# Digital Media and Democracy: A Systematic Review of Causal and Correlational Evidence Worldwide

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## ABSTRACT

One of today's most controversial and consequential questions is whether the rapid, worldwide uptake of digital media is causally related to a decline in democracy. We conducted a systematic review of causal and correlational evidence ($N = 498$ articles) on the link between digital media and different political variables, such as trust, polarization or news consumption. We further focused on the subset of articles that employed causal inference methods. Across methods, the articles report associations between digital media use and most political variables. Some associations, such as increases in political participation and information consumption, are likely to be beneficial for democracy and were often observed in the Global South and emerging democracies. Other consistently reported associations, such as declining political trust, advantages for populists, and growing polarization, are likely to be detrimental to democracy and were more pronounced in established democracies. We conclude that while the impact of digital media on democracy depends on the specific political variable and the political system in question, several variables show clear directions of associations. We believe that the evidence calls for further research efforts and vigilance by governments and

civil societies to better understand and actively design the intimate interplay of digital media and democracy.

## Introduction

The ongoing heated debate on the opportunities and dangers that digital media pose to democracy has been hampered by disjointed and conflicting results (for recent overviews see [1–4]). Disagreement about the role of new media is not a novel phenomenon; throughout history, evolving communication technologies have provoked concerns and debates. One likely source of concern is the dual-use dilemma: technologies can be used for both noble and malicious aims. For instance, when radio emerged during the Second World War, it was used as a propaganda tool by Nazi Germany [5], whereas allied radio, such as the BBC, supported resistance against the Nazi regime[1] [6, 7]. In the context of the Rwandan genocide, radio was used to incite Rwandan Hutus to massacre the country's Tutsi minority [8]. In the aftermath of the genocide, using the same means to cause different ends, the radio soap opera *Musekeweya* successfully reduced intergroup prejudice in a yearlong field experiment [9, 10].

Digital media appears to be another double-edged sword. On the one hand, it can empower citizens, as demonstrated in movements such as the Arab Spring [11], Fridays for Future, and #MeToo [12]. On the other hand, digital media can also be instrumental in inciting destructive behaviours and tendencies such as polarization and populism [13], as well as fatal events such as the attack on the United States Capitol in January 2021.

Digital media appear to be capable of fostering liberation, democratization, and participation, but they can also play an important role in eroding democracy. The role of digital media is further complicated because unlike other communication technologies, it enables individuals to easily produce and disseminate content themselves and offers largely frictionless interaction between users. These properties have not only moved the self-organised political behaviour of citizens into the spotlight [14], they have also shifted power to large digital media platforms. Unlike broadcasters, digital media platforms typically do not create content; instead, their power lies in providing and governing a digital infrastructure. Although that infrastructure could serve as an online public sphere [15], it is the platforms, that are having much control over the dynamics of information flow.

Our goal is to advance the scientific and public debate by providing an evidence-based picture of this complex constellation. To this end, we comprehensively reviewed and synthesized the available scientific knowledge [16] on the link between digital media and various political variables such as participation, trust and polarization.

### Approach and Scope

We aimed to answer the preregistered question *If, to what degree and in which contexts, do digital media have detrimental effects on democracy?* (preregistered protocol, including research question and search strategy, at https://osf.io/7ry4a/).

[1] In this case, radio was used mainly to provide tactical information on allied military activities rather than for propaganda.

A major difficulty facing researchers and policy makers is that most studies relating digital media use to political attitudes and behaviours are correlational. Because it is nearly impossible to simulate democracy in the laboratory, researchers are forced to rely on observational data that typically only provide correlational evidence. We therefore pursued two approaches: First, we collected and synthesized a broad set of articles that examine associations between digital media use and different political variables. We then conducted an in-depth analysis of the small subset of articles reporting causal evidence. This two-step approach permitted us to focus on causal effects while still taking the full spectrum of correlational evidence into account.

We aimed to synthesize evidence on a broad spectrum of political attitudes and behaviours that are relevant to basic democratic principles [17]. We therefore grounded our assessment of political variables in the literature that examines essential elements of modern democracies, such as citizens' basic trust in media and institutions [18], a well-informed public [19], an active civil society [20, 21], and exposure to a variety of opinions [22, 23]. We also included phenomena that are considered detrimental to democracy, including open discrimination against people [24], political polarization to the advantage of political extremists and populists [25], and social segregation in homogeneous networks [22, 26].

The political variables in focus are themselves multi-dimensional and may be heterogeneous and conflicting. For example, polarization encompasses partisan sorting [27], affective polarization [28], issue alignment [29, 30], and a number of other phenomena (see [31] for an excellent literature review on media effects on variations of ideological and affective polarization). For our purpose, however, we take a broader perspective, examining and comparing across different political variables the directions—beneficial or detrimental to democracy—in which digital media effects play out.

Notwithstanding the nuances within each dimension of political behavior, wherever possible we explicitly interpret each change in a political variable as tending to be either beneficial or detrimental to democracy. Even though we try to refrain from normative judgements, the nature of our research question required us to interpret the reported evidence with regard to its relation with democracy. For example, an increase in political knowledge is generally considered to be beneficial under the democratic ideal of an informed citizenry [19]. Similarly, a certain level of trust in democratic institutions is crucial for a functioning democracy [32]. By contrast, various forms of polarization (particularly affective polarization) tend to split societies into opposing camps and threaten democratic decision making [33, 34]. Likewise, populist politics, that are often coupled with right-wing nationalist ideologies, artificially divide society into a corrupt "elite" that is opposed by "the people", which runs counter to the ideals of a pluralistic democracy and undermines citizens' trust in politics and the media [35, 36]. We therefore consider polarization and populism, for example, to be detrimental for democracy.

There are already some systematic reviews of subsets of associations between political behaviour and media use that fall within the scope of our analysis, including reviews of the association between media and radicalization [37, 38], polarization [31], hate speech [39], participation [40–44], echo chambers [45], and campaigning on Twitter [46]. For the most relevant review articles, we matched the references provided in these reviews with our reference list (see

Materials and Methods section for details). Importantly, and unlike some extant reviews, our focus is not on institutions, the political behaviour of political elites (e.g., their strategic use of social media; see [46, 47]), or higher-level outcomes (e.g., policy innovation in governments [48]). We also do not consider the effects of traditional media (e.g., television or radio) or consumption behaviours that are not specific to digital media (e.g., selective exposure [49]). Furthermore, we do not focus on the microscopic psychological mechanisms that could shape polarization on social media (for a review see [50]). For reasons of external validity, we omitted small scale laboratory-only experiments (e.g., [51]), but included field experiments in our review. We included studies using a variety of methods—from surveys to large-scale analyses of social media data—and across different disciplines, that are relevant to our research question. Details on the inclusion and exclusion criteria are provided in the Materials and Methods section. Our goal with this knowledge synthesis is to provide a nuanced foundation of shared facts for a constructive stage in the academic but also societal debate about the future of digital media and their role in democracy.

## Results

After conducting a preregistered search (most recent update September 15, 2021) and selection process, we arrived at a final sample of $N = 498$ articles. For further analysis, we classified the articles by the constellation of variables between which they report associations: type of digital media (e.g., social media, online news), political variables (e.g., trust, participation), and characteristics of the information ecology (e.g., misinformation, selective exposure), as depicted in Fig. 1a. Each article was coded according to the combination of these variables as well as method, specific outcome variable, and, if applicable, the direction of association and potential moderator variables (see Materials and Methods for details). The resulting table of the fully coded set of studies is at https://osf.io/7ry4a/, alongside the code for the analyses and visualizations offered here.

Fig. 1 reports the composition of the set of included articles. Fig. 1a confirms that the search query mainly returned articles concerned with the most relevant associations between digital media and political outcomes (A–B, $N = 298$). Most of the articles were published in the last 5 years, highlighting the fast growth of interest in the link between digital media and democracy. Articles were conducted across various disciplines, including political science, psychology, computational science, and communication science. Although a preponderance of articles focused on the United States, there was still a large geographical variation overall (see Fig. 1b).

Fig. 1c shows the distribution of measurements (counted separately when one article reported several outcomes) across methods and political variables. Our search query was designed to capture a broad range of politically relevant variables (see Fig. 6 in the Materials and Methods section), which meant that we had to group them into broader categories. The 10 most frequently reported categories of variables that we found in our sample, were trust in institutions, different ways of political participation (e.g., voter turnout or protest participation), exposure to diverse viewpoints in the news, political knowledge, political expression, measures of populism (e.g., support for far-right parties or anti-minority rhetoric), volume and spread of misinformation, measures of polarization (e.g., negative attitudes towards political

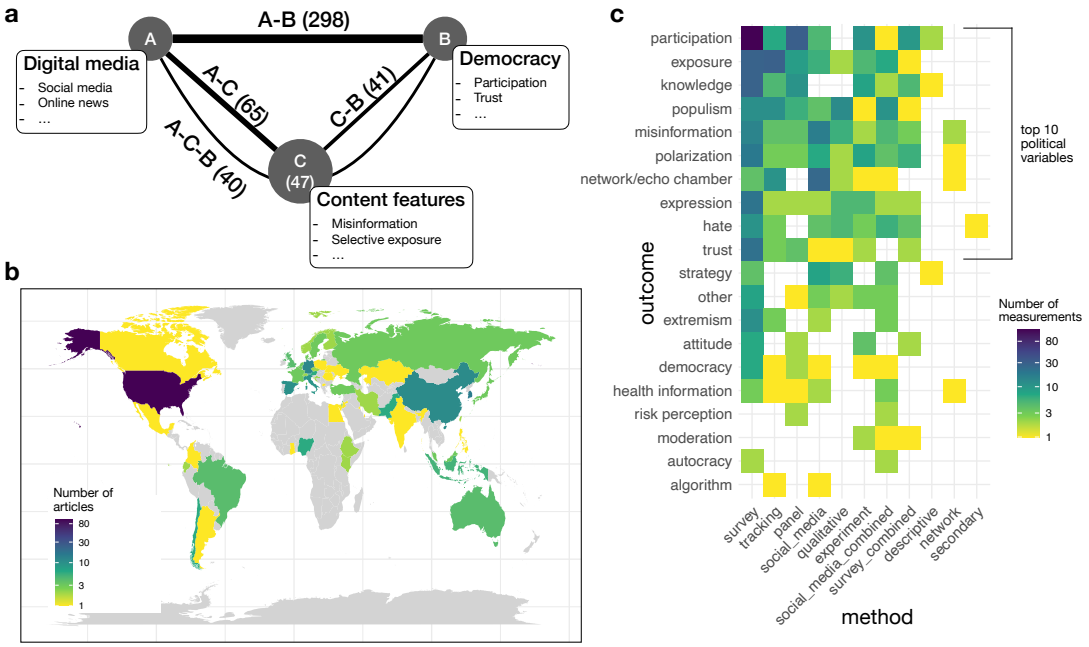


Figure 1: Summary of the reviewed articles. **a** Combinations of variables in the sample: digital media (A), political variables (B) and content features such as selective exposure or misinformation (C). Numbers in brackets count articles in our sample that measure an association between variables. **b** Geographic distribution of articles that reported site of data collection. **c** Distribution of measurements (counted separately whenever one article reported several variables) over combinations of variables and methods.

opponents or fragmented and adversarial discourse), homophily in social networks (i.e., how often people who share attributes or opinions are socially connected) and forms of hate (often hate speech or crimes). For a breakdown of the reported variables within each category, see Fig. 6d in the Materials and Methods section; the full table, including both, reported and grouped variables, can be found at https://osf.io/7ry4a/. Fig. 1 also reveals gaps in the literature, such as rarely explored geographical regions (e.g., Africa) and method–variable combinations (e.g., methods that combine data sources such as social media data with survey or secondary data).

