnaire was collected to investigate the feasibility, effectiveness, and motivation level for the home exercise program.	53% of the participants agreed on the program's effectiveness on adherence. The use of Instagram with the home exercise program as a motivational modality could be attractive and effective to reinforce adherence and maintain appropriate physical activity levels.
B15. Fernandez- Luque et al. (2017) ¹⁵ with an erratum published ¹⁶	Instagram	Intervention group: 53 boys and 55 girls; control group: 60 boys and 59 girls.	To explore the feasibility of capturing health-related information using quantified self-technologies by overweight children and their families.	Cluster-randomized experimental study. The health intervention consisted of a number of health coaching and education activities, including health camp, weekend clubs and a	Instagram was used as a part of the "weekend club" intervention. Researchers gave 50 mobile phones with a pre-configured Instagram account to parents of 50 participants (30 boys and 20 girls) at the end of the health	Of the 50 mobile phones with pre-configured Instagram accounts, only 25 were used for the experimental purpose. While a total of 937 images were uploaded, three participants uploaded 70% of these images (highly skewed data). The researchers identify a very weak

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
B23. Kinard (2016)¹⁷	Instagram	384 participants (20 underweight participants were later excluded from the analysis)	To assess if higher BMI leads to more positive social media activity toward healthy food posts.	summer break intervention that targets mothers of participants. Participants were put into the intervention or the control group. The unit of randomization was a school (from which the participants were recruited).	camp, so that they could take photos of the food consumed by their children in the remaining section of the intervention program and upload them to the Instagram account. The purpose was to monitor the health camp participants' dietary habits and capture their families' dietary preferences. Social media posts were created by the researcher, and were divided into two types: high activity (with 105 likes and multiple positive comments) and low activity (0 likes and no comments). Participants were randomly assigned to a type and had to rate their response after viewing the post.	(and statistically insignificant) correlation between "the extent of use of this Instagram account" and the change in the child's BMI ($r = -$ 0.179 , $p=0.425$). They found that more active users experience a better BMI. However, as the researchers admitted that this was likely a correlation between level of engagement and BMI improvement. Individuals with a higher body mass index may be more likely to engage in social media activity (likes, shares, comments); obese individuals are more likely to engage with healthy food posts compared with their normal and overweight counterparts. ¹⁷

Table S4. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to mental health (excluding substance abuse)

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
A10. Ghaznavi & Taylor (2015) ¹⁸	Twitter and Pinterest	300 images	What are the characteristics of thinspiration content on social media? What additional tags are used to categorize thinspiration content on social media sites?	"thinspiration" "thinspo"	Analyzed "thinspiration" images from pro- eating disorder websites to photo-sharing sites.	Analyzed likes and favorites; re- pins and re- tweets	--	The study found that thinspiration content widely exists on social media and generally promotes an objectified, sexual, and extremely thin ideal.
A18. Moreno et al. (2016) ¹⁹	Instagram	201 images	To evaluate the meaning, popularity, and content of advisory warnings related to ambiguous nonsuicidal self- injury hashtags on Instagram.	#selfharmmm	Analyzed #selfharmmm photos for content.	Analyzed number of search hits for #selfharmmm on Instagram on two random occasions 5 months apart.	--	Nonsuicidal self-injury content is popular on Instagram and being covered by ambiguous hashtags. Content advisory warnings were not reliable; thus, parents and providers remain on the cornerstone of prompting discussions about nonsuicidal self- injury content on social media and providing resources for teens.
A34. Yom-Tov et al. (2012) ²⁰	Flickr	After labelling, 172 pro- recovery users and 319 pro- anorexia users. 242710 photos of which 25,689 were "highly relevant".	1. To understand the community dynamics of the pro-anorexia and pro- recovery communities 2. To investigate why pro-recovery users post their content and to understand if this facilitates the recovery of pro-anorexia users	Search terms: "thinspo", "thinspiration" or "pro-ana". Flickr groups: "Eating disorders art", "anorexia nervosa", "anorexia help" and "ED healing". Favorited photos tagged with both	--	Volume of highly relevant photos. Analyzed photos meta- information (title, tags, description, date posted, the number of times that the photo was viewed and	Categorized users as pro- anorexia or pro-recovery; Users' public contacts	Comments from people of a given category (pro- anorexia and pro- recovery) and the category of one's contacts are the best predictor of one's category. Comment and contacts are more likely to be between members of the same community and not between communities. Posting comments to pro- anorexia photos by pro-

B5. Reade (2016) ²¹	Instagram	50 images	1) How is the female body represented in fitspiration images on Instagram? 2) Do these representations mirror and/or transgress contemporary notions of the "ideal" body?	#fitspiration	Analyzed "fitspiration" images for content and sorted into themes/topics.	--	geographic location information). Also analyzed were comments for photos and favoriting of photos by users	recovery users was found to be counter-productive, leading pro-anorexia users to continue posting pro-anorexia photos for a longer period of time, and if they stop posting, to do so later.
B10. Carrotte et al. (2017) ²²	Instagram, Tumblr	415 "fitspo" social media posts (Instagram, n=360; Tumblr, n=39; Facebook, n=12; Twitter, n=4)	To conduct a content analysis to identify the characteristics of fitspiration content posted across social media and whether this differs according to subject gender.	#fitspo	Analyzed "fitspo" images for content and sorted into themes/topics.	--	Performed a gendered analysis between posts depicting women and posts depicting men.	"Fitspiration" on social media can encourage exercise in order to reach appearance aligned with gendered body image ideals. Fitspiration imagery features men almost as often as it features women, and men are just as likely as women to be objectified.
B12. Cavazos-Rehg (2017) ²³	Tumblr	3360 posts from 17 users, of which 2739 posts were	To gain an understanding of the depression, self-harm, and suicidal content that is being shared on Tumblr.	depressed, suicide, self-mutilation, and cutting	Analyzed posts for content and sorted them into themes/topics.	Analyzed number of re-blogs, likes, and number of posts.	Analyzed the basic characteristics and demographics	Four in five posts (82%) were related to depression, suicide, or self-harm. Common themes were self-

			relevant and with workable links for qualitative analysis	This study focused on how depression has been portrayed and communicated on Pinterest.	depression, clinical depression, depressive disorder, and bipolar disorder	Analyzed posts for depression content and sorted them into themes/topics.	Analyzed number of re-pins, likes and comments.	--	of the related Tumblr accounts (i.e., gender, age).	loathing, loneliness/feeling unloved, self-harm, and suicide. Suicide prevention efforts are needed due to the depression and suicidal content that was readily observed on Tumblr. Depression-focused pins elicited high response levels for re-pins, likes, and comments; more than half of the pins expressed perception of depression as a severe disorder. Practitioners should engage in depression-focused social media communication.
B18. Guidry, Zhang et al. (2016) ²⁴	Pinterest	783 pins related to depression								
B21. Holmberg et al. (2016) ²⁵	Instagram	1001 Instagram accounts, of which 854 had posted a food image. Total, 854 food images.	To explore how adolescents communicate food images in a widely used social media image-sharing application.	#14år	Images related to food items were analyzed for content and sorted into themes/topics.	--	Analyzed accounts associated with "#14år" ("14 years").			Food images were found in most Instagram accounts of adolescents. Food images were often portrayed in a positive way. Social media makes it more difficult to monitor young people's exposure to marketing of unhealthy foods.
B25. Marcus (2016) ²⁶	Instagram	800 posts (n=400 images from the fat acceptance community; n=400 from	How do pro-anorexic and fat acceptance image posts accentuate similarities to their in-groups? How do pro-anorexic and fat acceptance image posts accentuate the differences between their in-	#Bodypositive, #effyourbeauty standards, #celebratemyself, #honormycurves, #bbw,	Analyzed images for content.	Analyzed comments associated with images.	Analyzed how users of both communities provided social support to one another.			Fat acceptance members communicated with hashtags related to positivity and self-love, while pro-anorexic members

		the pro-anorexic community)	group and their out-groups? In what ways do pro-anorexic and fat acceptance image posts receive support from their networks?	#Proanaa, #thinspo,oo, #thighgap, #anatips, #anabuddy	--			communicated with hashtags related to thinspiration and negativity. Fat acceptance members distinguished outsiders by reframing beauty, and pro-anorexic members distinguished against outsiders by arguing with recovered anorexics. Both communities provided social support by complimenting other users' appearances.
B28. Myers et al. (2016)²⁷	Google, Twitter, Instagram, YouTube	133 sites, first 60 tweets for each keyword, 67 YouTube videos and 13 YouTube channels, 6126 Instagram posts	To examine the online representation of psychogenic non-epileptic seizures (PNES) on varied existing internet options and the frequency of searches for PNES and its associated terminology using acronyms as well as whole words	'pnes', 'pseudoseizure', 'nonepileptic', 'stress seizure', 'dissociative seizure', 'nonepileptic attack disorder', 'NEAD', 'psychogenic seizure', 'psychogenic seizures'.	--			The Instagram-related results in this paper focused only on the frequency of images with PNES-related hashtags. #nead (n=4331) was the most common hashtag but only ¼ were related to non-epileptic attack disorder. Of images with #pnes (n=1273), ¾ were related to psychogenic non-epileptic seizures.
B31. Pila et al. (2017)²⁸	Instagram	600 images	To characterize cheat meals, and explore the meaning ascribed to engagement in this practice.	#cheatmeal	--			Many of the photos showed calorie-dense foods. Images commonly portrayed highly-muscular bodies with intentional body exposure. Textual content showed the idealization of overconsumption, strict commitment to fitness,

<p>B35. Santarossa et al. (2016)²⁹</p>	<p>Instagram</p>	<p>Text & network analysis: 10,000 #fitspo posts, of which only 6528 had #fitspo in the caption were kept for analysis. Of these 150 images randomly chosen and 122 #fitspo images met inclusion criteria for content analysis.</p>	<p>To discover popular/emerging themes/text around #fitspo images, and to investigate the author characteristics and assess a random sample of images.</p>	<p>#fitspo</p>	<p>Analyzed #fitspo images for content.</p>	<p>--</p>	<p>Analyzed authors (users) of #fitspo images.</p>	<p>and a reward-based framework around diet and fitness. Cheat meals are shown as a goal-oriented dietary practice in pursuit of physique-ideals, and underscore potential clinical repercussions.</p> <p>#fitspo posts may motivate through appearance-mediated themes, as the largest content categories were 'feeling good' and 'appearance'. Furthermore, #fitspo posts may create peer influence/ support as personal accounts were associated with higher popularities of images. Finally, most images contained posed individuals with some degree of objectification.</p>
<p>B37. Simpson & Mazzeo (2017)³⁰</p>	<p>Pinterest</p>	<p>1,050 pins related to the keywords #fitspiration, #fitsporation, and #fitspo.</p>	<p>Investigated the following research questions: 1. What body image standards (values) does fitspiration promote? 2. What behaviors for achieving body image ideas are encouraged? 3. What outcome expectancies are conveyed? 4. What model</p>	<p>Fitspiration, fitsporation, fitspo</p>	<p>Posts were coded by type of image, gender, race/ethnicity, weight, amount of body shown, amount of clothing shown, and the activity that he or she was doing.</p>	<p>Number of repins, likes, comments, and the total number of times the post was engaged was recorded.</p>	<p>--</p>	<p>Messages encouraged appearance-related body image standards and weight management behaviors more frequently than health-related standards and behaviors, and emphasized attractiveness as motivation. Fitspiration</p>