### Direction of Associations

To ascertain whether the available evidence suggest that the effects of digital media are beneficial or detrimental to democracy, we first selected subsets of articles that addressed the 10 most frequently studied categories of political variables (from here on simply referred to as political variables). A total of $N = 347$ associations were reported for these variables (when an article examined two relevant outcome variables, two associations were counted). The independent variable in these articles was a measure of the usage of some type of digital media, such as online news consumption or social media uptake. At a statistical level, the independent variables can be positively or negatively associated with the political outcome variable. For instance, more digital media use could be associated with more expression of hate (positive association) or less expression of hate (negative association), or there could be no association

between the two. We decided to present data not at a statistical level but at a conceptual level. We therefore classified each observed statistical association as beneficial or detrimental depending on whether its direction was aligned or misaligned with democracy. For example, a positive statistical association between digital media use and hate speech was coded as a detrimental association; by contrast, a positive statistical association between digital media use and participation was coded as beneficial. Throughout this paper, we represent beneficial associations in turquoise and detrimental associations in orange, irrespective of the underlying statistical polarity.

Fig. 2 provides an overview of the 10 most frequently studied political variables and the reported directions—color-coded in terms of whether they are beneficial or detrimental to democracy—of each of their associations with digital media use. This overview encompasses both correlational and causal evidence. Some findings in Fig. 2 suggest that digital media can foster democratic objectives. First, the associations reported for participation point mostly in beneficial directions for democracy (aligned with previous results [44]), including a wide range of political and civic activities (see Fig. 1d), from low-effort participation such as liking/sharing political messages on social media to high-cost activities such as protesting in oppressive regimes. Second, measures of political knowledge and diversity of news exposure appeared to be associated with digital media in beneficial ways, but the overall picture was slightly less clear. Third, the literature was also split on how political expression is associated with digital media. Articles reporting beneficial associations between digital media and citizens' political expression were opposed by a number of articles describing detrimental associations. These detrimental associations relate to the "spiral of silence" idea.

Fourth, we observed consistent detrimental associations for a number of variables. Specifically, the associations with trust in institutions were consistently and overwhelmingly pointing in directions detrimental to a functioning democracy. Measures of hate, polarization, and populism were also widely reported to have detrimental associations with digital media use in the clear majority of articles. Likewise, increased digital media use was often associated with a greater prevalence of misinformation. Finally, we also found that digital media were associated with homophily in social networks in detrimental ways (mostly measured on social media), but the pattern of evidence was a little less consistent. Differences in the clarity of results were also reflected when broken down along measurement methods (see the insets in Fig. 2): For instance, polarization measures were consistently associated with digital media across different methods; in contrast, results for homophily varied between measurements in tracking- and social media data.

Next, we distinguished between articles reporting correlational versus causal evidence and focused on the small subset of articles showing causal evidence ($N = 21$)[2].

### Causal inference

Our next goal was to synthesize causal evidence for the effects of digital media on political variables. Usually, the absence of randomized treatment assignment, an inevitably feature of observational data (e.g., survey data), precludes

[2]We excluded causal evidence on the effects of voting advice applications from our summary as they are a very specific form of digital media, constructed to enhance political participation in democracies. The effects of voting advice applications are already extensively discussed in a meta analysis [52].

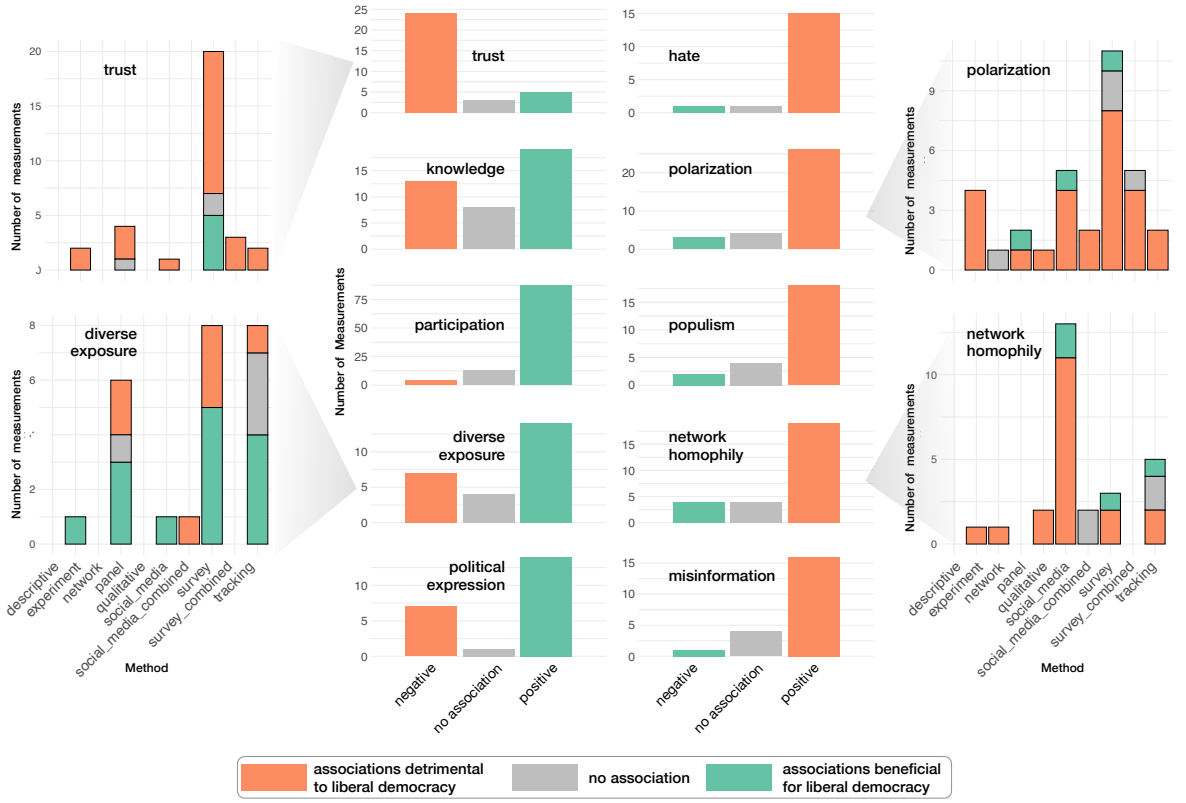


Figure 2: Distribution of directions of associations from the full sample, reported for various political variables (see Fig. 1d for a breakdown). Insets show exemplary the distribution of associations with trust, news exposure, polarization, and network homophily over the different methods used for their measurement.

the identification of causal effects because individuals differ systematically on variables other than the treatment (or independent) variable. However, under certain conditions it is possible to rule out noncausal explanations for associations, even in studies without random assignment that are based on observational data (see [53–55]). For a more detailed explanation of the fundamental principles of causal inference, see the Supplementary Material and, for example, the work of this year's laureates of the Nobel Memorial Prize in Economics [53–55].

Common causal inference techniques that were used in our sample include instrumental variable designs that introduce exogenous variation in the treatment variable [56–60], matching approaches to explicitly balance treatment and control groups [61–63], and panel designs that account for unobserved confounders with unit and/or time fixed effects [64, 65]. We also found multiple large-scale field experiments conducted on social media platforms [66–69] as well as various natural experiments [56, 58, 59, 70] (for more details on the techniques, see Fig. 3).

Fig. 4 summarizes the findings and primary causal inference techniques of these articles. Again, causal effects were coded as beneficial for or detrimental to democracy. This figure is structured according to whether evidence stemmed from established, mostly Western, democracies or from emerging democracies and authoritarian regimes, adopting classifications from the Liberal Democracy Index provided by the Varieties of Democracy project [17]. In non-Western

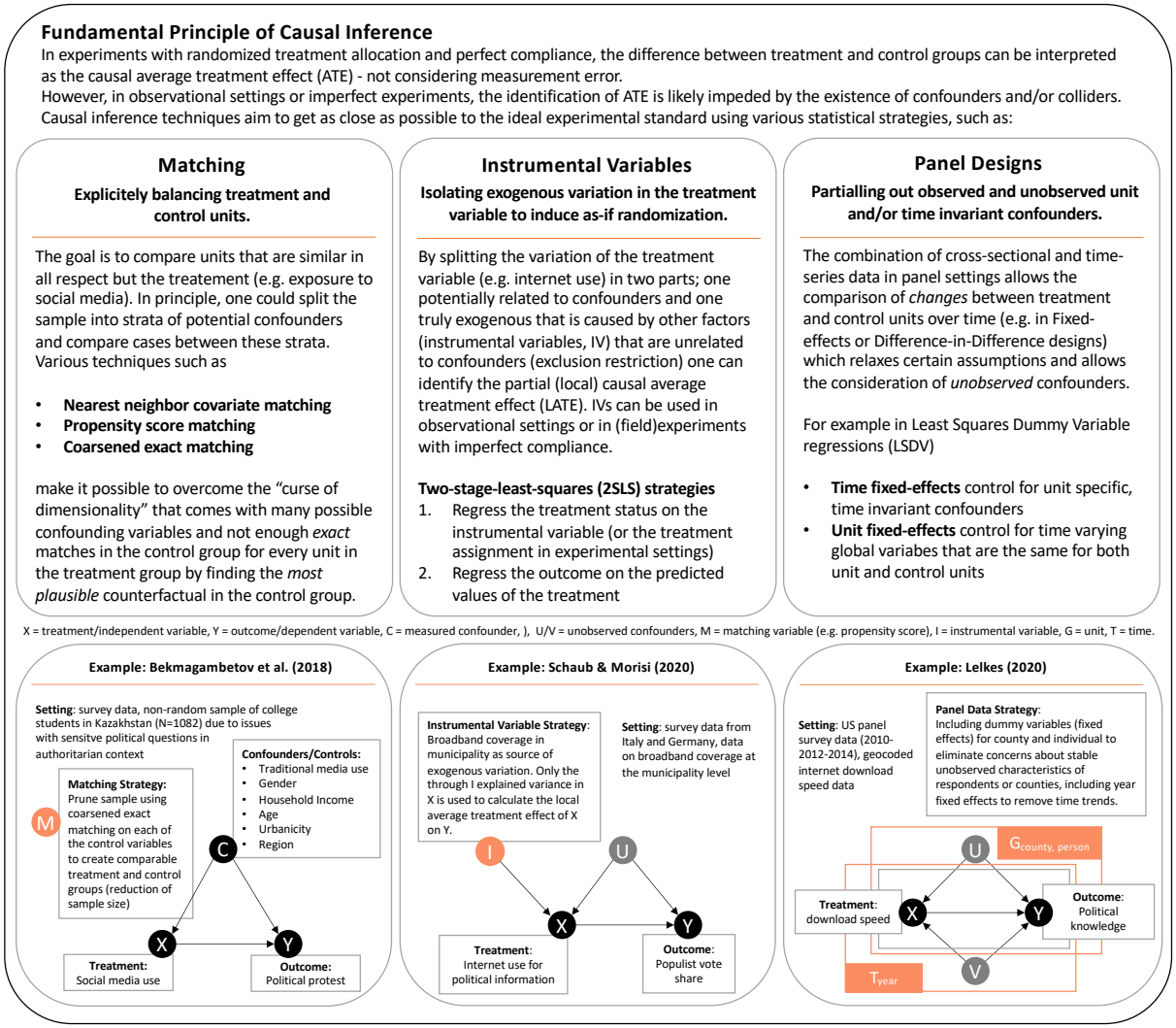


Figure 3: Summary of causal inference techniques used in our sample of causal evidence. Regression discontinuity designs did not appear in this review sample but constitute another important causal inference strategy.

emerging democracies and autocratic regimes (e.g., China), it is particularly difficult to interpret the effects on certain political variables as beneficial or detrimental. For example, a loss of trust in government suggests a precarious development for an established democracy; in authoritarian regimes, however, it may indicate a necessary step toward overcoming the regime and, eventually, progressing toward a more liberal and democratic system. Instead of simply adopting the authors' interpretation of the effects or imposing our own interpretation of effects in authoritarian regimes and emerging democracies, we leave this interpretation to the reader (denoted in purple in the figure). The overall picture converges closely with the one drawn in Fig. 2. We found general trends of digital media use increasing participation and knowledge but also increasing political polarization and decreasing trust.