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<p>B39. Tiggemann & Zaccardo (2016)³¹</p>	<p>Instagram</p>	<p>600 images</p>	<p>characteristics (i.e., ethnicity, body type, age) are depicted? 5. How do users engage with fitspiration content on Pinterest?</p>	<p>#fitspiration</p>	<p>Analyzed #fitspiration images for content.</p>	<p>--</p>	<p>--</p>	<p>messages included a comparable amount of “fit praise” and “thin praise”. Findings may suggest that these images are problematic for those with high risk of eating disorders and related issues.</p>
<p>B41. Wilkinson et al. (2016)³²</p>	<p>Pinterest</p>	<p>500 pins</p>	<p>To determine the presence of health behavior theory (HBT) constructs in pins found on Pinterest; to assess the relationship between various pin characteristics and the likelihood of inclusion of HBT.</p>	<p>‘Nutrition infographic’ and ‘healthy eating infographic’</p>	<p>Analyzed “nutrition infographic” and “health eating infographic” pins for content.</p>	<p>--</p>	<p>--</p>	<p>Majority of images of women contained only thin and toned body types; most images contained objectifying elements. Fitspiration images may be inspirational to viewers, but also may have negative side effects on the viewer’s body image.</p>
<p>B42. Ging & Garvey (2017)³³</p>	<p>Instagram</p>	<p>7,650 images</p>	<p>To investigate the extent and how pro-anorexia practices and discourses in the manifest themselves on a more open, image-based platform such as Instagram.</p>	<p>#ana, #starve, #fasting</p>	<p>Analyzed frequency of the images of the nine categories under each of the three hashtags</p>	<p>Comments, re-pins, likes</p>	<p>identifiability</p>	<p>Infographics targeting health eating contain few HBT elements. Health professionals and organizations should create and disseminate infographics that have more HBT elements to influence health eating behaviors.</p> <p>Nine categories: Thinspiration (25%), Gamified & interactive (4%), text-based quotes (26%), pro-anorexia linked with depression (3%), pro-anorexia linked with self-harm and suicide (6%), tips on maintaining and concealing an ED (10%),</p>

<p>C4. Branley and Covey (2017)³⁴</p>	<p>Tumblr and Twitter</p>	<p>Thematic analysis: 190 posts in total; content analysis: Tumblr, N=356, and Twitter, N=353</p>	<p>To identify and compare the types of eating-disorder-related information people using Twitter and Tumblr are being exposed</p>	<p>proana/#proana/pro-ana/proana; anorexia/#anorexia; anorexic/#anorexic; #promia; bulimia/#bulimia; bulimic; #eatingdisorder /eating disorder; #edproblems; ednos/#ednos; thinspiration/#thinspiration; #thinspo/#thinspo</p>	<p>Nature of post; body images and nature of image; emotion expressed; support offered and nature of support; raising awareness; challenging norms; humor</p>	<p>Location where post originated</p>	<p>Gender; identifiability</p>	<p>pro-recovery (8%), selfies (6%) and others (12%) #Starve produced the highest number of images classified as thinspiration and classified as text-based quotes, the highest number of images in the pro-ana linked with depression category, and linked with suicide and self-harm category, the lowest number of pro-recovery posts, selfies, and other images. #Fasting produced the highest number of images in the gamified and interactive categories.</p> <p>Pro-ana posts are more common on Twitter (25.8%; 91/353) vs Tumblr (13.8%; 49/356); while anti-ana posts are more common on Tumblr (175/356; 49.2%) vs Twitter(95/353; 26.9%). No significant difference between the 2 platforms for pro-recovery posts (Twitter, 38/353, 10.8%; Tumblr, 50/356, 14%).</p>
<p>C6. Brown et al. (2018)³⁵</p>	<p>Instagram</p>	<p>32182 pictures from 6721</p>	<p>To provide a comprehensive analysis of non-suicidal self-injury (NSSI) pictures</p>	<p>#klinge ('blade'), #narben</p>	<p>Content of pictures: directly depicted</p>	<p>Comments: general discussion;</p>	<p>Gender; identifiability; age</p>	<p>Users: 958/1154 (83.0%) anonymous. Pictures: N=32182 using most</p>

		user accounts were posted during 4 weeks in April 2016 using the most common German hashtags for NSSI. 2826 (8.8%) of these pictures contained NSSI content coming from 1154 accounts.	published on Instagram over the course of 4 weeks in Spring 2016, which were associated with the most common German self-injury hashtags	('scars'), #selbstverletzung ('self-injury'), #ritzen ('cutting'), #suizidedanke ('suicidal thoughts'), #klingenliebe ('blade-love'), #blut ('blood'), #sw ('acronym for self-injurious behavior'), #selbsthass ('self-hate'), #depressiv ('depressive'), #depressionen ('depressions'), #suizid ('suicide'), #suizidegegend ('suicide area'), #ritzen ('cutting against the pain'), #selbstmord ('suicide'), #deprimiert ('depressed') and #sterben ('dying').	wounds: levels: mild, moderate, severe; types: cut, bruises, biting, burning, skin picking, undefinable, and combinations of several types. Body region: upper extremities; lower extremities; combination of both extremities; torso; head; neck; undefined body region. Objects along with wound: razor blades or other blades; fingernails; knives and ropes. Text cut into skins (34 instances)	empathic; warnings asking the user to stop the behavior; offering help; abuse; complimented the wound or picture. Time-stamp	--	common German hashtags for NSSI, of which 8.8% (n=2826) pictures directly depicted wounds. Of these, 39.6%: mild; 47.8%: moderate; 12.6% severe. Posts less frequent in early morning hours (compared with control, Instagram photos from Berlin). Comments: 3291/6651, 49.5% part of a general discussion; 1562/6651, 23.5% empathic; 770/6651, 11.6%, warnings asking the user to stop the behavior; pictures directly depicting wounds generated around twice as many comments (Wound mean = 4.1, SD 13.9; No wound mean = 2.1, SD 9.3, p<0.001). Severe wounds generated more comment than moderate wounds and mild wounds (p<0.001)
C20. Miguel et al. (2017)³⁶	Tumblr, Instagram, Twitter	1155 posts from three platforms all together. 385/1155 (33.3%) posts excluded because	To systematically examine a representative sample of publicly accessible content related to self-cutting; examined a number of variables not yet investigated in the literature. To analyze the extent to which social media cutting-related posts	#cutting	Graphic; containing negative self-evaluations; references to specific mental health problems (depression, eating disorders,	--	--	458/770 (59.5%) of sampled posts depicted graphic content (Instagram: 235/359, 65.5%; Tumblr: 190/333, 57.1%; Twitter: 33/78, 42.3%). 357/770 (46.4%) of sampled posts included

		<p>they were not related to mental health; therefore, 770 posts analyzed</p>	<p>are graphic, contain negative self-evaluations, cross-reference specific mental health problems, discourage cutting, and/or provide cutting recovery resources. To examine whether properties of posts differ between the social media platforms.</p>		<p>anxiety, borderline personality disorder, discouraging self-injury, recovery-oriented resources</p>			<p>negative self-evaluations (Instagram: 236/359, 65.7%; Tumblr: 103/333, 30.9%; Twitter: 18/78, 23.1%). Only 73/768 (9.5%) images discouraged self-injury (Instagram: 27/359, 7.5%; Tumblr: 24/333, 7.2%; Twitter: 22/78, 28.2%). Only 5 tweets and 2 Tumblr posts (7/767; <1%) included formal recovery resources. Instagram posts displayed the greatest proportion of graphic content and negative self-evaluations, whereas Twitter exhibited the smallest proportion of each.</p>
<p>C23. Park et al. (2017)³⁷</p>	<p>Tumblr</p>	<p>254 posts and 67 images</p>	<p>To examine how discourse about anorexia is being circulated among Tumblr users</p>	<p>thinspo, wannarexic, proana, starvation buddy, eating disorder, or anorexia</p>	<p>Posts were coded for Testimony, blogger's stance, affective tone. Images were coded to see if they contained topic, stance in quotations, body weight, and body exposure</p>	<p>---</p>	<p>Analyzed if users were anorexic or not and if they were pro- or anti-anorexia</p>	<p>Testimonies were not a significant factor as to whether posts were reblogged or not. Posts with other-testimony were reblogged 71% more than post with self-testimony. Pro-ana posts were reblogged at a higher rate than anti-ana posts. Tumblr users generally did not like to reblog posts with a noticeable affective tone, but they did so if the post identified someone as having an eating disorder. Among the images showing human bodies, 53.1%</p>

<p>C30. Reece and Danforth (2017)³⁸</p>	<p>Instagram</p>	<p>43950 photos from 166 Instagram users, of whom 71 had a history of depression.</p>	<p>H1: Instagram posts made by individuals diagnosed with depression can be reliably distinguished from posts made by healthy controls, using only measures extracted computationally from posted photos and associated metadata. H2: Instagram posts made by depressed individuals prior to the date of first clinical diagnosis can be reliably distinguished from posts made by healthy controls. H3a: Human ratings of Instagram posts on common semantic categories can distinguish between posts made by depressed and healthy individuals. H3b: Human ratings are positively correlated with computationally-extracted features.</p>	<p>--</p>		<p>Comparison of accuracy metrics for All-data and Pre-diagnosis model predictions (Recall, specificity, precision, negative predictive value, F1 score). Regression model predictors: hue, saturation, brightness, comments, likes, posts/day, used filters, face presence, face count. Instagram filter usage difference between depressed and healthy users.</p>	<p>Survey of participants on depression to group them into two groups: with and without depression</p>	<p>Photos posted by depressed individuals tended to be bluer, darker, and grayer. Depressed participants: more comments received; fewer likes received; higher posting frequency; more likely to post photos with faces; lower average face count per photograph; less likely to apply Instagram filters to their posted photos, than healthy participants. Human ratings can distinguish Instagram posts made by depressed and healthy individuals; but showed little or no correlation with most computational features.</p>	<p>depicted underweight bodies and 48% of the images had a high degree of body exposure.</p>
<p>C40. Webb et al.</p>	<p>Instagram</p>	<p>500 images; 250 with</p>	<p>Primary objectives were to compare: (a) the multi-</p>	<p>#healthatweverysize or #haes;</p>	<p>Visual vs text vs Visual+text; the</p>	<p>--</p>	<p>--</p>	<p>Images related to #fatspiration often</p>	

(2017) ³⁹	<p>#healthteverysize or #haes; 250 with #fatspo or #fatspiration; 100 images (50 per hashtag theme) were used for refining the initial coding instrument and for training. 400 images were for official coding.</p>	<p>faceted strategies used to visually portray and motivate fat acceptance in two complementary-themed Instagram environments (i.e., #fatspiration/#fatspo and #healthateverysize/#haes); (b) the simultaneous presence of fat-stigmatizing, dieting/weight loss, and eating-related content in these contexts; and (c) the consistency of these themes with the ways in which fat acceptance has been visually represented and promoted in previous analyses of blogs featured in the first-generation web-based Fatspiration movement. †</p>	#fatspo or #fatspiration	<p>attributes of the individual featured in the image (gender; race/ethnicity); fat shaming contents; General fat acceptance frame; physical appearance pride frame; physical activity and health frame; eating and weight loss-related content</p>		<p>focused on fat acceptance than those posted with #HAES. #fatspiration and #fatspo were often visual in nature. Overall these hashtags usually focused on the whole body rather than just the face. Results revealed that images posted to #fatspiration/#fatspo more often endorsed the theme of fat acceptance than those posted to #healthateverysize/#haes. Images tagged with #fatspiration/#fatspo were more often visual in nature only, selfies, had a clothing item or a fashion accessory prominently featured, and contained additional fashion and beauty hashtags in comparison to HAES®-themed Instagram images. Results also indicate that across fat acceptance hashtag themes, the majority of individuals' bodies were displayed in photos versus primarily just one's face in these Instagram communities with a minority of images containing body fragmentation. Those attributes characterizing the broader physical</p>
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									activity and health fat acceptance frame were more often represented among Instagram images tagged with #healthateverysize/#haes.
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† Specific hypotheses for C40: H1. The authors expected that Instagram posts tagged with #fatspiration or #fatspo relative to HAES®-themed comparison images would more frequently: (i) convey messages of fat acceptance and anti-thinspiration; and (ii) display a range of elements reflecting taking pride in and valuing one’s physical appearance (e.g., selfies, body exposing attire and other fashion- and beauty-related activism. H2. The authors anticipated that images tagged with #healthateverysize or #haes in comparison to #fatspiration/#fatspo posts would: (i) more often feature general physical activity and health motivators, along with images specifically geared toward stimulating engagement in embodying physical activities like yoga; (ii) more strongly endorse health and wellness; (iii) more frequently depict conventionally “healthy” foods; and (iv) contain more fat shaming posts. H3. The authors predicted that weight loss and dieting content alongside images displaying body fragmentation would be minimally rep-resented across both Fatspiration and Health at Every Size® hashtag themes. The authors also explored the extent to which individuals posting to these fat acceptance Instagram communities tended to simultaneously tag their images with eating disorder recovery themes to offer messages of hope and encouragement.

Table S5. Studies of human participants exposed to Instagram, Pinterest, Tumblr and Flickr images pertinent to mental health (excluding substance abuse)

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
A22. Tiggemann & Zaccardo (2015) ⁴⁰	Instagram	130 participants	To experimentally investigate the impact of fitspiration images on women's body image. Analyzed mood or changes in behavior and self-esteem due to "fitspiration" images in under-graduates	Between-subjects design. Participants were randomly allocated to one of two experimental groups (fitspiration, travel) with equal number of images exposed. The major outcome variables were negative mood and body dissatisfaction, state appearance self-esteem, and state appearance comparison.	Exposure: The "fitspiration" group: 16 "fitspiration" images of women posing in fitness clothing or engaging in exercise, plus 2 travel-related images. The "travel" group: 18 travel-related images of which 11 also contained people. Pre-exposure survey: social media use (i.e., participants reported number of logins/day, time spent on social media, etc.) and visual analogue scales (VAS). Post-exposure survey: VAS, measures of state self-esteem, state appearance comparison, inspirational goals and trait appearance comparison.	Exposure to fitspiration images resulted in greater body dissatisfaction and lower state appearance self-esteem than did exposure to control (travel) images.
B9. Brown & Tiggemann (2016) ⁴¹	Instagram	138 participants	To investigate the impact of attractive celebrity and peer images on women's body image.	A between-subjects experimental design was used to investigate the effect of image type (celebrity, peer, travel) on the dependent variables of negative mood and body dissatisfaction (after controlling for baseline scores). In addition, state appearance comparison was tested as a mediating variable and celebrity worship was tested as a potential moderating variable.	Participants were tested in groups of 2-3. Before exposure to images, participants were asked to answer questions about social networking use and pre-exposure measures of mood and body dissatisfaction. After viewing the images, post-exposure data measures were collected. Data on the number of Instagram followers and the amount of importance placed on photo quality was measured using a Likert Scale, negative mood and body dissatisfaction were measured using the visual analogue scales, the State Appearance Comparison Scale	Exposure to celebrity and peer images increased negative mood and body dissatisfaction relative to travel images, with no significant difference between celebrity and peer images. Exposure to attractive celebrity and peer images can be detrimental to a woman's body image.

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
B20. Holland & Tiggemann (2017) ⁴²	Instagram	203 participants (101 women who post fitspiration images; 102 women who post travel images)	To investigate disordered eating and exercise in women who post fitspiration on Instagram.	Instagram's search function was used to find photos tagged with the specified hashtags of #fitspiration or #travel. Account owners that met the criteria, were sent an invitation to complete an online survey in the form of a comment on one of their posts	was used to collect data on the amount of comparison participants engaged in, and the Celebrity Attitude Scale measured participants' levels of celebrity worship. Participants had to complete a survey. In the survey, disordered eating was assessed by Drive for Thinness, Bulimia, and Body Dissatisfaction subscales of the Eating Disorders Inventory (EDI). Muscularity was measured with a similar scale. Compulsive exercise was measured using the four-item Emotional Element subscale of the Obligatory Exercise Questionnaire.	Women who post fitspiration images on Instagram scored higher on drive for thinness, bulimia, drive for muscularity, and compulsive exercise; almost a fifth were at risk for diagnosis of a clinical eating disorder compared to control group. For some women, posting fitspiration images on Instagram may signify maladaptive eating and exercise behaviors.
C35. Slater et al. (2017) ⁴³	Instagram	160 female undergradu ates aged between 18 and 25 years	To examine the impact of exposure to both fitspiration images and images containing self- compassion quotes on Instagram on women's state body satisfaction, body appreciation, negative mood, and self- compassion. Hypothesis 1: women who viewed fitspiration images on Instagram would show lower levels of state body satisfaction, positive body image (i.e., body appreciation), self- compassion, and higher	Between-subjects experimental design. Participants were randomly assigned to one of the four experimental conditions: 1) control, 2) fitspiration, 3) self- compassion, and 4) fitspiration and self-compassion using restricted randomization with minimization. Major dependent variables were state body dissatisfaction, body appreciation, self-compassion, and negative mood. Trait tendency for appearance comparison and for internalization of the thin ideal were examined as potential moderating variables.	After informed consent, participants were randomly assigned to the experimental conditions. They were asked to complete questions regarding general social media usage and baseline Visual Analogue Scales of body satisfaction, self- compassion, body appreciation, and negative mood. Participants then view an Instagram account containing 20 images for 5 minutes. Participants can move back and forth through the images at their own pace. Following exposure to the images, they completed the post-exposure VAS measures,	Results showed no differences between viewing fitspiration images compared to viewing neutral images, except for poorer self- compassion among those who viewed fitspiration images. However, women who viewed self-compassion quotes showed greater body satisfaction, body appreciation, self- compassion, and reduced negative mood compared to women who viewed neutral images. Further, viewing a combination of fitspiration images and self-compassion

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
			<p>levels of negative mood than women who viewed appearance-neutral control images (interior design images).</p> <p>Hypothesis 2: women who viewed self-compassion quotes would experience more positive body image and self-compassion, and reduced negative mood compared to women who viewed control images.</p> <p>Hypothesis 3: Women who viewed a combination of fitspiration and self-compassion images would experience more positive body image and self-compassion and reduced negative mood compared to women who viewed only fitspiration images.</p>	<p>Experimental stimuli: images obtained from public Instagram accounts</p> <p>Control: appearance-neutral images of home interiors without text or human bodies (search term: “interior design”)</p> <p>Fitspiration: images of young women with lean and toned bodies wearing form-fitting work-out clothing (search terms: #fitspiration or #fitspo)</p> <p>Self-compassion: images with quotes that conveyed the basic principles of self-compassion, self-acceptance, and understanding one’s own imperfections, in the absence of any images of human bodies (search terms: self-compassion, self-love, positive body image)</p> <p>Fitspiration and self-compassion: 15 images of ‘fitspiration’ and 5 in ‘self-compassion’</p>	<p>and measures of trait appearance comparison and internalization of the thing ideal. To ensure that participants paid attention to the images, and to be consistent with the cover story (participants were recruited to do a “Instagram and memory recall” experiment), they were asked to recall a number of features of the Instagram account that they had just viewed (e.g., features of the images, words seen, hashtags used).</p>	<p>quotes led to positive outcomes compared to viewing only fitspiration images. Trait levels of thin-ideal internalization moderated some effects.</p>

Table S6. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to substance abuse

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
A8. Guidry, Yin et al. (2016) ⁴⁴	Pinterest	800 images	How is waterpipe smoking portrayed and represented on Pinterest? How do Pinterest users respond to the waterpipe pins they encounter on Pinterest? How are perceived severity of health risks of waterpipe smoking communicated in waterpipe-smoking-focused Pinterest pins?	"hookah", "shisha", "waterpipe" and "narghile"	Analyzed pins for content related to waterpipe smoking.	Analyzed content of links of pins.	Analyzed poster's identity (individual, organization, etc.)	The content analysis showed that the vast majority of waterpipe-related pins portray waterpipe smoking in a positive light.
A19. Barry et al. (2015) ⁴⁵	Instagram	10 user profiles	Assess whether alcohol companies restrict youth/adolescent access, interaction, and exposure to their marketing on Twitter and Instagram.	--	--	Analyzed underage user's ability to like and follow alcohol brand pages.	--	All user profiles, both those under the minimum legal age of 21 and those of legal drinking age, were able to view, interact, and comment on advertising content from alcohol companies on both Instagram and Twitter. The age gate was not employed on Instagram; thus, all profiles on Instagram could receive alcohol industry advertisements directly to their smartphones.
B4. Allem et al. (2017) ⁴⁶	Instagram	1,705 images	This study characterized waterpipe-related posts on Instagram to inform regulatory and policy activities in the United States.	#hookah	Analyzed #hookah images for content.	Analyzed user-input geo-location of posts.	--	Results show that #hookah appears to be a mechanism of advertisement by bars/restaurants/nightclubs. The removal of policy exceptions could prevent waterpipe use

<p>B11. Cavazos-Rehg et al. (2016)⁴⁷</p>	<p>Instagram</p>	<p>5,000 images</p>	<p>To examine marijuana-related content on Instagram to better understand the varied types of marijuana-related social networking occurring on Instagram</p>	<p>#420, #high, #highlife, #710, #highsociety, #kush, #stoner, #cannabis, #marijuana, #shatter, #maryjane, #weedstagram420, #instaweed, #thc, #stayhigh, #blunt, #pot, #stonernation, #blunts, #wakenbake, #pothead, #smokeweedeveryday, #justblazeig, #staygreen, #bong, and #joint.</p>	<p>Analyzed for marijuana-related content</p>	<p>--</p>	<p>Inferred demographics of users of accounts (gender, race, marital status, and age)</p>	<p>Images of marijuana were common. Findings show promotion of marijuana in its traditional plant-based form; novel modes of marijuana use were also endorsed. The explicit marketing of marijuana that was observed on Instagram may have potential to influence social norms surrounding marijuana use.</p>	<p>from being part of nightlife promotion and entertainment in the future.</p>
<p>B13. Chu et al. (2017)⁴⁸</p>	<p>Instagram</p>	<p>2,208 images</p>	<p>To investigate vaping and e-cigarette-related images on Instagram describing themes, as well as users' reactions through "likes" and comments; explored the differences in what language people used to caption their vaping and e-cigarette images</p>	<p>Analyzed the following hashtags for e-cigarette and vaping-related content</p>	<p>The number of likes of each type of image was recorded and caption text was analyzed.</p>	<p>--</p>	<p>Analyses found that advertisement-themed images were most common. Vaping-related text greatly outnumbered e-cigarette-related text in the image captions. Findings show that Instagram posting of e-cigarette-related behaviors and provides opportunity for advertisers to display their products. Future research should incorporate novel data streams to improve surveillance, survey development, and educational campaigns.</p>	<p>Analyses found that advertisement-themed images were most common. Vaping-related text greatly outnumbered e-cigarette-related text in the image captions. Findings show that Instagram posting of e-cigarette-related behaviors and provides opportunity for advertisers to display their products. Future research should incorporate novel data streams to improve surveillance, survey development, and educational campaigns.</p>	