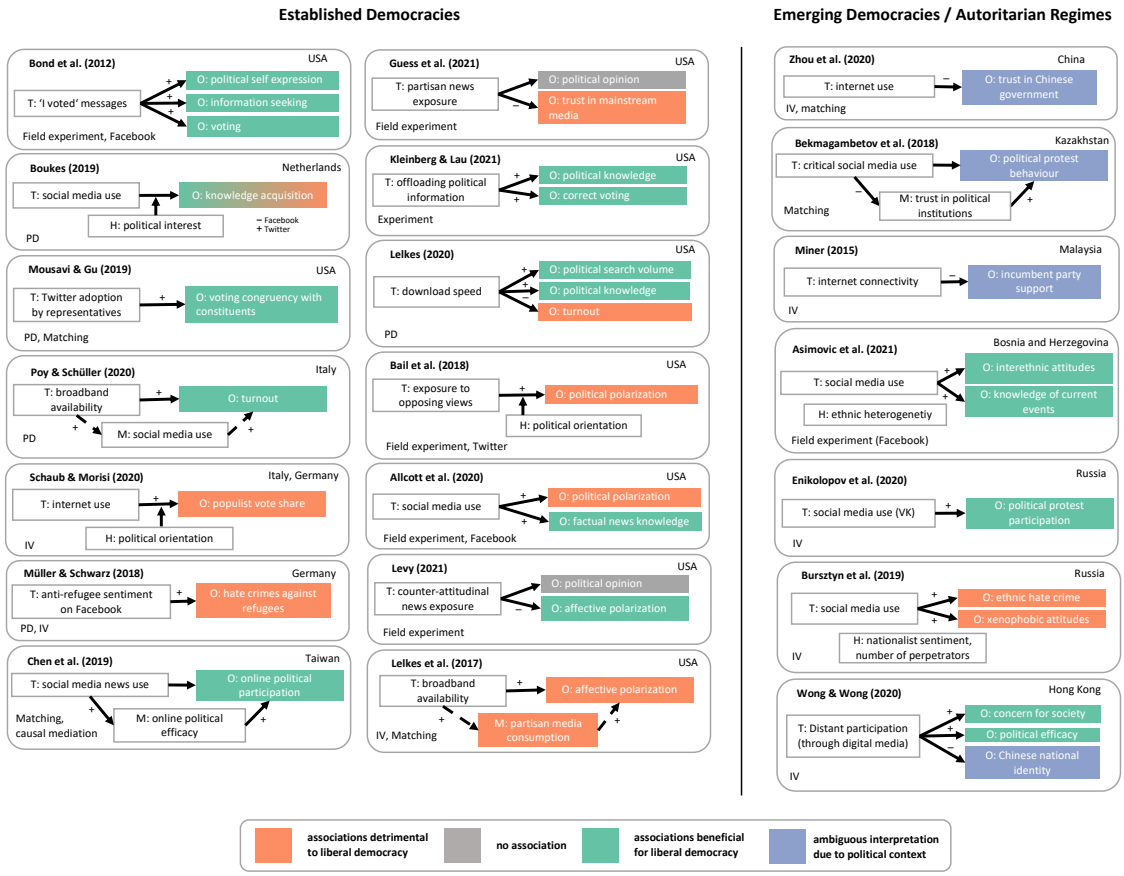


Figure 4: Summary of causal evidence for digital media effects on political variables. Each box represents one article. Treatments are in white boxes on the left, political outcome variables in coloured boxes on the right; M denotes mediators; H represents sources of effect heterogeneity or moderators. Positive (+) and negative (−) signs at paths indicate reported direction of effects. Location of sample indicated in top right corner of boxes, primary causal inference strategy in bottom left. Strategies include statistical estimation strategies such as instrumental variables (IV), matching, and panel designs (PD) that use, for example, fixed effects (FE) or difference in difference (DiD) for causal estimation, as well as lab or field experiments (e.g., field experiments rolled out on various platforms that are often supplemented with IV estimation to account for imperfect compliance). Detrimental effects on liberal democracy are shown in orange, beneficial effects in turquoise, effects open to interpretation in purple, and null effects in grey.

### Effects on key political variables

In the following, we provide a short synopsis of the results, point to conflicting trends, and highlight some examples of the full set of correlational and causal evidence, reported in Fig. 2 and Fig. 4, for six variables that we found to be particularly crucial for democracy: participation, trust, political knowledge, polarisation, populism, network structures and news exposure. The chosen examples are stand-ins and illustrations of the general trends.

**Participation.** Consistent with past meta-analyses [41, 42, 44], the body of correlational evidence supported a beneficial association between digital media use and political participation and mobilization.

In our sample, causal analyses of the effects of digital media on political participation in Western democracies mostly studied voting and voter turnout [61, 64, 68, 71–73]; articles concerned with other regions of the world focused on political protest behavior [56, 58, 63]. Other articles considered online political participation [62, 68]. One study, applying causal mediation analysis to assess a causal mechanism [74], found that information-oriented social media use affects political participation, mediated or enabled through the user's online political efficacy [62]. Overall, our analysis found largely beneficial mobilizing effects for political participation across this set of articles. Our review sample did not include any studies that examined causal effects of digital media on political participation in authoritarian regimes in Africa or the Middle East.

**Trust.** Many articles in our sample found detrimental associations between digital media and various dimensions of trust (Fig. 2). For example, detrimental associations were found for trust in governments and politics [56, 57, 63, 75–79], trust in media [80], and social and institutional trust [81]. During the COVID-19 pandemic, digital media use was reported to be negatively associated with trust in vaccines [82, 83]. Yet the results about associations with trust are not entirely homogeneous. One multinational survey found beneficial associations with trust in science [84]; others found increasing trust in democracy with digital media use in Eastern and Central European samples [85, 86]. Nevertheless, the large majority of reported associations between digital media use and trust appear to be detrimental for democracy. While the evidence stems mostly from surveys, results gathered with other methods underpin these findings (see Fig. 2 inset).

Few articles have shed light on causal effects between social media use and trust. A field experiment in the United States that set browser defaults to partisan media outlets [36] found a long-term loss of trust in mainstream media. In authoritarian regimes in Asia, increasing unrestricted internet access decreased levels of trust in the political system [56, 70, 87]. This finding confirms the predominant association observed in most other countries. Yet it also illustrates how digital media is a double-edged sword, depending on the political context: By reducing trust in institutions, digital media can threaten existing democracies as well as foster emerging democratic developments in authoritarian regimes.

**Political knowledge.** The picture was less clear for associations between the consumption of digital media and political knowledge. Still, the majority of associations point in beneficial directions and were found in both cross-sectional surveys [88–95] and panel surveys [96–98]. Studies linking web-tracking and survey data showed increased learning about politics [99], but also a turning away from important topics [100], whereas other experiments demonstrated an overall beneficial effect of digital media on issue salience [101]. These findings, however, stand in contrast to fewer, yet several other studies that find a detrimental association between political knowledge and digital media use [102–106].

The body of causal evidence on political knowledge looks relatively promising for this relationship, too. Multiple articles found that enhanced engagement with digital media increased political knowledge [64, 67, 69, 71] and that increased engagement with political content on social media increased political interest among adolescents [107]. In line with these findings, it has been reported that political messages on social media, as well as faster download speed, can increase information-seeking in the political domain [64, 68]. By contrast, there is evidence for a decrease in

political knowledge [108], which is mediated through the news-finds-me effect: Social media users believe that actively seeking out news is no longer required to stay informed, as they expect to be presented with important information.

It is important to note that most of these effects are accompanied by considerable heterogeneity in the population that benefits and the type of digital media. For example, politically interested individuals showed higher knowledge acquisition when engaging with Twitter, whereas the opposite effects emerged for engagement with Facebook [109]. Furthermore, there is evidence that the news-finds-me effect on social media can be mitigated when users consult alternative news sources [108].

**Polarization.** Most articles found detrimental associations between digital media and different forms of political polarization [110–114]. Our review found evidence for increasing out-group polarization on social media in a range of political contexts and on various platforms [115–118]. Increasing polarization was also linked to exposure to viewpoints opposed to one's own on social media feed [66, 119]. Articles comparing several political systems found associations that were country-dependent [120], again highlighting the importance of political context [121]. Nevertheless, increased digital use was for the most part linked to increased polarization overall, although there was some evidence for balanced online discourse without pronounced patterns of polarization [122–124], as well as evidence for potentially depolarizing association with social media [125].

The body of causal articles largely supported the detrimental associations of digital media on polarization that we identified in correlational articles. Among established Western democracies, both social media use and overall internet use increased political polarization [60, 67]. This was also the case in an experimental treatment that exposed users to opposing views on Twitter [66]. However, some findings run counter to the latter result [126]: in a 2-month field experiment, exposure to counterattitudinal news on Facebook reduced affective polarization (the authors used opposing news outlets as treatment instead of opinions on social media). Furthermore, one other field experiment did not find evidence that exposure to partisan online news substantively shifted political opinions, but found a long-term loss of trust in mainstream media [36]. Still, taking correlational and causal evidence into account, the overall picture remains largely consistent on the detrimental effects of digital media on polarization.

**Populism.** Articles on populism in our review examined either vote share and other popularity indicators for populist parties or the prevalence of populist messages and communication styles on digital media. Overall, articles using panel surveys, tracking data, and methods linking surveys to social media data consistently found that increased digital media use was associated with increased populism. For example, digital platforms were observed to benefit populist parties more than they benefit established politicians [127–130]. In a panel survey in Germany, a decline in trust that accompanied increasing digital media consumption was also linked to a turn towards the hard-right populist AfD party [77]. There is also evidence for an association between increased social media use and online right-wing radicalization in Austria, Sweden, and Australia [131–133]. Only a minority of articles found no relation or a negative relation between digital media and populism [134–136]. For instance, in Japan, internet exposure was associated with increased tolerance towards foreigners [137].

Similarly, most causal inference studies linked increased populism to digital media use. For instance, digital media use in Europe led to increased far-right populist support [60, 138], and there was causal evidence that digital media can propagate ethnic hate crimes in both democratic and authoritarian countries [59, 65]. However, in Malaysia, internet exposure was found to cause decreasing support for the authoritarian, populist government [57].