<p>B24. Laestadius et al. (2016)⁴⁹</p>	<p>Instagram</p>	<p>85 posts (n=43 #ecig posts; n=42 #vape posts)</p>	<p>To analyze electronic cigarette content found on Instagram; to highlight public health challenges created by this content and support understanding of electronic cigarette promotion and usage.</p>	<p>#ecigarette, #vape, #vaping, #vapelite, #vapelyfe, #vapeporn, #ejuice.</p>	<p>Analyzed for electronic cigarette-related content</p>	<p>The total number of posts on Instagram for each of these hashtags was collected on four different dates to track growth of hashtags over time.</p>	<p>Analyzed type of users posting images (corporate, personal).</p>	<p>The total number of #vape posts on Instagram grew by 4,163,274 during the study period, while #ecig posts increased by 741,916. Corporate users made up over half of the posts. No posts were critical of electronic cigarettes and few mentioned electronic cigarettes in the context of health. Findings show users characterized e-cigarettes as novel devices rather than equivalents to cigarettes.</p>
<p>B32. Primack et al. (2016)⁵⁰</p>	<p>Tumblr</p>	<p>140 posts</p>	<p>To compare hookah-related image content posted by and about males and females.</p>	<p>Hookah and shisha</p>	<p>Analyzed “hookah” and “shisha”-related images for content.</p>	<p>--</p>	<p>Sociodemographic characteristics of both posters and individuals depicted in images were recorded.</p>	<p>The most prominent features displayed in all posts were references to or images of hookahs themselves, sexuality, socializing, alcohol, hookah smoke, and “tricks” performed with hookah smoke. Males more frequently posts images of hookahs and alcohol-related images or references compared to females. These findings can help with development of targeted interventions in the future.</p>
<p>C1. Allem et al. (2017)⁵¹</p>	<p>Instagram</p>	<p>1967 of 7408 posts collected (27%)</p>	<p>To characterize Swisher little cigar- and cigarillo-related posts on Instagram to inform the</p>	<p>#swisher</p>	<p>5 mutually exclusive themes: (1) Tobacco</p>	<p>Average number of likes per theme</p>	<p>--</p>	<p>24.71% (486/1967): marijuana themed; 17.69% (348/1967): tobacco product or</p>

<p>C3. Bierut et al. (2017)⁵²</p>	<p>Instagram (and other platforms: Facebook, Twitter, LinkedIn, Google+, YouTube, and Vine)</p>	<p>2249 Instagram followers of Weedmaps</p>	<p>design of tobacco education campaigns and the development of future tobacco control efforts, and to further demonstrate the utility in using big social media data in understanding health behaviors</p>	<p>Not applied</p>	<p>product or promotion; (2) Smoking; (3) Marijuana; (4) Meme; (5) Other. Also, presence or absence of alcohol in the image</p>	<p>--</p>	<p>To use Demographics Pro proprietary algorithm to infer demographics: descriptive statistics (gender, age, race/ethnicity, state: CA, WA, CO)</p>	<p>promotion; 16.47% (324/1967); showed smoking; 225/1967 (11.44%); meme; 29.69% (584/1967); other. Likes: Meme (mean 11), other (mean 8), marijuana (mean 7), smoking (mean 5), tobacco product or promotion (mean 4). Swisher products used to make blunts (hollow cigar filled with marijuana)</p>
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C18. Lee et al. (2017) ⁵³	Instagram, Pinterest	900 pictures (Instagram) and 900 pictures (Pinterest); For each platform, 10 pictures captured from each search term; 9 search terms; 2 captures per week for 5 weeks (=10 captures)	related marketing occurring online. To explore e-cigarette content in visual materials posted Instagram and Pinterest.	vape, vapelife, vapor, vapelife, vapeporn, ecig, vaping, ecigs, electroniccigarette	Frequency of categories by keywords and by platforms. Categories: customization, juice flavors, memes, marketing celebrities, health benefits, anti-smoking, models, tricks, marijuana, social acceptance. Categories were not mutually exclusive.	--	--	915/1800 (51%) of all images featured customization of e-cigarettes (Instagram: 339/900, 38%; Pinterest: 576/900, 64%). 956/1800 (53%) of all images were devoted to marketing e-cigarettes (Instagram: 541/900, 60%; Pinterest: 415/900; 46%). 148/1800 (13%) of all images featured a professional or amateur model using e-cigarettes (Instagram: 109/900, 12%; 39/900, 4%). 175/1800 (10%) of all images mentioned Juice flavors (Instagram: 158/900, 18%; 17/900, 2%)
C41. Yang and Luo (2017) ⁵⁴	Instagram	4819 Instagram posts (of which 1260 were positive); 206 Instagram accounts (of which 27 were positive); 4329 Google images.	To propose a novel approach to automate the detection of drug abuse and dealing through using multimodal data on social media.	Instagram posts: hashtag-based search on Instagram. Google images: Google Image Search: searching the same terms as keywords. Instagram accounts: if a post is annotated as drug-related, then the corresponding account is viewed as a drug-related account.	To apply image and text classifiers to identify drug-related posts from a sample of potential drug-related posts	--	Drug-related accounts were identified through drug-related posts. Using timeline data to determine if this account belongs to a drug dealer	Results of drug-related post recognition. Accuracy: 88.1; precision: 83.1; recall: 68.1; F1 score: 0.75.

Table S7. Experimental studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to substance abuse

Paper ID Authors (year)	Social Media Platforms	Participants & Sample Size	Objectives	Experimental design	Experimental procedures	Major findings and public health implications
B7. Boyle et al. (2017) ⁵⁵	Instagram, Facebook, Snapchat	408 participants	To examine the hypothesis that students tend to use Instagram most often for photos glamorizing drinking compared to Snapchat and Facebook.	Participants completed a pre-matriculation assessment. Additional surveys were emailed to participants one month into the fall semester and six weeks into their second semester	Participants were shown images related to alcohol use and participants were asked to select which social media site on which they would most likely see the post depicted.	Instagram was seen as the most probable destination for photos depicting alcohol as attractive and glamorous. Researchers should shift their focus to mitigating potential influences of college students' alcohol-related posts to Instagram.
C25. Phua et al. (2018) ⁵⁶	Instagram	141 participants	To examine the effects of endorser type (celebrities, non-celebrities and products only) in e-cigarette brand Instagram advertisements on e-cigarette attitudes and smoking intentions. H1: Celebrity endorsers on an e-cigarette Instagram page will result in significantly (a) more positive attitudes towards e-cigarettes and (b) greater e-cigarette smoking intentions than non-celebrity endorsers or products only. H2: Celebrity endorsers on an e-cigarette Instagram page will be rated significantly higher on (a) competence, (b) trustworthiness, (c) goodwill and (d) attractiveness than non-celebrity endorsers. H3: Social identification will moderate the relationship between endorser type (celebrities vs non-celebrities) and perceived (a) competence, (b) trustworthiness, (c) goodwill and (d) attractiveness. H4: The relationship between endorser type (celebrities vs non-celebrities) and attitudes towards e-cigarettes and smoking intentions will be moderated by (a) attention to social comparison, and (b) health consciousness and (c) SNS use.	A pre-test to choose the brand to use in the main experiment. The main experiment: participants were randomly assigned to be exposed to an Instagram page under one of the three conditions: 1) celebrity, 2) non-celebrity, 3) products only. Stimuli: Three versions of the e-cigarette Instagram page were digitally manipulated using Adobe Photoshop, with celebrities featured in the 'celebrity' condition, non-celebrities featured in the 'non-celebrity' condition and products featured in the 'products only' condition. Other aspects of the Instagram pages, including brand description, number of posts and number of followers, were kept constant.	Participants were randomly assigned to one of the three conditions. They were asked to view the experimental stimuli. They were instructed to note the brand and endorser type carefully, and then answer the online questionnaire. A manipulation check indicated that all participants correctly identified the endorser type on the Instagram stimulus they were assigned.	H1a and H1b are supported. H2a, H2b, H2c, H2d were supported. H3b supported; not H3a, H3c, H3d. Attention to social comparison (H4a) significantly interacted with endorser type to influence attitudes towards e-cigarettes but not e-cigarette smoking intentions. Health consciousness (H4b) significantly interacted with endorser type to influence e-cigarette smoking intentions but not attitudes towards e-cigarettes. Social networking sites use (H4c) significantly interacted with endorser type to influence attitudes towards e-cigarettes but not e-cigarette smoking intentions.

Table S8. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to sexual and reproductive health.

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
B6. Bowden et al. (2016) ⁵⁷	Flickr	40 images	To examine images of birth rooms in developed countries to analyze the messages and visual discourse being communicated through images.	hospital birth room, delivery room, birth unit design, maternity unit design, hospital labour ward birth space, and childbirth	Analyzed images related to birth rooms	--	--	Three kinds of birth room images were identified: the technological, the “homelike”, and the hybrid domesticated birth room; the technological birth room was most dominant, with a focus on medical equipment and the labor bed. These findings reinforce the notion that the bed is the most appropriate place to give birth and the use of medical equipment is intrinsically involved in the birth process, construing childbirth as risky/dangerous.

Table S9. Experimental studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to sexual and reproductive health.

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
C21. O'Donnell and Willoughby (2017) ⁵⁸	Instagram	839 participants (weighted in the sample's racial component)	Research question 1: How does message design, based on the visual placement of information, affect perceived message effectiveness? Research question 2: How does message design, based on the visual placement of information, affect perceived message effectiveness, after controlling for information processing and seeking motivations? Hypothesis 1: Systematic processing of sexual health information will be positively associated with perceived message effectiveness. Hypothesis 2: Heuristic processing of sexual health information will be negatively associated with perceived message effectiveness. Hypothesis 3: Prior attitudes toward condoms will be positively associated with perceived message effectiveness. Hypothesis 4: Likelihood to use a sexual health Instagram service will be positively associated with perceived message effectiveness. Hypothesis 5: Perceived message sensation value will be positively associated with perceived message effectiveness.	Participants were randomly assigned to 1 of 4 conditions. Condition 1: The health information was placed in the Instagram photo captions. Condition 2: The health information was split between the Instagram photo and the caption. Condition 3: The health information was solely embedded in the Instagram photos. Condition 4: Control. No sexual health information; only background images were presented.	Participants were asked preliminary questions including demographics, Instagram use, and safe sex behaviors; then information processing questions with measures from the heuristic- systematic model. Participants then read the explanation that the messages were created by health professionals for a sexual health question and answer service. They were randomly assigned to one of four experimental conditions and viewed 5 Instagram posts in the format of their assigned condition. After they were exposed to the messages, participants were asked questions how likely they would use a similar service, their perceived message sensation value and perceived message effectiveness.	Message embedded in a photo was most effectiveness (perceived message effectiveness mean=2.97); it is significantly different from "message both as a caption and embedded in a photo" (perceived message effectiveness mean=2.76) and control (2.25), but not significantly different from that of the condition with the health messages as a photo caption (perceived message effectiveness mean=2.87). H1: Individuals who were likely to think deeply about safe sex practices (systematic processing) rated the messages as effective more often (beta=0.13, SE=0.02, P<0.001); H2: Heuristic processing of sexual health information as negatively associated with perceived message effectiveness (beta=-0.04, SE=0.02, p<0.05); H3: Attitudes toward condoms positively associated with perceived message effectiveness (beta=0.17, SE=0.03, P<0.001); H4: No evidence to support H4 that using a sexual health Instagram service would be positively associated with perceived message effectiveness (beta=0.02, SE=0.02, p=0.17); H5: perceived message sensation value was positively associated with perceived message effectiveness (beta=0.43, SE=0.03, P<0.001). Compared with control group, participants in the condition with messages embedded in photos had the highest frequency of rating the messages as effective (beta=0.66, SE=0.05, p<0.001), followed by the condition with messages placed as captions (beta=0.57, SE=0.05, P<0.001) and then the mixed group (beta=0.49, SE=0.05, P<0.001).

Table S10. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to pharmacovigilance.

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
A16. Correia et al. (2016) ⁵⁹	Instagram	5,329,720 posts from 6,927 user timelines	To determine the potential of Instagram for public health monitoring and surveillance from drug-drug interaction, adverse drug reaction, and behavioral pathology at large.	"fluoxetine" "sertraline" "paroxetine" "citalopram" "trazodone" "escitalopram" "fluvoxamine"	Used drug, symptom, and natural product libraries to match photos pulled with keywords related to FDA- approved drugs for depression.	--	Performed population- level behavior analysis of users.	The results demonstrate that Instagram can be navigated for public health monitoring, whereby analysts can search and visualize user timelines of interest.

Table S11. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to surgery.

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
B33. Ramkumar et al. (2017) ⁶⁰	Instagram and Twitter	Patients: Instagram- 3377 posts. Physicians: Twitter- avg of 94 posts by a surgeon. Hospital: Instagram- avg of 325 posts made by a hospital. Twitter- Avg of 6,785 posts	To investigate and analyze the presence and shared content of anterior cruciate ligament (ACL) patients, sports surgeons, and top orthopaedic hospitals on popular social media streams	#aclsurgery	Posts analyzed using a binary scoring system: media format (photograph or video), time (preoperatively or postoperatively), perioperative period (within 1 week of surgery or <1 week before surgery or <1 week after surgery), tone (positive or negative), return-to-work (RTW) reference (presence or absence), return-to-play (RTP) reference (presence or absence), rehabilitation reference (presence or absence), surgical-site reference (presence or absence), satisfaction reference (presence or absence), and dissatisfaction reference (presence or absence).	--	--	Patients: 3,145 public posts of human subjects were shared on Instagram 92% were personal recovery stories (emphasis on postoperative photographs). Posts focused on surgical site 25%, return to sport 30%, and postop rehabilitation 37%. Physicians, 16% had Twitter accounts with an average of 94 posts. None had Instagram. Hospitals 96% had Twitter accounts and 32% had Instagram accounts. Hospital Instagram mostly focused on patients or celebrities
C10. Dorfman et al. (2018) ⁶¹	Instagram	189 posts* (163 met inclusion criteria).	Research questions: 1) what plastic surgery-	1) #plasticsurgery; 2) #cosmeticsurgery; 3) #aestheticsurgery; 4) #plasticsurgeon;	categories of the posts (self-promotional vs education); meta-	Total number of posts using each	categories of users who posted the top images;	"Top" posts posted by users: foreign (n=68), non-American Society for Aesthetic Plastic

<p>C27 Ramkumar et al. (2017)⁶²</p>	<p>Instagram, Twitter, Facebook, and LinkedIn</p>	<p>233 Instagram posts; 465 tweets; 91 Facebook posts and 55 LinkedIn pages</p>	<p>To report on the marketing of cellular therapy for musculoskeletal conditions by evaluating the content in popular social media channels</p>	<p>For Instagram and Twitter: 25 hashtag combinations + 3 hashtags: #celltherapy #arthritis #celltherapy #bonemarrow #celltherapy #cartilage #celltherapy #ortho #celltherapy #osteoarthritis #mesenchymal #arthritis #mesenchymal #bonemarrow #mesenchymal #cartilage #mesenchymal #ortho #mesenchymal #osteoarthritis #adipose #arthritis #adipose #bonemarrow #adipose #cartilage #adipose #ortho</p>	<p>related content is being posted to Instagram; 2) who is posting this content; 3) what specific hashtags are they using?</p>	<p>5) #cosmeticsurgeon; 6) #aestheticsurgeon; 7) #breastlift; 8) #mastopexy; 9) #breastaugmentation; 10) #boobjob; 11) #breastimplant; 12) #nosejob; 13) #rhinoplasty; 14) #rhytidectomy; 15) #facelift; 16) #tummytuck; 17) #abdominoplasty; 18) #brazilianbuttlift; 19) #buttockaugmentation; 20) #bodycontouring; 21) #liposuction</p>	<p>data (likes, comments)</p>	<p>hashtag;</p>	<p>--</p>	<p>Surgery (ASAPS) eligible physicians (n=43), ASAPS eligible board-certified plastic surgeons (n=29), patients (n=21), medical interest groups (n=2). More self-promotional (n=94, 67.1%) than educational (n=46, 32.9%) posts, but there was no difference in number of likes (P=0.54) or comments (P=0.82). Board-certified plastic surgeons were more likely to post educational contents, as compared to nonplastic surgeons (62.1% vs 38.1%, P=0.02), but there was no difference in the number of likes (P=0.55) or comments (P=0.44).</p>	<p>Instagram data: Majority advertisement by business: 187/233 Instagram posts were posted by business or organization. 165/233 Instagram posts were advertisement. 10.2 hashtags per Instagram post.</p>
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<p>C28. Ramlumar et al. (2017)⁶³</p>	<p>Instagram</p>	<p>1287 total joint arthroplasty (TJA) posts; of which n=649 for total knee arthroplasty (TKA), 638 for total hip arthroplasty (THA)</p>	<p>To investigate the nature of the shared content of total joint arthroplasty (TJA) patients</p>	<p>#adipose #osteoarthritis #amniotic #arthritis #amniotic #bonemarrow #amniotic #cartilage #amniotic #ortho #amniotic #osteoarthritis #stemcell #arthritis #stemcell #bonemarrow #stemcell #cartilage #stemcell #ortho #stemcell #osteoarthritis #orthokine #regenokine #Regenexx</p> <p>For Facebook and Linkedln: "orthopedic cell therapy".</p>	<p>Media format: photo vs video. Timing: pre-operative vs post-operative. Perioperative period: perioperative vs not perioperative. Tone: positive or negative; Focus of the posts, binary for each variable: activities of daily living, rehabilitation, return-to-work, x-rays, industry advertisements, satisfaction and /or dissatisfaction, weight loss, or surgical site). These were compared between hip and knee arthroplasties.</p>	<p>--</p>	<p>Perspectives of the user's post</p>	<p>Majority (1199/1287, 93.2%) tone positive. 1176/1287 (91.4%) postoperative. 86.5% made by the patient themselves. TKA posts focused more on rehabilitation than THA posts (58.9% vs 8.8%, P<0.001). TKA posts featured the surgical site more than THA posts (14.5% vs 3.3%, P<0.001). In addition, THA posts highlighted activity of daily livings more than TKA posts (60.5% vs 7.6%, P<0.001)</p>
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*Dorfman et al. (2017) stated in their paper that a “total of 1,789,270 posts utilized the 21 hashtags sampled in this study.”⁶¹ The authors of this systematic review choose not to report this number in this table, because a detailed read of the paper reviewed that this is just the sum of the number of Instagram posts returned through a hashtag query. Since the actual content analysis was done on 163 posts sampled from this population of posts, the number of 1.8 million should probably be referred to as the population size, from which an approximately 1 in 10,000 sample was selected.

Table S12. Observational studies of Instagram, Pinterest, Tumblr and Flickr posts pertinent to injury prevention.

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Search terms (e.g., hashtags) used	Content of posts	Metadata of posts	User characteristics	Major Findings and public health implications
B2. Ahmed et al. (2016) ⁶⁴	Pinterest, Instagram, Flickr	176 images total (70 from Pinterest, 63 from Flickr, 43 from Instagram)	To systematically identify and analyze concussion- related images shared on popular image-sharing sites (Pinterest, Instagram, Flickr) with reference to current international guidelines	"Sports concussion" and "Concussion"	Analyzed the content of concussion- related images and its accompanying meta data	--	--	64% of images were of another person or a scene, with 39% of the content depicting injured individuals. Sharing a concussion-related incident (33%) and dispensing education (19%) were the main purposes of the images. 91% of images evaluated reflected the Sports Concussion Assessment Tool 3 (SCAT3) guidelines.
C11. Drake et al. (2017) ⁶⁵	Instagram	135 posts	To create an educational campaign to increase adolescent seatbelt use	Not applied.	Number of Instagram posts by content category: celebrity/trend, factual, follower response, health fair photos, humor and other	Likes used as measure for social media engagement	--	The difference between postings most liked (celebrities wearing seat belts) and least liked (postings made at the high school health fair) was significant ($p=0.01$), otherwise, differences among postings liked (humor postings, response requests, pictures of celebrities, factual data) were not significant.

Table S13. Functional Magnetic Resonance Imaging (fMRI) studies of adolescent psychology

Paper ID Authors (year)	Social Media Platforms	Sample Size	Objectives	Experimental design	Experimental procedures	Major Findings and public health implications
B36. Sherman et al. (2016) ⁶⁶	Instagram	32 typically developing adolescent	To investigate which adolescent peer influence occurs on social media using a functional MRI to simulate Instagram, a popular image sharing site.	Investigated how the content of a photo (neutral photo vs. photos that feature risky behaviors) influence adolescents to “like” the photos. Investigated how the number of likes affect adolescents’ behavioral and neural responses.	Participants were invited to a lab when they were given 3D googles that simulated the experience of browsing Instagram on a smartphone. While in the MRI, participants were viewed the photos. Participants could like a photo or move on without liking the photo. Researchers created two different versions of the imaging paradigm and randomly assigned them to the participants	Viewing photos with many likes was associated with greater neural activity. Risk photos (as opposed to neutral photos) decreased activation in the cognitive-control network. Possible mechanisms underlying peer influence during adolescence are discussed.
C33. Sherman et al. (2018) ⁶⁷	Instagram	34 high school students and 27 university students. 2 high school and 1 college participant were excluded from fMRI data analysis due to scanner malfunction or excessive movement	1. Replicate prior behavioral and neural findings in an older population that is nonetheless still experiencing social and brain development (i.e., college students); 2. Examine between-group differences and age-related effects in the high school and college cohorts in neural regions implicated in reward and executive functions; 3. Explore individual differences in neural activity as a function of health-related risky behavior.	Comparison between two samples from two populations (high school students and university students); comparison of responses between three types of stimuli (participant’s own images, neutral images and images showing risky health behavior); comparison of responses between “popular” (23-45 likes) and “unpopular” (0-22 likes) images.	Participants were asked to submit photographs from their own accounts. Beside their own photos, other photos were selected by the study team from publicly available images on Instagram. During fMRI scanning, participants viewed each photo for 3 seconds with the number of likes displayed underneath. The number of likes of each photo was manipulated and assigned by the study team with a “popular” value in one version and an “unpopular” value in another version. Following MRI scan, participants completed the	Both high school students and college students showed significantly higher activation in both left and right nucleus accumbens (NAcc) when they viewed their own photos that received many likes (versus few likes). In the college sample, seeing popular risky photos leads to higher significant activation than unpopular risky photos in the left NAcc. Bilateral NAcc responsivity to the many likes (popular) > few likes (unpopular) contrast increased with age in the high school sample but not in the college student sample. Significant differences were observed in dmPFC between high school students and college students. Frequency scores on CARE-R for college students were higher than those of high school students. Seeing risky photos with many > few

					<p>Revised Cognitive Appraisal of Risky Events.</p>	<p>likes, high school students with higher composite CARE-R scores showed greater activation in a region of the occipital cortex. When comparing all risky images to all neutral images for all participants, those with higher CARE-R scores again showed significantly greater activation in visual areas as well as the precuneus/PCC.</p>
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Table S14. Funding information of the 66 articles included in the systematic review.