**Echo chambers and news exposure.** The evidence on echo chambers points in different directions depending on the outcome measure. On the one hand, when looking at news consumption, several articles showed that social media and search engines diversify people's news diets [64, 139–142]. On the other hand, when considering social networks and the impact of digital media on homophilic structures, the literature contains consistent reports of ideologically homogeneous social clusters [143–147]. This underscores an important point: Some seemingly paradoxical results can potentially be resolved by looking more closely at context and specific outcome measurement. The former observation of diverse news exposure might fit with the positive relationship between digital media and knowledge reported in [64, 71, 90, 91, 98], and the homophilic social structures could be connected to the prevalence of hate speech and anti-outgroup sentiments [116, 148–151].

### Heterogeneity

Fig. 5 shows the geographical distribution of effect directions around the globe. Notably, most beneficial effects on democracy were found in the Global South, in emerging democracies in South America, Africa, and South Asia. Mixed effects, by contrast, were distributed across Europe, the United States, Russia, and China. Similarly, detrimental outcomes were mainly found in Europe, the United States and Russia, although this may reflect a lack of studies undertaken in the Global South. These patterns are also shown in Fig. 5c and d, where countries are listed according to the Liberal Democracy Index. Moderators—variables such as partisanship and news consumption that are sources of effect heterogeneity—displayed in Fig. S1 also show slight differences between outcomes. Beneficial outcomes seemed to be slightly more moderated by political interest and news consumption, whereas detrimental outcomes tended to be moderated by political position and partisanship.

Furthermore, many causal articles acknowledge that effects differ between subgroups of their sample by including interaction terms in their statistical models. For example, the polarizing effects of digital media differ between Northern and Southern European media systems [138]: While consumption of right-leaning digital media increased far-right votes, especially in Southern Europe, the consumption of news media and public broadcasting in Northern European media systems with high journalistic standards could mitigate these effects. Another example of differing effects between subgroups was found in Russia, where the effects of social media on xenophobic violence were only present in areas with pre-existing nationalist sentiment. This effect was especially pronounced for hate crimes with a larger number of perpetrators, indicating that digital media was serving a coordinating function. In summary, a range of articles found heterogeneity in effects for varying levels of political interest [64, 109], political orientation [60, 66, 67], and different characteristics of online content [107].

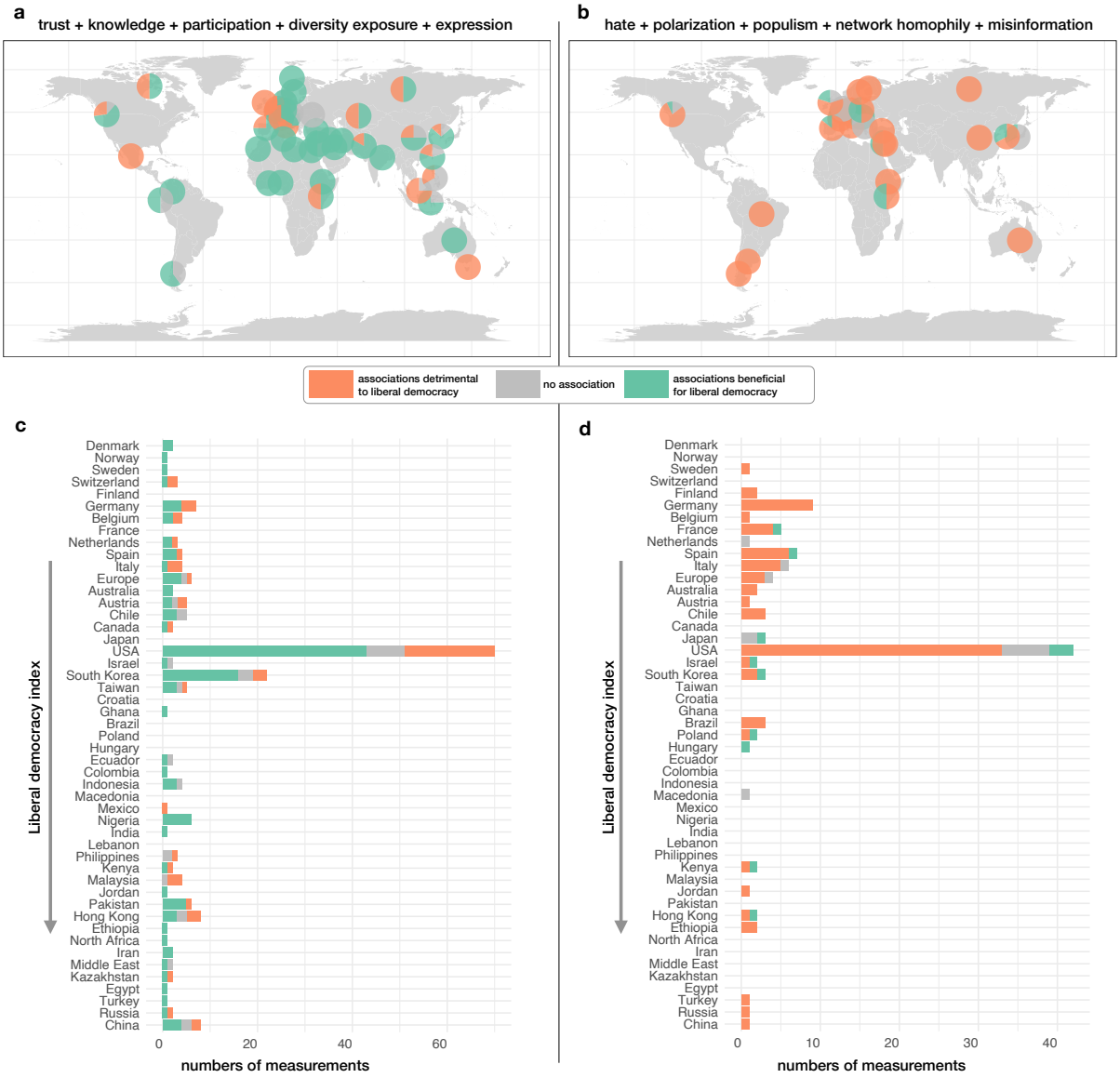


Figure 5: Geographical distribution of associations, split vertically between beneficial and detrimental outcomes. **a** Geographical distribution of reported associations for the variables trust, knowledge, participation, exposure, and expression. Pie charts show the composition of directions for each country studied. **b** Geographic representation of reported associations for the variables hate, polarization, populism, homophily, and misinformation. **c** Data and variables in **a**, in absolute numbers of reported associations and sorted along the Liberal Democracy Index [17]. **d** Data and variables in **b**, in absolute numbers of reported associations and sorted along the Liberal Democracy Index.

Most authors, particularly those of the causal inference articles in our body of evidence, explicitly emphasized the national, cultural, temporal and political boundary conditions for interpreting and generalising their results (see, e.g., [107]). By contrast, especially in articles conducted on U.S. samples the national context was often not mentioned as pronounced. We strongly caution against a generalization of findings that are necessarily bound to a specific political setting (e.g. the US) to other contexts.

## Discussion

Regardless of whether they are authoritarian, illiberal, or democratic, governments around the world are concerned with how digital media affects political systems. A flurry of recent interdisciplinary research, stimulated in part by new methodological possibilities and data sources, has shed light on this potential interplay.

Although classical survey methods are still predominant, novel ways of linking data types, for example linking URL tracking data or social media data with surveys, permit more complex empirical designs and analyses. Furthermore, digital trace data allow an expansion in sample size. The articles we reviewed included surveys with a few hundred, up to a few thousand participants, but also large-scale social media analyses that included behavioral traces of millions. Yet with computational social science in its early days, the amount of evidence supporting and justifying causal conclusions is still limited. Causal effects of digital media on political variables are also hard to pin down empirically due to a plethora of complexities and context factors, as well as the highly dynamic technological developments that make predictions difficult. While emergent political phenomena are hard to simulate in the lab, the value of estimation and data collection strategies to draw causal inferences from real-life data is enormous. However, the long established trade-off between internal and external validity still applies which also highlights the value of high quality descriptive work.

Taking into account both, correlational and causal evidence, our review suggests that digital media use is clearly associated with variables such as trust, participation, and polarization, which are critical for the functioning of any political system, in particular democracies. Extant research reports relatively few null effects. However, the trends on each factor mostly converge, both across research methods and across correlative and causal evidence.

Our results also highlight that digital media are a double-edged sword, with both beneficial and detrimental effects on democracy. What is considered beneficial or detrimental will, at least partly, hinge on the political system in question: Intensifying populism and network homophily may benefit a populist regime or a populist politician but undermine a pluralistic democracy. For democratic countries, evidence clearly indicates that digital media increases political participation. Less clear but still suggestive are the findings that digital media has positive effects on political knowledge and exposure to diverse viewpoints in news. On the negative side, however, digital media use is associated with eroding the "glue that keeps democracies together" [32]: trust in political institutions. The results indicating this danger converge across methods. Furthermore, our results also suggest that digital media use is associated with increases in hate, populism, and polarisation. Again, the findings converge across causal and correlational articles.

Alongside the need for more causal evidence, we found several research gaps, including the relationship between trust and digital media and the seeming contradiction between network homophily and diverse news exposure. Methods that link tracking data for measuring news exposure with behavioural data from social media (e.g., sharing activities or the sentiment of commenting) are crucial to a better understanding of this apparent contradiction.

**Limitations**

The articles in our sample incorporate a plethora of methods and measures. As a result, it was necessary to classify variables and effects into broad categories. This is a trade-off we had to make in exchange for the breadth of our overview of the landscape of evidence across disciplines. For the same reason, we could not provide a quantitative comparison across the diverse sample of articles. We believe that digital media research would benefit from more unified measures (e.g., for polarization), methods across disciplines to allow for better comparability in the future, and a systematic comparison of different digital media (i.e., Facebook and Twitter are not of one kind nor, in all likelihood, are their effects). This follows other recent calls for commensurate measures of political and affective polarization [152].

The interpretation of our results was in several cases hampered by a lack of appropriate baseline measures. There is no clear measure of what constitutes a reasonable benchmark of desirable political behaviour in a healthy democracy. In addition, there were no means of quantification of some of these behaviours in the past, outside of digital media. This problem is particularly pronounced for factors such as exposure to diverse news, social network homophily, misinformation, and hate speech. Measuring these phenomena at scale is possible through digital media (e.g., by analysing social network structure); much less is known about their prevalence and dynamics in offline settings. Many articles therefore lacked a baseline. For instance, it is not clear what level of homophily in social networks is desirable in a democratic society. Nor is it clear how to interpret the results of certain studies on polarization [66, 126], whose findings depend on whether one assumes that social media has increased or decreased the exposure to opposing views relative to some offline baseline. For example, if exposure to opposing views is increased on social media, the conclusion of one study [126] would be that it reduces polarization, but if exposure is decreased one would come to the opposite conclusion. Notably, counter attitudinal exposure was, actually in this study, found to be down-ranked by Facebook's news feed—hence supporting a process that fosters polarization instead of counteracting it.

We found relatively few null effects for some variables. This could be accurate, but it could also be driven by the file-drawer problem—the failure to publish null results. However, even null effects of digital media on these variables would be important enough to suggest that they have been reported rather than filed away; therefore, the file-drawer problem may be limited in this research domain. To shed light on other potential biases in reported associations, we examined temporal variation in the directions of reported associations and found a slight trend toward an increasing number of both detrimental directions and null effects over time (see Fig. S2). There was no clear pattern in the associations reported by those authors who published the greatest number of articles in our sample; several authors variously reported detrimental and beneficial effects as well as null effects, with a few exceptions (see Fig. S3). Their co-authorship network did not reveal any pronounced pattern either (see Fig. S4). Overall, we did not find evidence of a systematic bias in either direction driven by temporal trends or particular authors.