		Count of included papers
Funding information not reported		27
Reported that no funding received		11
Funded		28
Type of funders	Funding Organizations	
US Government		17
	National Institutes of Health	15
	NCATS: National Center for Advancing Translational Sciences	1
	NCI: National Cancer Institute	4
	NCRR: National Center for Research Resources	2
	NHLBI: National Health, Lung, and Blood Institute	1
	NIAAA: National Institute on Alcohol Abuse and Alcoholism	1
	NIDA: National Institute on Drug Abuse	5
	NIMH: National Institute of Mental Health	1
	NLM: National Library of Medicine	1
	OD: Office of the Director of NIH	1
	National Science Foundation	2
	Food and Drug Administration	4
	Center for Tobacco Products	4
	Department of Homeland Security	1
Non-US Governments		7
	Australia Research Council	1
	Social Sciences and Humanities Research Council of Canada	1
	Norwegian Research Council	1
	Qatar National Research Fund	1
	The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FROMAS)	1
	United Kingdom Economic and Social Research Council	2
Foundations		5
	Brain Mapping Support Foundation, Pierson-Lovelace Foundation, The Ahmanson Foundation, Capital Group Companies Charitable Foundation, William M. and Linda R. Dietel Philanthropic Fund, and Northstar Fund.	2
	CAPES Foundation	1
	Dr. Mortimer and Theresa Sackler Foundation	1
	Volkswagen Foundation	1
University, research institutes, and hospitals		10
	Brain Mapping Medical Research Organization (associated with UCLA Ahmanson-Lovelace Brain Mapping Center)	2
	Seattle Children's Research Institute; Seattle Children's Hospital	2
	King Saud University	1
	Burnet Institute (associated with Monash University)	1
	EpiLife (Center for epidemiologic studies on mental health and physical health interacting over the life course), University of Gothenburg	1
	Goergen Institute for Data Science of the University of Rochester	1
	University of Louisville	1
	Washington University in St Louis	1
For-profit companies		2
	Persistent Systems	1
	Yahoo	1

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APPENDIX C

Public Health Implications of Image-based Social Media: A Systematic Review of Instagram,

Pinterest, Tumblr and Flickr

Appendix C. Exclusion table

Table S15. The list of articles excluded after full-text download with reasons for their exclusion provided.

Paper Number	Authors (Year)	Paper Title	Reason for Exclusion
A1	Custers, K. (2015)	The urgent matter of online pro-eating disorder content and children: clinical practice	This is a review paper.
A2	Santoro, E. (2013)	I social media, le apps e la trasformazione della comunicazione, della formazione e dell'assistenza in sanità [Social media and medical apps: how they can change health communication, education and care]	This is an editorial. It was written in Italian with an English abstract and the team was unable to read the full text due to our own limitations in language abilities.
A3	Lamberts, R. (2012)	What Instagram and Kodak have to do with health reform	This is an opinion paper.
A4	Carroll, C.L., & Ramachandran, P. (2014)	The intelligent use of digital tools and social media in practice management	This is a "Topics in Practice Management" piece. This is not a research article.
A5	La Sala, L., et al. (2014)	What do we mean by social networking sites?	This is a survey of self-reported social media use.
A6	Randeree, E. (2009)	Exploring technology impacts of Healthcare 2.0 initiatives.	This is a review paper. Its abstract says "This paper reviews the changing patient-physician relationship in the Healthcare 2.0 environment, explores the technological challenges, and highlights areas for research."
A7	Suler, J. (2008)	Image, word, action: interpersonal dynamics in a photo-sharing community	This is a psychology paper, with no public health implications.
A11	Whitsitt, J. et al. (2015)	Dermatology on Pinterest	This is a commentary.
A12	Roberts, J.A. et al. (2014)	The invisible addiction: Cell-phone activities and addiction among male and female college students	This is a survey of self-reported cell phone use.

A13	Shellenbarger, T. & Robb, M. (2013)	Pinstructive Ideas: Using a Social Networking Bulletin Board for Nursing Education	This is not original research. The authors shared their experience of using Pinterest in a nursing education setting.
A14	Lambert, D.N. et al. (2014)	A Formative Evaluation of a Social Media Campaign to Reduce Adolescent Dating Violence	This is not an original research article. This is a Protocol article. This is an evaluation of the Start Strong Atlanta 2007 social marketing campaign, "Keep It Strong ATL." While there were some social media components in this social marketing campaign, this does not present original research of the specific social media platforms included for this systematic review.
A15	McCann, A.D. & McCulloch, J.E. (2012)	Establishing an Online and Social Media Presence for Your IBCLC Practice	This is not an original research article. This paper provides recommendations to International Board Certified Lactation Consultant on how to establish their online and social media presence.
A17	Cool, C.T., et al. (2015)	Social media as a risk communication tool following Typhoon Haiyan	This is not an original research article. This is a "Lessons from the Field" paper that documents the actions of the WHO Representative Office in the Philippines during and after Typhoon Haiyan.
A20	Landry, M., et al. (2015)	Evaluation of Social Media Utilization by Latino Adolescents: Implications for Mobile Health Interventions	This is a survey of self-reported social media use.
A24	Nesi, J., & Prinstein, M.J. (2015)	Using Social Media for Social Comparison and Feedback-Seeking: Gender and Popularity Moderate Associations with Depressive Symptoms	This is a survey of self-reported social media use.
A25	Karimkhani, C. et al. (2014)	Dermatology on Instagram	This is a commentary.
A26	Jacobs, M.A. et al. (2016)	Using Tumblr to Reach and Engage Young Adult Smokers: A Proof of Concept in Context	This is not a research article. This paper describes a specific Tumblr blog smoking cessation intervention. This is more a description of what had been done in the field type of paper.
A27	Elliot, D. et al. (2015)	Focus Groups Move Online: Feasibility of Tumblr Use for eHealth Curriculum Development	This paper is about online curriculum development (out of scope). This paper is an evaluation project, using self-reported data from a survey to evaluate a Tumblr page.

A28	Barchiesi, D., Preis, T. et al. (2015)	Modelling human mobility patterns using photographic data shared online	This paper is about human mobility pattern (out of scope).
A29	Barchiesi, D., Moat, H.S. et al. (2015)	Quantifying International Travel Flows Using Flickr	This paper is about estimating the number of international visitors to the United Kingdom (out of scope).
A30	Hatfield & Rapson (2015)	From pen pals to chat rooms: the impact of social media on Middle Eastern Society	This is a review paper.
A31	Barry, S.J. (2014)	Using Social Media to Discover Public Values, Interests, and Perceptions about Cattle Grazing on Park Lands	This paper is about cattle grazing (out of scope).
A32	Preis, T. et al. (2013)	Quantifying the digital traces of Hurricane Sandy on Flickr	This paper is about identifying the statistical correlation between Flickr posts with titles, descriptions or tags related to Hurricane Sandy, and the atmospheric pressure in the US state of New Jersey during that period. This is out of scope.
A33	Hempel, G. et al. (2013)	Medizinstudium 2.0 dank Web 2.0?! – Risiken und Chancen am Beispiel des Leipziger Medizinstudiums [Study of medicine 2.0 due to Web 2.0?! -- risks and opportunities for the curriculum in Leipzig]	This paper is about the use of new media in medical education in a university in Germany (out of scope). Notes: We read the full-text English translation of the paper that was originally published in German.
A35	Liang, B.A., et al. (2012)	Suspect online sellers and contraceptive access	This research article reports results from Google search only (out of scope).
A36	Chu, L.F., et al. (2012)	Information technology and its role in anaesthesia training and continuing medical education	This is a review paper for the use of information technology, including social media, in medical education (out of scope).
A37	O'Mara, B. (2013)	Social media, digital video and health promotion in a culturally and linguistically diverse Australia	This is an opinion paper ("Perspectives").
A38	Liang, B.A., & Mackey, T.K. (2012)	Online availability and safety of drugs in shortage: a descriptive study of internet vendor characteristics	This paper is a study of websites that sold drugs online. This is not about social media (out of scope).
A39	Renner, B., et al. (2012)	First Impressions of HIV Risk: It Takes Only Milliseconds to Scan a Stranger	This paper is excluded because while the authors used photos obtained via

			Flickr as stimuli for their experiments, the paper really is not about social media posts and their public health implications.
A40	Gibbons, M.C., et al. (2011)	Exploring the Potential of Web 2.0 to Address Health Disparities	This is a review article.
A41	George, D.R., & Dellasega, C. (2011)	Use of social media in graduate-level medical humanities education: two pilot studies from Penn State College of Medicine	This paper is about the integration of social media into medical education (out of scope).
A43	Mull, I.R. & Lee, S.-E. (2014)	“PIN” pointing the motivational dimensions behind Pinterest.	This paper reports a survey of self-reported data of Pinterest use.
A44	Doring, N. et al. (2016)	How gender-stereotypical are selfies? A content analysis and comparison with magazine adverts	This paper is about gender stereotyping. This is not related to public health (out of scope).
A45	Kent, J.D. & Capello, H.T., Jr. (2013)	Spatial patterns and demographic indicators of effective social media content during the Horsethief Canyon fire of 2012	This paper is about the Horsethief Canyon fire of 2012. This is borderline with regard to public health implications. The data use included Instagram, Twitter, Flickr and Picasa. However, the authors' primary interests are the geolocation of the posts. The paper does not separate the Instagram and Flickr data stream from that of Twitter, for example. Thus, we cannot extract Instagram-specific data or Flickr-specific data from this paper. Taken both points into consideration, we decided to exclude this paper.
A46	Levin, N., et al. (2015)	Where have all the people gone? Enhancing global conservation using night lights and social media	This paper is about conservation of the natural environment. Precisely, this paper quantifies human presence beyond populated areas by using social media data and remote sensing tools. This is not public health-related (out of scope).
B1	Ahadzadeh, A.S., Sharif, S.P., et al. (2017).	Self-schema and self-discrepancy mediate the influence of Instagram usage on body image satisfaction among youth.	This study is a survey with self-reported Instagram use.
B8	Boyle, S.C., LaBrie, J.W., et al. (2016).	Different digital paths to the keg? How exposure to peers' alcohol-related social media content	This study is a survey with self-reported Instagram, Snapchat, and Facebook use.

		influences drinking among male and female first-year college students.	
B14	Diaz-Bustamante-Ventisca, M. & Llovet-Rodriguez, C. (2017).	Empowerment or Impoverishment of Children from Social Networks? Perceptions of Sexualized Images of Girls in Instagram."	This study examines sexualized images of girls; not a public health topic (out of scope).
B19	Hindman, F.M., Jr., Bukowitz, A.E. et al. (2017).	No filter: A characterization of #pharmacist posts on Instagram	this paper is about the portrayal of pharmacists on Instagram and is not public health related (out of scope).
B26	Martorell, L. B., Nascimento, W.F.d., et al. (2016)	O Uso de Imagens em Redes Sociais e o Respeito ao Paciente Odontológico.	It discusses the legal and ethical ramifications of dentists sharing images on Instagram. While this study did look at images on Instagram, our team deemed it not relevant to public health, as it was more policy-oriented.
B27	McNabb, J. and Gray, R.	Staying Connected on the Road: A Comparison of Different Types of Smart Phone Use in a Driving Simulator	This research article focuses on the level of distraction experienced by the drivers (as measured in brake reaction times) as they interacted with their cell phone in different ways. We determined that is out of scope for this review.
B29	Pardo Sainz, R. (2017).	Mental Illness, Photojournalism and Internet: toward a more humanized and normalized image.	This is actually a review paper. The author did show a few examples of images on social media and discuss them in relation to photography and mental illness. However, it was used to basically just reflect on photography. There was no methodical content analysis and results, as in other papers included in this systematic review.
B30	Park, M.S., He, Z. et al. (2016).	Consumers' Use of UMLS Concepts on Social Media: Diabetes-Related Textual Data Analysis in Blog and Social Q&A Sites.	Reason: the focus of this paper is to investigate the overlap between consumer concepts from social media and professional concepts in the Unified Medical Language System. The team deemed this paper not relevant to public health.
B34	Ridgway, J.L. & Clayton, R.B. (2016).	Instagram Unfiltered: Exploring Associations of Body Image Satisfaction, Instagram #Selfie Posting, and Negative Romantic Relationship Outcomes.	This paper is a survey of self-reported Instagram use.

B40	Turner, P.G. & Lefevre, C.E. (2017).	Instagram use is linked to increased symptoms of orthorexia nervosa	This paper distributed a survey of self-reported social media use.
C2	Bew, R., Hunter, E., & McDermid-Thomas, A. (2017)	Using Instagram as an Alzheimer Scotland occupational therapy intern to share knowledge of occupation in order to live well with dementia.	This is a conference abstract only.
C5	Braunerger, T., et al. (2017)	Global skin diseases on Instagram hashtags	This is a "commentary" with original data presented.
C7	Burgess, J.D, et al. (2017)	The Adoption of Social Media to Recruit Participants for the Cool Runnings Randomized Controlled Trial in Australia	The Instagram ad data are mixed with Facebook ad data; cannot distinguish the two in the report.
C8	Chung C.-F. et al. (2017)	When Personal Tracking Becomes Social: Examining the Use of Instagram for Healthy Eating.	This study contained only self-reported use of Instagram data from interviews with 16 individuals individually.
C9	Djafarova, E., & Trofimenko, O. (2017)	Exploring the relationships between self-presentation and self-esteem of mothers in social media in Russia.	This study is not related to public health (out of scope).
C12	Frison, E., & Eggermont, S. (2017)	Browsing, Posting, and Liking on Instagram: The Reciprocal Relationships Between Different Types of Instagram Use and Adolescents' Depressed Mood.	This study contained only self-reported use of Instagram from 2 surveys.
C15	Hendrickse, J., et al. (2017)	Instagram and college women's body image: Investigating the roles of appearance-related comparisons and intrasexual competition.	This study contained only self-reported data from a questionnaire.
C16	Hill, S. (2017)	Exploring Disabled Girls' Self-representational Practices Online.	This is not public health-related (girlhood and disability) and it is a qualitative analysis of one individual's Instagram posts.
C24	Parwani, P., & Tison, G. (2017)	Understanding social media usage related to cardiology: underlying motivation and untapped opportunities	This is an abstract only.
C26	Pokhrel, P., et al. (2018)	Social media e-cigarette exposure and e-cigarette expectancies and use among young adults.	This paper only contain data of self-reported use of social media.
C29	Ranginwala, S., & Towbin, A.J. (2018)	Use of Social Media in Radiology Education.	This paper is a review of social media use in radiology education.

C31	Salzmann-Erikson, M., & Eriksson, H. (2017)	A descriptive statistical analysis of volume, visibility and attitudes regarding nursing and care robots in social media.	This paper is about social media posts mentioning nursing care robots. This is out of scope (not public health).
C34	Singh, V., et al. (2017)	An analysis of social media use surrounding the approval of Ustekinumab (Stelara) for the treatment of Crohn's disease	This is an abstract only.
C36	Stapleton P, Luiz G, Chatwin H. (2017)	Generation Validation: The Role of Social Comparison in Use of Instagram Among Emerging Adults.	This paper is a survey about self-reported social media use and self-reported self-esteem. This is not public health-related (out of scope).
C37	Urso, B., et al. (2017)	Acne treatment utilization among patients on social media platforms.	This is an abstract only.
C39	Webb, J.B., et al. (2017)	Fitspo at every size?: a comparative content analysis of #curvyfit versus #curvyoga Instagram images	This is a poster presentation.

APPENDIX D

Public Health Implications of Image-based Social Media: A Systematic Review of Instagram, Pinterest, Tumblr and Flickr

Appendix D. Additional sections on Methods and Results

Methods

Details of data extraction and quality assessment

Both data extraction and quality assessment were completed by May 2018.

Papers retrieved for full text were reviewed by at least two co-authors (Batch A: EBB, SLC, AMJ, JCJ; Batch B & C: EBB, JOA, LKC, EAD; Batch C: ICHF, EBB, JOA, LKC) to determine their inclusion eligibility. Each was assigned a unique identifier. If an article was determined to be included, two co-authors extracted the data and assessed the quality of the article independently.

A standardized data extraction form was used to record the following information: the paper's unique identifier, title, authors, year of publication, study design, the choice of the quality assessment tool, social media platforms studied, research questions/aims, data collection method, time frame of images retrieved, search terms, inclusion/exclusion of any data, sample size, content coding method, analytic method, outcome measures, main findings, and limitations. We also reviewed the data extraction methods for account and content identification, Institutional Review Board approval and participant's consent, as well as funding sources reported. If there was any disagreement in the inclusion/exclusion decision between the two reviewers, a co-author served as the adjudicator (Batch A: CHD & ICHF, Batch B & C: ICHF). Papers written in Spanish and Portuguese were read by the co-first author (EBB) only.

Results

Sampling of images in observational studies

Sampling methods vary greatly among the observational studies.

(I) Some studies attempted to capture **all posts that met their inclusion criteria**: with a specific keyword or hashtag, or posted by certain accounts, and/or within a certain time frame (C13, C14, C19, A34, C30, C3, C6, B38, A16, B33, C27, C28).⁴⁻¹⁵

(II) **Random sampling** was applied in some studies, but in different ways.

(a) **Simple random sample**: In Fung et al. (B16),¹⁶ Cavazos-Rehg et al. (B11)¹⁷ and Chu et al.

(B13),¹⁸ the researchers collected all the Instagram images that met the inclusion criteria and then analyzed a simple random sample.

(b) **Random sample of images, stratified by time**: Allem and colleagues collected all Instagram images that met their inclusion criteria but they then did a stratified random sampling by week (B4, C1).^{19,20}

(c) **Random sample of images, replacing images from the same users with the next images posted by users whose images were not previously selected**: This method made sure that the sample in Warner et al. (C38)²¹ would not be dominated by images that were uploaded by the same group of users.

(d) **Random sample of time slots to capture images**. For example, Carrotte et al. (C10) randomly generated 3 time slots and then screenshot all images tagged with hashtag #fitspo that were uploaded by users over the next 10 minutes.²² Lee et al. (C18) captured 10 images per search term twice a week a random day and time (between 8 am and 11 pm).²³ Miguel et al. (C20) screenshot the first 10 images chronologically generated from each search for 6 months; the time and platform (Instagram, Tumblr

and Twitter) of the search were randomly chosen and reflect all 24 hours across all 3 platforms in their study.²⁴

Non-random sampling methods were used in other studies:

- (a) **A convenience sample by reaching a target:** for example, Pila et al. (B31) sampled the first 300 images that appeared in two non-consecutive days (to include both weekday and weekend);²⁵ or, the authors attempted to download all the posts until a certain limit set by the software they used was reached as in the Instagram images download by Santarossa et al.²⁶ (B35) and the Pinterest data collection in Fung et al. (B16).¹⁶
- (b) **The most popular group:** for example, Paige et al. (A42) identified the 10 most followed COPD group pinboards and collect all their pins.²⁷
- (c) **The most popular users:** for example, Cavazos-Rehg et al. (B12) identified users who posted the most popular posts related to each of the four search terms, and then they randomly selected 200 posts that were posted by the selected users.²⁸
- (d) **The most recent posts:** for example, Marcus (B25) sampled 80 of the most recent posts from each hashtag of interest.²⁹
- (e) **The posts that show up first:** for example, Ahmed (B2) identified the first 50 images when they searched for “sports concussion” and “concussion”.³⁰
- (f) **Every “fifth” pin:** for example, Guidry and colleagues (A8, A9, B18) selected every fifth pin for each keyword search, until it reached the target of 200 pins per keyword (with duplicates removed).³¹⁻³³ A variation of this method was used by Webb and colleague (C40).³⁴ They used a random number generator to generate a number, such as “2”, and then they would extracted the second image of each row. This was not a truly random sample, because their method basically put images into several groups and then selected one of them.

- (g) **A small sample over time:** for example, Seltzer et al. (C32) captured 15-20 posts every three days until they reached their target of 500 images.³⁵

Methods of data capture in observational studies

Data capture methods varied across papers:

- (a) **Application Programming Interface (API):** Eight used API (A34, B4, B11, B13, B16, C1, C6, C19).^{6,7,10,16-20} This was especially important for those researchers who attempted to collect all images that met their inclusion criteria
- (b) **Firehose:** One used Firehose for Tumblr, known as DiscoverText (C4).³⁶
- (c) **Proprietary platforms:** Examples included Brandviewer (C17),³⁷ DemographicsPro (C3),⁹ Iconosphere (B33),¹³ Iconosquare (C28),¹⁵ Netlytic (B35),²⁶ Picodash (C27, C28),^{14,15} Pinsta.me (B42),³⁸ Simply Measured (B12),²⁸ and Statigram (B21).³⁹
- (d) **Screenshots:** Screenshots were used by some to capture images directly off the interfaces of social media platforms, for example, Instagram (B5, B10, C20),^{22,24,40} Pinterest (B16; B18; B37),^{16,33,41} and Tumblr (C20).²⁴
- (e) **Provided by participants:** Reece and Danforth (C30) recruited participants who shared their Instagram photos through an app that was embedded in the survey that allowed participants to securely log into their Instagram accounts and agree to share their data with the research team.⁸

Ethical approval and written consent

Twenty-eight (42% of 66) mentioned obtaining approval or exemption from Institution Review Board or equivalent (A18, A19, A21, A23, A42, B3, B7, B9, B11, B12, B15, B16, B20, B21, B36, B41, C1, C3, C4, C6, C20, C21, C27, C30, C32, C33, C35, C38).^{8-10,14,16,17,20,21,24,27,28,35,36,39,42-55}

Of the 12 experimental studies with human participants, six explicitly mentioned participants' written consent (B3, B9, B15, B36, C33, C35)^{46,48,49,51,54,55} and six did not (A22, B7, B20, B23, C21, C25).^{47,50,53,56-58} The observational Photovoice project with human participants mentioned institutional review board (IRB) approval and participants' consent (A23).⁴⁵

Funding

Among these 66 papers, 28 were funded (A16, A18, A23, A34, B3, B4, B6, B7, B10, B11, B12, B13, B15, B17, B21, B31, B32, B36, C1, C3, C4, C6, C18, C20, C30, C33, C38, C41);^{7-10,12,17-25,28,36,39,42,45-47,49,51,54,59-62} 11 reported receiving no funding (A21, B2, B16, B28, B35, B39, B42, C10, C25, C27, C32)^{14,16,26,30,35,38,44,58,63-65} and 27 did not report at all (A8, A9, A10, A19, A22, A42, B5, B9, B18, B20, B23, B24, B25, B33, B37, B38, B41, C11, C13, C14, C17, C19, C21, C23, C28, C35, C40).^{4-6,11,13,15,27,29,31-34,37,40,41,43,48,50,52,53,55-57,66-69} Among the 28 funded papers, 15 were funded by the National Institutes of Health, 2 by National Science Foundation, 4 by Food and Drug Administration, 1 by Department of Homeland Security, 7 by non-US governments, 5 by philanthropic foundations, 10 by universities, research institutes or hospitals, and 2 by private for-profit companies; please note that some of these papers were funded by multiple sources (Table S14, Appendix B).