**Conclusion**

Our results provide grounds for concern. Alongside the positive effects of digital media for democracy, there is clear evidence of serious threats to democracy. In light of the importance of these potentially difficult-to-reverse effects for democracy, a better understanding of the diverging effects of digital media in different political contexts (e.g., authoritarian vs. democratic) is urgently needed. To this end, methodological innovation is required. This includes, for instance, more research using causal inference methodologies, as well as research that examines digital media use across multiple and interdependent measures of political behaviour. More research and better study designs will, however, also depend on access to data collected by the platforms. This access has been restricted or foreclosed. Yet without independent research that has full access to all relevant data, the effects of digital media can hardly be be understood in time. This is concerning even more so because digital media can implement architectural changes that, even if seemingly small, can scale up to widespread behavioral effects. Regulation may be required to facilitate this access [153]. Most importantly, we suggest that the bulk of empirical findings summarized here can be attributed to the current status quo of an information ecosystem produced and curated by large, commercial platforms. They have succeeded in attracting a vast global audience of users. The sheer size of their audience as well as their power over what content and how content gets the most attention has led, in the words of the philosopher Jürgen Habermas, to a new structural transformation of the public sphere [15]. In this new public sphere, everybody can be a potential author spontaneously producing content, both right-wing radical networks as well as the courageous Belarus women standing up for human rights and against a repressive regime. One need not share Habermas' conception of "deliberate democracy" to see that current platforms fail to produce an information ecosystem that empowers citizens to make political choices that are as rationally motivated as possible. Our results show how this ecosystem plays out to have important consequences for political behaviours and attitudes. Our results further underscore that finding out which aspects of this relationship are detrimental to democracy and how they can be contained while actively preserving and fostering the emancipatory potential of digital media is perhaps one of the most important tasks of the present. Our analysis hopes to contribute to the empirical basis of this endeavour.

## Materials and Methods

This systematic review follows the MOOSE Guidelines for Meta-Analyses and Systematic Reviews of Observational Studies [154]. The detailed protocol of the review process was preregistered on OSF at https://osf.io/7ry4a/.

Fig. 6 summarizes the the search query that we used on two established academic databases, Scopus and Web of Science (both highly recommended search tools [155]), the resulting number of articles from the query and the subsequent exclusion steps, leading to the final sample size of $N = 498$ articles under consideration.

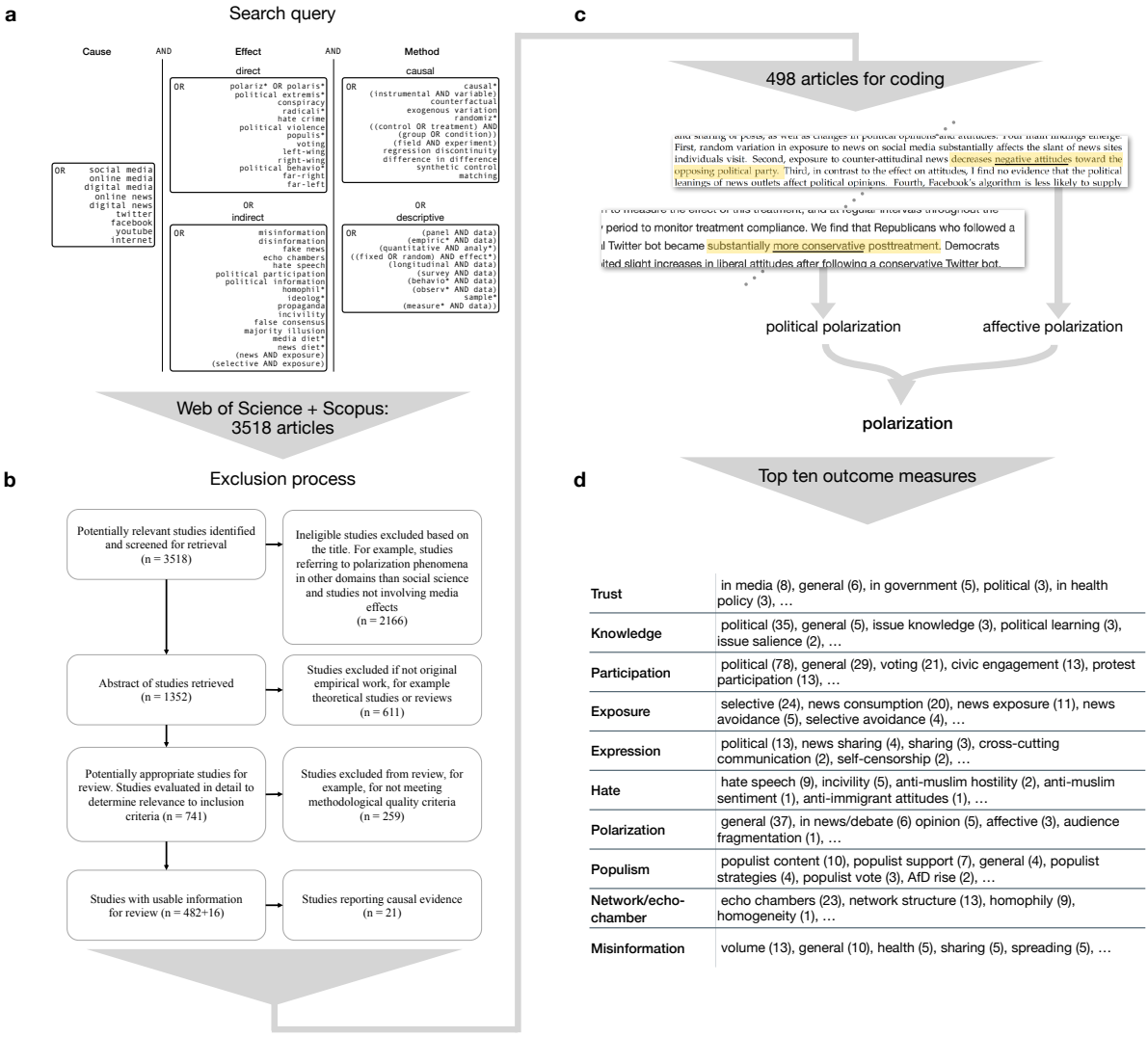


Figure 6: Strategy for curating the sample of relevant articles. **a** Causal, amplifying, and enabling mechanisms, for example between digital media and political polarization. **b** The search query that was derived from the conceptual framework and run on Scopus and Web of Science. **c** Example of the step-wise grouping of variables. **d** Breakdown of the most frequently reported political variables into more fine-grained categories. Numbers in brackets are counts of measurements in the set.

**Study selection criteria.** We included only original, empirical work. Conceptual or theoretical work, simulation studies, and evidence synthesizing studies were excluded. Articles had to be published in academic journals in English. We excluded small-*N* laboratory experiments and small-*N* student surveys from our body of original work due to validity concerns. Although correlational evidence cannot establish a causal direction, we focused on articles that examined effects of digital media on democracy but not the opposite. We therefore excluded, for example, articles that examined ways to digitize democratic procedures. To be included, articles had to include at least two distinct variables, treatment or independent variable and outcome. Articles measuring a single variable were only included if this variable was a feature of digital media (e.g., hate speech prevalence, homophily in online social networks, prevalence of misinformation in digital media).

**Search strategy, study selection, and data extraction.** Articles eligible for our study had to be published before September 15, 2021. We sourced our review database from Scopus and Web of Science, as suggested by [155]. The search query (see Fig. 6) was constructed in consultation with professional librarians and was designed to be as broad as possible in order to pick up any articles containing original empirical evidence of direct or indirect effects of digital media on democracy (including correlational evidence). We further consulted recent, existing review articles in the field [31, 38, 39] to check for important articles that did not appear in the review body. Articles that were included manually are referenced separately in the flow chart (see Fig. 6). Two authors independently screened all titles and abstracts returned from the database search for eligibility. A full-text screen was performed in cases where the relevant information could not be retrieved from the abstract and for all articles implying causal evidence. The following information was extracted from each article using a standardized data extraction form: variable groups under research (digital media, features of media and/or political outcome variables), explicit outcome variable, methods used, country of origin, causal claims, and possible effect heterogeneity (moderation).

The query retrieved $N = 3,518$ articles, 1,352 of which were retained after screening the titles for irrelevant topics. After screening the abstracts to exclude irrelevant articles, this number was reduced to 741. A total of 498 articles remained in our sample after we applied our set of inclusion and exclusion criteria. After cross-checking the results of our literature search against the references from existing reviews, we found and included a further $N = 16$ articles that met our thematic criteria but were not identified by our search string. All steps were performed in parallel by two independent coders. At the final stage of quality review, intercoder reliability was 87% agreement (Krippendorf's alpha = 0.66 and Cohen's kappa = 0.66 [0.59;0.72]). Disagreement between coders was resolved through discussion. Ultimately, 498 articles were selected.

**Data synthesis and analysis.** Due to considerable heterogeneity in methods in the articles—including self-report surveys through network analysis of social media data, URL tracking data, and field experiments—no calculation of meta-analytic effect sizes was possible. The final table of selected articles with coded variables will be published alongside this article as a major result of this review project. The effect directions of 10 important political outcome variables (four consistent with liberal democracy, four opposing democratic values) are summarized in Fig. 2. For

articles dealing with these political variables, we also assessed the country in which the study was conducted, explicit sources of effect heterogeneity such as demographic characteristics of study participants or characteristics of the digital media platform (Fig. 5).

For the overview analysis, which includes both correlational and causal evidence, we mainly restricted ourselves to the evaluation effects reported in the abstracts. Articles making explicit causal claims and/or using causal inference methods (Fig. 3) were examined in-depth and summarized as simplified path diagrams with information on mediators, moderators, country of origin, and method used (Fig. 4).

## Ethics

This study does not involve the collection of original data; ethical approval by a research ethics committee is therefore not required. We will make the results available through publication in a scientific journal.

**Conflict of interest:** We report no conflicts of interest.

**Data availability:** The fully coded table of articles as well as scripts for all figures are available at: `https://osf.io/7ry4a/`

**Author Contributions:** All authors designed the study. PLS and LO selected and coded the literature. PLS and LO evaluated the coded tables. All authors analyzed the results and wrote the manuscript. PLS and LO contributed equally to this work.