Discussion

Restrictions on Instagram application programming interface (API)

Third-party apps for Instagram have been impacted due to the restrictions on Instagram's API imposed in 2017 and 2018.⁷⁰ These third-party apps depend on API in order to receive and analyze users' Meta data (e.g. posts and followers), and search for specific hashtags.⁷¹

Instagram's new restrictions include: a required Instagram account to search for a hashtag, the removal of real-time updates (RTU), a reduction in requests made per hour, and each app must undergo a permission approval process.⁷¹ In order for the researcher to pull data, the Instagram users must first log in to their account and give permission. This requirement could reduce the total information obtained by the researchers. The missing information skews the data of Instagram analytics due to the use of a smaller sample size.

Since early 2018, another main restriction has been the reduction in API requests from 5000 per hour to 200 per hour.⁷² Instagram researchers are pulling less data, since they are reaching their API limit faster. The researchers must craft their research questions and hypotheses carefully that could be examined with limited dataset. Since the app must request an update to the API, this will add an extra step before the data collection. This implication can also cause researchers to miss information from updates in real-time.

Ethical approval and written consent

We caution against jumping to the conclusion that some of the studies did not seek IRB approval. Perhaps certain journals only required the authors to report their IRB approval to the journal editors and did not require such approval to be printed in the article.

Funding and data access

The issue of funding is closely tied to the issue of data access. As API restriction is increasingly tight, researchers who do not have research funding to pay for proprietary data access services will encounter problems regarding data retrieval and sampling. This will limit research on image-based social media to well-funded researchers based in research-intensive universities. It is our opinion that the era has ended for the equalitarian and democratic participation of

scholars and graduate students, funded or not by external funding agencies, to study image-based social media as represented by the studies reviewed herein. One unintended downstream consequence will be the limitations on graduate student research on these social media platforms conducted by underprivileged (rural, minority) students who are the mainstay of student enrollment in non-research-intensive universities that the corresponding author's institution represents. Notwithstanding privacy concerns of individual users, we call upon social media companies to collaborate with academics for a more open-minded, equalitarian approach to data access for bona fide social science research.⁷³

Evaluation of the new checklist for quality assessment of studies

After performing quality assessment of the observational studies included in this systematic review, we evaluated the inter-rater reliability between two coders for each item of the new checklist using Cohen's kappa. Outliers aside, the inter-rater reliability for 8 of 10 items was between 0.4 and 0.6, representing moderate agreement.⁷⁴ Inter-rater reliability for Question 10 was perfect ($\kappa = 1$). However, the "slight agreement"⁷⁴ for inter-rater reliability for Question 4 ($\kappa = 0.111$) reflects that the question, "Specification (or limits) set for data retrieval clearly stated (1 yes; 0 no)," will require improvement in future research.

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APPENDIX E

Public Health Implications of Image-based Social Media: A Systematic Review of Instagram, Pinterest, Tumblr and Flickr

Appendix E. Quality assessment

Table S16. New checklist for the quality assessment of observational studies that analyzed image-based social media posts (excluding experimental studies or surveys with human participants)

1	Is there a clear statement of the aims of the research (the research questions)? (1 yes; 0 no)
Data retrieval information clearly stated:	
2	Keyword/hashtag used to retrieve data clearly stated (1 yes; 0 no)
3	Tool / method used to retrieve data clearly stated (1 yes; 0 no) <i>Example: API/screen capture/manual identification</i>
4	Specification (or limits) set for data retrieval clearly stated (1 yes; 0 no) <i>Example: limits to only English posts; limits to certain types of images</i>
5	Date (or time frame) of data retrieval clearly stated (1 yes; 0 no)
6	Was the sampling method representative of the social media posts (or populations) intended to the study? <i>Non-probability sampling (including; purposive, quota, convenience and snowball sampling) is 0</i> <i>Probability sampling (including: simple random, systematic, stratified, cluster, two-stage and multi-stage sampling) is 1</i> <i>Full population (i.e. everything retrieved under a search term) is 1</i>
7	If this is a content analysis of social media posts, is the classification reliable? <i>Manual coding with at least 10% double coded, with a reported kappa of 0.8 or higher (on average), then 1</i> <i>Manual coding with two coders, and all disagreements resolved by consensus or by a third reviewer, then 1</i> <i>Machine learning methods, then 1</i> <i>if not, then 0 (if no kappa reported, then 0, unless all disagreement resolved)</i> <i>If this is NOT a content analysis, then NA</i>
8	Statistical analysis. Did the investigator(s) control for confounding factors (e.g., stratification/matching/restriction/adjustment) when analyzing the associations? (yes 1; no 0) <i>If the study contains purely descriptive results, no association and prediction tests were conducted in the test, then Not applicable</i>
9	IRB approval or waiver obtained, or state that IRB determined that this is not human subject research. (yes 1; no 0)
10	Is there a clear statement of findings? (yes 1; no 0)

Maximum score = 10 out of 10

Table S17. Statistics of the scores of quality assessment using three different checklists.

	Papers assessed using a checklist	Maximum score possible	Scores received				Mean	Standard deviation	Range
			1 st quartile	Median	3rd quartile	Mean			
Downs and Black ^a	20	26	7.5	11	12.25	10.65	4.37	4 – 22	
Reporting		10	4	6	8	3.33	1.92	3 – 10	
External validity		3	0	0	1	0.25	0.74	0 – 2	
Internal validity – bias		7	2	3	3.25	1.53	1.30	1 – 5	
Internal validity – confounding		6	0	1	2	0.81	1.36	0 – 5	
CASP qualitative research checklist ^b	46	9	7	8	8	7.83	0.76	5 – 9	
New Checklist	54	10	5	6	8	6.05	1.66	1 – 9	

CASP: Critical Appraisal Skills Programme. Notes: a) Excluding Question 27; b) excluding Question 10.

Table S18. Summary scores of papers using the Downs & Black Checklist, excluding question 27.

	Reporting				External validity				Internal validity - bias				Internal validity - confounding			
	R1	R2	Min	R1	R2	Min	R1	R2	Min	R1	R2	Min	R1	R2	Min	
A10	6	6	6	1	1	1	4	3	3	1	1	3	1	1	1	
A16	7	4	4	1	1	1	2	2	2	2	2	2	2	2	2	
A22	6	7	6	3	1	1	5	4	4	4	4	4	4	5	4	
A34	7	3	3	0	0	0	2	1	1	1	1	1	1	0	0	
B7	8	8	8	1	0	0	3	4	3	1	1	3	1	1	1	
B9	7	8	7	1	0	0	3	5	3	4	4	3	4	2	2	
B15	10	10	10	2	2	2	5	5	5	5	5	5	5	5	5	
B16	8	8	8	0	0	0	3	4	3	3	3	3	3	2	2	
B23	7	7	7	2	2	2	1	1	1	1	1	1	1	1	1	
B35	8	8	8	0	0	0	3	3	3	3	3	3	3	3	3	
B36	9	5	5	0	0	0	5	5	5	3	3	5	3	0	0	
B41	8	6	6	0	0	0	3	3	3	3	3	3	3	2	2	
C6	5	4	4	2	0	0	2	1	1	0	0	1	0	1	0	
C13	4	3	3	1	0	0	2	2	2	0	0	2	0	0	0	
C21	8	8	8	0	0	0	2	2	2	1	1	2	1	1	1	
C25	9	4	4	2	0	0	4	2	2	1	1	2	1	0	0	
C30	6	6	6	0	0	0	4	4	4	2	2	4	2	2	2	
C33	8	4	4	0	0	0	5	1	1	2	2	1	2	0	0	
C35	8	8	8	2	2	2	5	5	5	2	2	5	2	2	2	
C41	5	5	5	0	0	0	2	2	2	1	1	2	1	1	1	

Table S19. Summary scores of papers using Critical Appraisal Skills Programme (CASP) qualitative research checklist, excluding Question 10.

Paper ID	Reviewer 1	Reviewer 2	Minimum of two
A8	8	7	7
A9	8	8	8
A18	9	8	8
A19	9	9	9
A21	9	8	8
A23	8	8	8
A42	9	9	9
B2	8	7	7
B3	8	8	8
B4	8	8	8
B5	8	5	5
B6	8	8	8
B10	9	7	7
B11	8	7	7
B12	8	8	8
B13	8	7	7
B17	8	8	8
B18	8	7	7
B20	7	7	7
B21	9	7	7
B24	9	9	9
B25	8	8	8
B28	8	8	8
B31	9	9	9
B32	9	9	9
B33	8	8	8
B37	9	8	8
B38	9	9	9
B39	8	8	8
B42	8	8	8
C1	8	8	8
C3	7	7	7
C4	8	8	8
C10	8	8	8
C11	7	7	7
C14	8	8	8
C17	7	-	7
C18	7	7	7
C19	8	8	8
C20	8	8	8
C23	8	8	8

C27	8	8	8
C28	8	8	8
C32	8	8	8
C38	9	9	9
C40	8	8	8

Note: C17 was a Portuguese paper and was evaluated by one individual only.

Table S20. Summary of papers using the New Quality Assessment Checklist.

Paper ID	Reviewer 1	Reviewer 2	Minimum of two
A8	8	8	8
A9	8	8	8
A10	8	8	8
A16	5	5	5
A18	7	7	7
A19	5	7	5
A21	8	8	8
A23	6	3	3
A34	8	8	8
A42	8	8	8
B2	7	6	6
B4	8	6	6
B5	5	5	5
B6	9	9	9
B10	5	7	5
B11	6	7	6
B12	8	6	6
B13	8	8	8
B16	9	9	9
B17	6	6	6
B18	5	7	5
B21	7	6	6
B24	5	8	5
B25	6	6	6
B28	6	6	6
B31	6	7	6
B32	8	8	8
B33	6	6	6
B35	7	7	7
B37	8	8	8
B38	5	8	5
B39	5	5	5
B41	9	10	9
B42	6	7	6
C1	9	8	8
C3	8	3	3
C4	8	8	8
C6	8	8	8
C10	5	8	5
C11	1	2	1
C13	7	8	7
C14	6	6	6

C17	8	-	8
C18	5	4	4
C19	5	5	5
C20	8	8	8
C23	5	8	5
C27	8	6	6
C28	6	6	6
C30	7	6	6
C32	8	9	8
C38	6	5	5
C40	8	6	6
C41	6	4	4

Note: C17 was a Portuguese paper and was evaluated by one individual only.

Table S21. Inter-rater reliability between two coders for each item of the New Checklist after coding the observational studies.

	Kappa	Standard Error	95% confidence interval	
Q1	0.547	0.226	0.103	0.991
Q2	0.47	0.216	0.046	0.894
Q3	0.541	0.143	0.261	0.821
Q4	0.111	0.146	-0.175	0.397
Q5	0.512	0.159	0.202	0.823
Q6	0.431	0.12	0.196	0.666
Q7	0.517	0.11	0.302	0.732
Q8	0.652	0.142	0.374	0.93
Q9	0.526	0.12	0.29	0.761
Q10	1	0	1	1