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## References


1. Persily, N. & Tucker, J. A. *Social Media and Democracy: The State of the Field, Prospects for Reform* (Cambridge University Press, 2020).
2. Tucker, J. A. *et al.* Social media, political polarization, and political disinformation: A review of the scientific literature. *Political polarization, and political disinformation: a review of the scientific literature (March 19, 2018)* (2018).
3. Rau, J. P. & Stier, S. Die Echokammer-Hypothese: Fragmentierung der Öffentlichkeit und politische Polarisierung durch digitale Medien? *Zeitschrift für Vergleichende Politikwissenschaft* **13,** 399–417 (2019).
4. Lewandowsky, S. *et al.* Technology and democracy: Understanding the influence of online technologies on political behaviour and decision-making (2020).
5. Adena, M., Enikolopov, R., Petrova, M., Santarosa, V. & Zhuravskaya, E. Radio and the Rise of the Nazis in Prewar Germany. *The Quarterly Journal of Economics* **130.** Publisher: MIT Press, 1885–1939 (2015).
6. Adena, M., Enikolopov, R., Petrova, M. & Voth, H.-J. Bombs, broadcasts and resistance: Allied intervention and domestic opposition to the Nazi regime during World War II. *Available at SSRN 3661643* (2021).
7. Gagliarducci, S., Onorato, M. G., Sobbrio, F. & Tabellini, G. War of the waves: Radio and resistance during World War II. *American Economic Journal: Applied Economics* **12,** 1–38 (2020).
8. Li, D. Echoes of violence: Considerations on radio and genocide in Rwanda. *Journal of Genocide Research* **6.** Publisher: Taylor & Francis, 9–27 (2004).
9. Paluck, E. L. Reducing intergroup prejudice and conflict using the media: a field experiment in Rwanda. *Journal of personality and social psychology* **96.** Publisher: American Psychological Association, 574 (2009).
10. Staub, E. & Pearlman, L. A. Reducing intergroup prejudice and conflict: A commentary. Publisher: American Psychological Association (2009).
11. Howard, P. N. & Hussain, M. M. *Democracy's fourth wave?: digital media and the Arab Spring* (Oxford University Press, 2013).
12. Jackson, S. J., Bailey, M. & Welles, B. F. *# HashtagActivism: Networks of race and gender justice* (MIT Press, 2020).
13. Engesser, S., Ernst, N., Esser, F. & Büchel, F. Populism and social media: How politicians spread a fragmented ideology. *Information, communication & society* **20,** 1109–1126 (2017).
14. Bak-Coleman, J. B. *et al.* Stewardship of global collective behavior. *Proceedings of the National Academy of Sciences* **118** (2021).
15. Habermas, J. Überlegungen und Hypothesen zu einem erneuten Strukturwandel der politischen Öffentlichkeit. *LEVIATHAN,* 470 (2021).
16. The value of evidence synthesis. en. *Nature Human Behaviour* **5,** 539–539. ISSN: 2397-3374. (2021) (May 2021).

17. Coppedge, M. *et al. Varieties of Democracy: Measuring Two Centuries of Political Change* ISBN: 978-1-108-42483-7. (2021) (Cambridge University Press, Cambridge, 2020).

18. Warren, M. E. in *Handbook on political trust* (Edward Elgar Publishing, 2017).

19. Milner, H. *Civic literacy: How informed citizens make democracy work* (UPNE, 2002).

20. Kohler-Koch, B. & Quittkat, C. *De-mystification of participatory democracy: EU-governance and civil society* (OUP Oxford, 2013).

21. O'connell, B. & Gardner, J. W. *Civil society: The underpinnings of American democracy* (UPNE, 1999).

22. Sunstein, C. R. The law of group polarization. *Journal of political philosophy* **10.** Publisher: Wiley Online Library, 175–195 (2002).

23. Habermas, J., Lennox, S. & Lennox, F. The public sphere: An encyclopedia article (1964). *New German Critique.* Publisher: JSTOR, 49–55 (1974).

24. Howard, J. W. Free speech and hate speech. *Annual Review of Political Science* **22.** Publisher: Annual Reviews, 93–109 (2019).

25. Müller, J.-W. *What is populism?* (University of Pennsylvania Press, 2016).

26. Pariser, E. *The filter bubble: What the Internet is hiding from you* (Penguin UK, 2011).

27. Davis, N. T. & Dunaway, J. L. Party polarization, media choice, and mass partisan-ideological sorting. *Public Opinion Quarterly* **80,** 272–297 (2016).

28. Iyengar, S., Lelkes, Y., Levendusky, M., Malhotra, N. & Westwood, S. J. The origins and consequences of affective polarization in the United States. *Annual Review of Political Science* **22,** 129–146 (2019).

29. Kozlowski, A. C. & Murphy, J. P. Issue alignment and partisanship in the American public: Revisiting the 'partisans without constraint'thesis. *Social Science Research* **94,** 102498 (2021).

30. Baldassarri, D. & Gelman, A. Partisans without constraint: Political polarization and trends in American public opinion. *American Journal of Sociology* **114,** 408–446 (2008).

31. Kubin, E. & von Sikorski, C. The role of (social) media in political polarization: a systematic review. *Annals of the International Communication Association,* 1–19 (2021).

32. Dodsworth, S. & Cheeseman, N. Political trust: The glue that keeps democracies together. *London: Westminster Foundation for Democracy* (2020).

33. McCoy, J. & Somer, M. Toward a theory of pernicious polarization and how it harms democracies: Comparative evidence and possible remedies. *The Annals of the American Academy of Political and Social Science* **681,** 234–271 (2019).

34. Danescu, E. *Varieties of Democracy (V-DEM) Annual Report 2019-" Democracy Facing Global Challenges"* tech. rep. (V-Dem Institute, the Department of Political Science at the University of . . ., 2019).

35. Bächtiger, A., Dryzek, J. S., Mansbridge, J. & Warren, M. Deliberative Democracy. *The Oxford handbook of deliberative democracy,* 1 (2018).

36. Guess, A. M., Barberá, P., Munzert, S. & Yang, J. The consequences of online partisan media. *Proceedings of the National Academy of Sciences* **118.** Publisher: National Acad Sciences (2021).

37. Odağ, Ö., Leiser, A. & Boehnke, K. Reviewing the role of the internet in radicalization processes1. *Journal for Deradicalization,* 261–300 (2019).

38. Hassan, G. *et al.* Exposure to Extremist Online Content Could Lead to Violent Radicalization: A Systematic Review of Empirical Evidence. *International Journal of Developmental Sciences* **12,** 71–88 (2018).

39. Castano-Pulgarın, S. A., Suárez-Betancur, N., Vega, L. M. T. & López, H. M. H. Internet, social media and online hate speech. Systematic review. *Aggression and Violent Behavior,* 101608 (2021).

40. Angyal, E. & Fellner, Z. How are online and offline political activities connected? A comparison of studies. *Intersections East European Journal of Society and Politics* **6,** 81–98 (2020).

41. Chae, Y., Lee, S. & Kim, Y. Meta-analysis of the relationship between Internet use and political participation: examining main and moderating effects. *Asian Journal of Communication* **29,** 35–54 (2019).

42. Oser, J. & Boulianne, S. Reinforcement effects between digital media use and political participation : a meta-analysis of repeated-wave panel data. *Public Opinion Quarterly* **84,** 355–365 (2020).

43. Boulianne, S. Social media use and participation: A meta-analysis of current research. *Information, communication & society* **18,** 524–538 (2015).

44. Boulianne, S. Twenty Years of Digital Media Effects on Civic and Political Participation. *Communication Research* **47,** 947–966 (2020).

45. Terren, L. & Borge-Bravo, R. Echo Chambers on Social Media: A Systematic Review of the Literature. *Review of Communication Research* **9,** 99–118 (2021).

46. Jungherr, A. Twitter use in election campaigns: A systematic literature review. *Journal of information technology & politics* **13.** Publisher: Taylor & Francis, 72–91 (2016).

47. Lewandowsky, S., Jetter, M. & Ecker, U. K. Using the president's tweets to understand political diversion in the age of social media. *Nature communications* **11,** 1–12 (2020).

48. LaCombe, S. J., Tolbert, C. & Mossberger, K. Information and Policy Innovation in US States. *Political Research Quarterly,* 10659129211006783 (2021).

49. Stroud, N. J. Polarization and partisan selective exposure. *Journal of communication* **60,** 556–576 (2010).

50. Van Bavel, J. J., Rathje, S., Harris, E., Robertson, C. & Sternisko, A. How social media shapes polarization. *Trends in Cognitive Sciences* (2021).

51. Banks, A., Calvo, E., Karol, D. & Telhami, S. # polarizedfeeds: Three experiments on polarization, framing, and social media. *The International Journal of Press/Politics* **26,** 609–634 (2021).

52. Munzert, S. & Ramirez-Ruiz, S. Meta-Analysis of the effects of voting advice applications. *Political Communication.* Publisher: Taylor & Francis, 1–16 (2021).

53. Of Sciences, T. R. S. A. *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2021* en-US. 2021. (2021).

54. Angrist, J. D. & Pischke, J.-S. *Mostly harmless econometrics* (Princeton university press, 2008).

55. Angrist, J. D. & Pischke, J.-S. The credibility revolution in empirical economics: How better research design is taking the con out of econometrics. *Journal of economic perspectives* **24,** 3–30 (2010).

56. Zhou, D., Deng, W. & Wu, X. Impacts of Internet Use on Political Trust: New Evidence from China. *Emerging Markets Finance and Trade* **56,** 3235–3251 (2020).

57. Miner, L. The unintended consequences of internet diffusion: Evidence from Malaysia. *Journal of Public Economics* **132,** 66–78. ISSN: 0047-2727 (Dec. 2015).

58. Enikolopov, R., Makarin, A. & Petrova, M. Social Media and Protest Participation: Evidence From Russia. *Econometrica* **88,** 1479–1514 (2020).

59. Petrova, M., Bursztyn, L., Egorov, G. & Enikolopov, R. Social Media and Xenophobia: Evidence from Russia (2020).

60. Schaub, M. & Morisi, D. Voter mobilisation in the echo chamber: Broadband internet and the rise of populism in Europe. *European Journal of Political Research* **59.** Publisher: Wiley Online Library, 752–773 (2020).

61. Mousavi, R. & Gu, B. The impact of twitter adoption on lawmakers' voting orientations. *Information Systems Research* **30,** 133–153 (2019).

62. Chen, C., Bai, Y. & Wang, R. Online political efficacy and political participation: A mediation analysis based on the evidence from Taiwan. *New Media and Society* **21,** 1667–1696 (2019).

63. Bekmagambetov, A. *et al.* Critical social media information flows: political trust and protest behaviour among Kazakhstani college students. *Central Asian Survey* **37,** 526–545. ISSN: 0263-4937 (2018).

64. Lelkes, Y. A Bigger Pie: The Effects of High-Speed Internet on Political Behavior. *Journal of Computer-Mediated Communication* **25,** 199–216. ISSN: 1083-6101 (May 2020).

65. Müller, K. & Schwarz, C. Fanning the flames of hate: Social media and hate crime. *Journal of the European Economic Association* (2018).

66. Bail, C. A. *et al.* Exposure to opposing views on social media can increase political polarization. *Proceedings of the National Academy of Sciences* **115.** Publisher: National Acad Sciences, 9216–9221 (2018).

67. Allcott, H., Braghieri, L., Eichmeyer, S. & Gentzkow, M. The welfare effects of social media. *American Economic Review* **110,** 629–76 (2020).

68. Bond, R. M. *et al.* A 61-million-person experiment in social influence and political mobilization. *Nature* **489,** 295–298. ISSN: 0028-0836 (Sept. 2012).

69. Asimovic, N., Nagler, J., Bonneau, R. & Tucker, J. A. Testing the effects of Facebook usage in an ethnically polarized setting. en. *Proceedings of the National Academy of Sciences* **118.** Publisher: National Academy of Sciences Section: Social Sciences. ISSN: 0027-8424, 1091-6490. (2021) (June 2021).

70. Wong, S. H.-W. & Wong, M. Y. H. "Distant Participation" and Youth Political Attitudes: Evidence from a Natural Experiment. *Social Science Quarterly* **101,** 1489–1512. ISSN: 0038-4941 (July 2020).

71. Kleinberg, M. & Lau, R. Googling Politics: How Offloading Affects Voting and Political Knowledge. *Political Psychology* **42,** 93–110 (2021).

72. Poy, S. & Schüller, S. Internet and voting in the social media era: Evidence from a local broadband policy. *Research Policy* **49** (2020).

73. Lee, S. & Xenos, M. Incidental news exposure via social media and political participation: Evidence of reciprocal effects. *New Media and Society* (2020).

74. Imai, K., Keele, L. & Tingley, D. A general approach to causal mediation analysis. *Psychological methods* **15.** Publisher: American Psychological Association, 309 (2010).

75. Porumbescu, G. Not All Bad News After All? Exploring the Relationship Between Citizens' Use of Online Mass Media for Government Information and Trust in Government. *International Public Management Journal* **20,** 409–441. ISSN: 1096-7494 (2017).

76. Zhu, Z., Liu, Y., Kapucu, N. & Peng, Z. Online media and trust in government during crisis: The moderating role of sense of security. *International Journal of Disaster Risk Reduction* **50** (2020).

77. Zimmermann, F. & Kohring, M. Mistrust, Disinforming News, and Vote Choice: A Panel Survey on the Origins and Consequences of Believing Disinformation in the 2017 German Parliamentary Election. *Political Communication* **37,** 215–237. ISSN: 1058-4609 (Mar. 2020).

78. Bucy, E. P. & Groshek, J. Empirical support for the media participation hypothesis: Trends across presidential elections, 1992-2012. *New Media & Society* **20,** 1889–1909. ISSN: 1461-4448 (May 2018).

79. Arlt, D. Who trusts the news media? Exploring the factors shaping trust in the news media in German-speaking Switzerland. *Studies in Communication Sciences* **18,** 231–245 (2019).

80. Park, S., Fisher, C., Flew, T. & Dulleck, U. Global Mistrust in News: The Impact of Social Media on Trust. *Jmm-International Journal on Media Management* **22,** 83–96. ISSN: 1424-1277 (Apr. 2020).

81. Sabatini, F. & Sarracino, F. Online Social Networks and Trust. *Social Indicators Research* **142,** 229–260 (2019).

82. Carrieri, V., Madio, L. & Principe, F. Vaccine hesitancy and (fake) news: Quasi-experimental evidence from Italy. *Health Economics (United Kingdom)* **28,** 1377–1382 (2019).

83. Casara, B., Suitner, C. & Bettinsoli, M. Viral suspicions: Vaccine hesitancy in the web 2.0. *Journal of Experimental Psychology: Applied* **25,** 354–371 (2019).

84. Huber, B., Barnidge, M., Gil de Zuniga, H. & Liu, J. Fostering public trust in science: The role of social media. *Public Understanding of Science* **28,** 759–777. ISSN: 0963-6625 (Oct. 2019).

85. Placek, M. A. #Democracy: social media use and democratic legitimacy in Central and Eastern Europe. *Democratization* **24,** 632–650. ISSN: 1351-0347 (June 2017).

86. Placek, M. Can the Internet Aid Democratic Consolidation?: Online News and Legitimacy in Central and Eastern Europe. *Placek, M.(2018). Can the Internet Aid Democratic Consolidation* (2018).

87. Min, G., Yu, Z. & Li, F. *Analysis of Moral Deviation in Netnews Post-Bumping* (eds Wang, Y. & Xu, H.) ISBN: 978-7-5629-5021-9 (2015).

88. Di, C. & Fang, W. New channels, new ways of becoming informed? Examining the acquisition of public affairs knowledge by young people in China. *Information Development* **35,** 688–702. ISSN: 0266-6669 (Nov. 2019).

89. Wei, K., Lin, Y.-R. & Yan, M. *Examining Protest as An Intervention to Reduce Online Prejudice: A Case Study of Prejudice Against Immigrants* in (2020), 2443–2454.

90. Alam, A., Adnan, H. M. & Kotamjani, S. S. Examining the Impact of Using Social Networks on Political Knowledge and Political Attitude by Iranian University Students. *Jurnal Komunikasi-Malaysian Journal of Communication* **35,** 125–140. ISSN: 2289-151X (2019).

91. Beaudoin, C. E. The internet's impact on international knowledge. *New Media & Society* **10,** 455–474. ISSN: 1461-4448 (June 2008).

92. Ida, R., Saud, M. & Mashud, M. An empirical analysis of social media usage, political learning and participation among youth: a comparative study of Indonesia and Pakistan. *Quality and Quantity* **54,** 1285–1297 (2020).

93. Salaudeen, M. & Onyechi, N. Digital media vs mainstream media: Exploring the influences of media exposure and information preference as correlates of media credibility. *Cogent Arts and Humanities* **7** (2020).

94. Imran, M. & Fatima, M. *Connectivism: E-learning of democratic values on social media public spheres* in. **2017-December** (2018), 82–89.

95. Park, C. & Kaye, B. News Engagement on Social Media and Democratic Citizenship: Direct and Moderating Roles of Curatorial News Use in Political Involvement. *Journalism and Mass Communication Quarterly* **95,** 1103–1127 (2018).

96. Gottfried, J. A., Hardy, B. W., Holbert, R. L., Winneg, K. M. & Jamieson, K. H. The Changing Nature of Political Debate Consumption: Social Media, Multitasking, and Knowledge Acquisition. *Political Communication* **34,** 172–199. ISSN: 1058-4609 (2017).

97. Kim, D. H. & Kwak, N. Media Diversity Policies for the Public: Empirical Evidence Examining Exposure Diversity and Democratic Citizenship. *Journal of Broadcasting & Electronic Media* **61,** 682–702. ISSN: 0883-8151 (2017).

98. Beam, M. A., Hutchens, M. J. & Hmielowski, J. D. Clicking vs. sharing: The relationship between online news behaviors and political knowledge. *Computers in Human Behavior* **59,** 215–220. ISSN: 0747-5632 (June 2016).

99. Edgerly, S., Thorson, K. & Wells, C. Young Citizens, Social Media, and the Dynamics of Political Learning in the U.S. Presidential Primary Election. *American Behavioral Scientist* **62,** 1042–1060 (2018).

100. Cardenal, A., Galais, C. & Majó-Vázquez, S. Is Facebook Eroding the Public Agenda? Evidence from Survey and Web-Tracking Data. *International Journal of Public Opinion Research* **31,** 589–608 (2019).

101. Feezell, J. T. Agenda Setting through Social Media: The Importance of Incidental News Exposure and Social Filtering in the Digital Era. *Political Research Quarterly* **71,** 482–494. ISSN: 1065-9129 (June 2018).

102. Kelly Garrett, R. Social media's contribution to political misperceptions in U.S. Presidential elections. *PLoS ONE* **14** (2019).

103. Lee, S. & Xenos, M. Social distraction? Social media use and political knowledge in two U.S. Presidential elections. *Computers in Human Behavior* **90,** 18–25 (2019).

104. Van Erkel, P. & Van Aelst, P. Why Don't We Learn from Social Media? Studying Effects of and Mechanisms behind Social Media News Use on General Surveillance Political Knowledge. *Political Communication,* 1–19 (2020).

105. Lee, S. Connecting social media use with gaps in knowledge and participation in a protest context: the case of candle light vigil in South Korea. *Asian Journal of Communication* **29,** 111–127. ISSN: 0129-2986 (Mar. 2019).

106. Cacciatore, M. A. *et al.* Is Facebook Making Us Dumber? Exploring Social Media Use as a Predictor of Political Knowledge. *Journalism & Mass Communication Quarterly* **95,** 404–424. ISSN: 1077-6990 (June 2018).

107. Moeller, J., Shehata, A. & Kruikemeier, S. Internet use and political interest: Growth curves, reinforcing spirals, and causal effects during adolescence. *Journal of Communication* **68,** 1052–1078 (2018).

108. Lee, S. Probing the Mechanisms Through Which Social Media Erodes Political Knowledge: The Role of the News-Finds-Me Perception. *Mass Communication and Society* **23,** 810–832. ISSN: 1520-5436 (Nov. 2020).

109. Boukes, M. Social network sites and acquiring current affairs knowledge: The impact of Twitter and Facebook usage on learning about the news. *Journal of Information Technology & Politics* **16,** 36–51. ISSN: 1933-1681 (2019).

110. Adam, S., Haussler, T., Schmid-Petri, H. & Reber, U. Coalitions and counter-coalitions in online contestation: An analysis of the German and British climate change debate. *New Media & Society* **21,** 2671–2690. ISSN: 1461-4448 (Nov. 2019).

111. North, S., Piwek, L. & Joinson, A. Battle for Britain: Analyzing Events as Drivers of Political Tribalism in Twitter Discussions of Brexit. *Policy and Internet* (2020).

112. Bryson, B. Polarizing the middle: internet exposure and public opinion. *International Journal of Sociology and Social Policy* **40,** 99–113 (2019).

113. Lee, C., Shin, J. & Hong, A. Does social media use really make people politically polarized? Direct and indirect effects of social media use on political polarization in South Korea. *Telematics and Informatics* **35.** Publisher: Elsevier, 245–254 (2018).

114. Cho, J., Ahmed, S., Keum, H., Choi, Y. & Lee, J. Influencing Myself: Self-Reinforcement Through Online Political Expression. *Communication Research* **45,** 83–111 (2018).

115. Yarchi, M., Baden, C. & Kligler-Vilenchik, N. Political polarization on the digital sphere: A cross-platform, over-time analysis of interactional, positional, and affective polarization on social media. *Political Communication.* Publisher: Taylor & Francis, 1–42 (2020).

116. Workneh, T. Social media, protest, & outrage communication in Ethiopia: toward fractured publics or pluralistic polity? *Information Communication and Society* **24,** 309–328 (2021).

117. Hawdon, J., Ranganathan, S., Leman, S., Bookhultz, S. & Mitra, T. *Social media use, political polarization, and social capital: is social media tearing the u.s. apart?* (2020).

118. Urman, A. News Consumption of Russian Vkontakte Users: Polarization and News Avoidance. *International Journal of Communication* **13,** 5158–5182. ISSN: 1932-8036 (2019).

119. Kibet, A. & Ward, S. Socially Networked Heterogeneity: The Influence of WhatsApp as a Social Networking Site on Polarisation in Kenya. *African Journalism Studies* **39,** 42–66. ISSN: 2374-3670 (2018).

120. Fletcher, R., Cornia, A. & Nielsen, R. How Polarized Are Online and Offline News Audiences? A Comparative Analysis of Twelve Countries. *International Journal of Press/Politics* **25,** 169–195 (2020).

121. Lu, J. & Luo, C. Development consensus in the Internet context: penetration, freedom, and participation in 38 countries. *Information Development* **36,** 288–300 (2020).

122. Lai, M., Tambuscio, M., Patti, V., Ruffo, G. & Rosso, P. Stance polarity in political debates: A diachronic perspective of network homophily and conversations on Twitter. *Data and Knowledge Engineering* **124** (2019).

123. Kobayashi, T., Ogawa, Y., Suzuki, T. & Yamamoto, H. News audience fragmentation in the Japanese Twittersphere. *Asian Journal of Communication* **29,** 274–290 (2019).

124. Nguyen, A. & Vu, H. Testing popular news discourse on the echo chamber effect: Does political polarisation occur among those relying on social media as their primary politics news source? *First Monday* **24** (2019).

125. Beam, M., Hutchens, M. & Hmielowski, J. Facebook news and (de)polarization: reinforcing spirals in the 2016 US election. *Information Communication and Society* **21,** 940–958 (2018).

126. Levy, R. Social media, news consumption, and polarization: Evidence from a field experiment. *American economic review* **111,** 831–70 (2021).

127. Carrella, F. #Populism on twitter: Statistical analysis of the correlation between tweet popularity and "populist" discursive features. *Brno Studies in English* **46,** 5–23 (2020).

128. Serrano, J., Shahrezaye, M., Papakyriakopoulos, O. & Hegelich, S. *The rise of Germany's AfD: A social media analysis* in (2019), 214–223.

129. Schumann, S., Boer, D., Hanke, K. & Liu, J. Social media use and support for populist radical right parties: assessing exposure and selection effects in a two-wave panel study. *Information Communication and Society* (2019).

130. Schumann, S., Thomas, F., Ehrke, F., Bertlich, T. & Dupont, J. C. Maintenance or change? Examining the reinforcing spiral between social media news use and populist attitudes. en. *Information, Communication & Society,* 1–18. ISSN: 1369-118X, 1468-4462. (2021) (Apr. 2021).

131. Heiss, R. & Matthes, J. Stuck in a Nativist Spiral: Content, Selection, and Effects of Right-Wing Populists' Communication on Facebook. *Political Communication* **37,** 303–328 (2020).

132. Bliuc, A.-M. *et al.* The effects of local socio-political events on group cohesion in online far-right communities. *PLoS ONE* **15** (2020).

133. Schulze, H. Who uses right-wing alternative online media? An exploration of audience characteristics. *Politics and Governance* **8,** 6–18 (2020).

134. Boulianne, S., Koc-Michalska, K. & Bimber, B. Right-wing populism, social media and echo chambers in Western democracies. *New Media and Society* **22,** 683–699 (2020).

135. Jeroense, T., Luimers, J., Jacobs, K. & Spierings, N. Political social media use and its linkage to populist and postmaterialist attitudes and vote intention in the Netherlands. *European Political Science* (2021).

136. Bosilkov, I. Media populism in Macedonia: Right-wing populist style in the coverage of the "migrant crisis". *Central European Journal of Communication* **12,** 206–223 (2019).

137. Seebruck, R. Technology and Tolerance in Japan: Internet Use and Positive Attitudes and Behaviors Toward Foreigners. *Social Science Japan Journal* **16,** 279–300. ISSN: 1369-1465 (2013).

138. DOROSHENKO, L. Far-Right Parties in the European Union and Media Populism: A Comparative Analysis of 10 Countries During European Parliament Elections. *International Journal of Communication* **12,** 3186–3206 (2018).

139. Fletcher, R. & Nielsen, R. Are people incidentally exposed to news on social media? A comparative analysis. *New Media and Society* **20,** 2450–2468 (2018).

140. Guess, A. M. (Almost) Everything in Moderation: New Evidence on Americans' Online Media Diets. *American Journal of Political Science.* ISSN: 0092-5853 (2021).

141. Strauss, N., Huber, B. & Gil de Zuniga, H. "Yes, I Saw It - But Didn't Read It ..." A Cross-Country Study, Exploring Relationships between Incidental News Exposure and News Use across Platforms. *Digital Journalism* **8,** 1181–1205. ISSN: 2167-0811 (Nov. 2020).

142. Yang, T., Majó-Vázquez, S., Nielsen, R. & González-Bailón, S. Exposure to news grows less fragmented with an increase in mobile access. *Proceedings of the National Academy of Sciences of the United States of America* **117,** 28678–28683 (2020).

143. Rivero, G. Preaching to the choir: ideology and following behaviour in social media. *Contemporary Social Science* **14,** 54–70 (2019).

144. Cinelli, M., de Francisci Morales, G., Galeazzi, A., Quattrociocchi, W. & Starnini, M. The echo chamber effect on social media. *Proceedings of the National Academy of Sciences of the United States of America* **118** (2021).

145. Cota, W., Ferreira, S., Pastor-Satorras, R. & Starnini, M. Quantifying echo chamber effects in information spreading over political communication networks. *EPJ Data Science* **8** (2019).

146. Guerrero-Solé, F. & Lopez-Gonzalez, H. Government Formation and Political Discussions in Twitter: An Extended Model for Quantifying Political Distances in Multiparty Democracies. *Social Science Computer Review* **37,** 3–21 (2019).

147. Koiranen, I., Koivula, A., Keipi, T. & Saarinen, A. Shared contexts, shared background, shared values – Homophily in Finnish parliament members' social networks on Twitter. *Telematics and Informatics* **36,** 117–131 (2019).

148. Barnidge, M., Macafee, T., Alvarez, G. & Rojas, H. Citizenship and Political Participation in Colombia: How Orientations Toward Citizenship Associate with Political and Civic Behaviors. *International Journal of Communication* **8,** 1831–1850. ISSN: 1932-8036 (2014).

149. Soral, W., Liu, J. & Bilewicz, M. Media of contempt: Social media consumption predicts normative acceptance of anti-muslim hate speech and islamoprejudice. *International Journal of Conflict and Violence* **14,** 1–13 (2020).

150. Tornberg, A. & Wahlstrom, M. Unveiling the radical right online:Exploring framing and identity in an online anti-immigrant discussion group. *Sociologisk Forskning* **55,** 267–292 (2018).

151. Rathje, S., Van Bavel, J. J. & van der Linden, S. Out-group animosity drives engagement on social media. *Proceedings of the National Academy of Sciences* **118.** Publisher: National Acad Sciences (2021).

152. Kubin, E. & von Sikorski, C. The role of (social) media in political polarization: a systematic review. *Annals of the International Communication Association* **45,** 188–206 (2021).

153. Pasquetto, I. V. *et al.* Tackling misinformation: What researchers could do with social media data. *The Harvard Kennedy School Misinformation Review* (2020).

154. Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Group, P., *et al.* Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine* **6.** Publisher: Public Library of Science, e1000097 (2009).

155. Gusenbauer, M. & Haddaway, N. R. Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research synthesis methods* **11,** 181–217 (2020).

# Supplementary material for:
# Digital Media and Democracy: A Systematic Review of Causal and Correlational Evidence Worldwide

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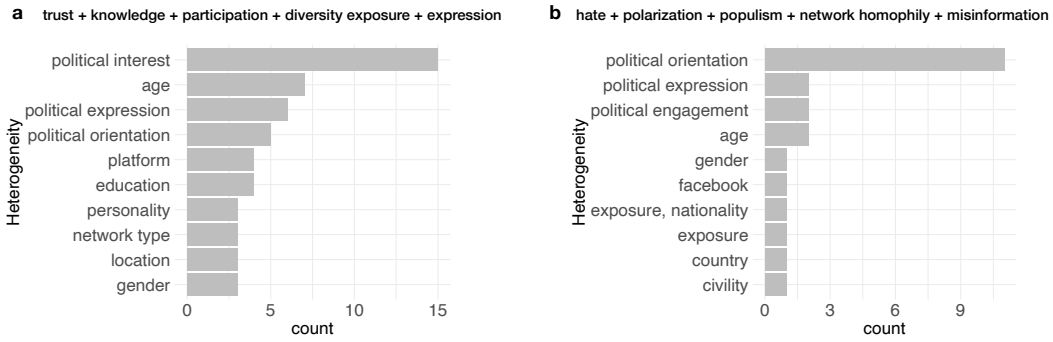


Figure S1: Moderator variables reported in studies within the review sample. (a) Reported sources of effect heterogeneity for studies with major outcome measures that are beneficial for democracy (trust, knowledge, participation and diversity of exposure). For example, the effect of digital media on political knowledge (or the relationship between the two variables) was moderated by political interest in 21 studies. (b) Most prominent moderator variables reported in studies with outcome measures that are detrimental for democracy (hate, polarization, populism, network homophily. For example, when the effect of digital media on polarization was moderated by political orientation, the effect varied (in strenth or directon) between people with different political orientation.

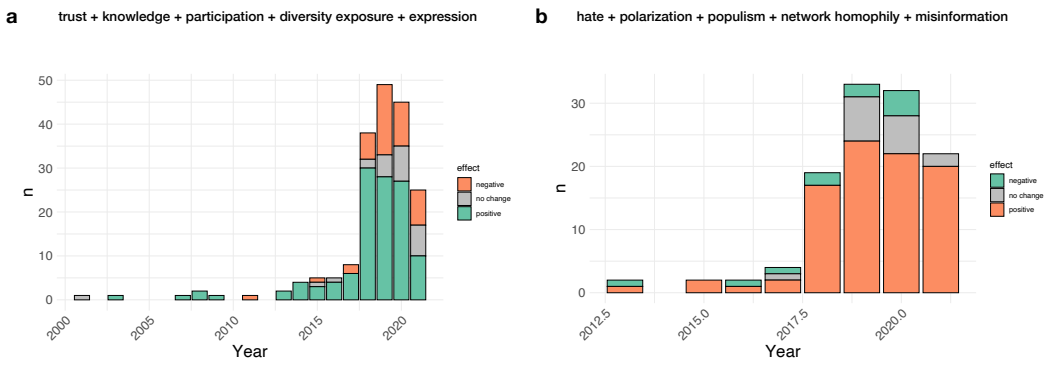


Figure S2: Number of studies published over time by effect direction. Colour representing effect valence with regard to democracy (green as beneficial, red as detrimental for democracy). (a) effects of studies published with outcome measures that are beneficial for democracy (trust, knowledge, participation and diversity of exposure). (b) effects of studies published with outcome measures that are detrimental for democracy (hate, polarization, populism, network homophily, misinformation). For both categories of outcome variables, authors found mostly statically positive relationships, that means, amplifications of positive but also negative phenomena through digital media.

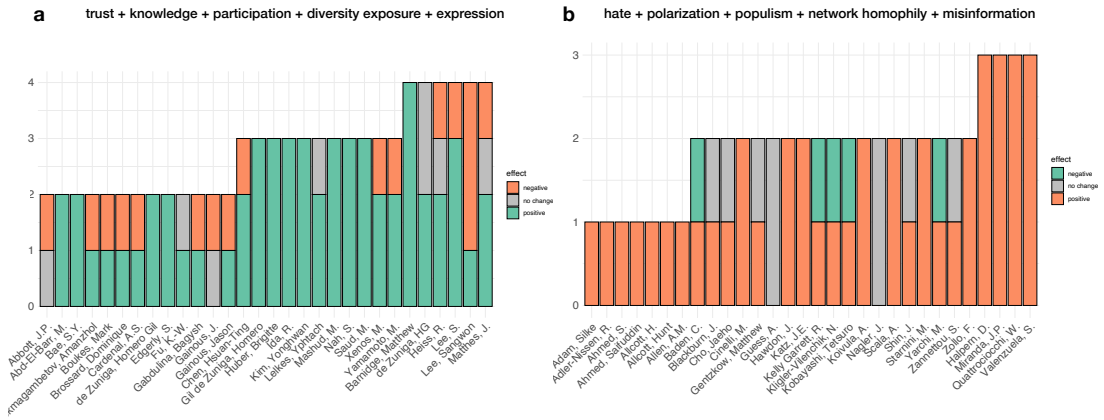


Figure S3: Number of studies published by authors, by effect direction. Colour representing effect valence with regard to democracy (green as beneficial, red as detrimental for democracy). (a) effects of studies published with outcome measures that are beneficial for democracy (trust, knowledge, participation and diversity of exposure). (b) effects of studies published with outcome measures that are detrimental for democracy (hate, polarization, populism, network homophily, misinformation). For both categories of outcome variables, authors found mostly statically positive relationships, that means, amplifications of positive but also negative phenomena through digital media. We do not find strong patterns for field dominating authors.

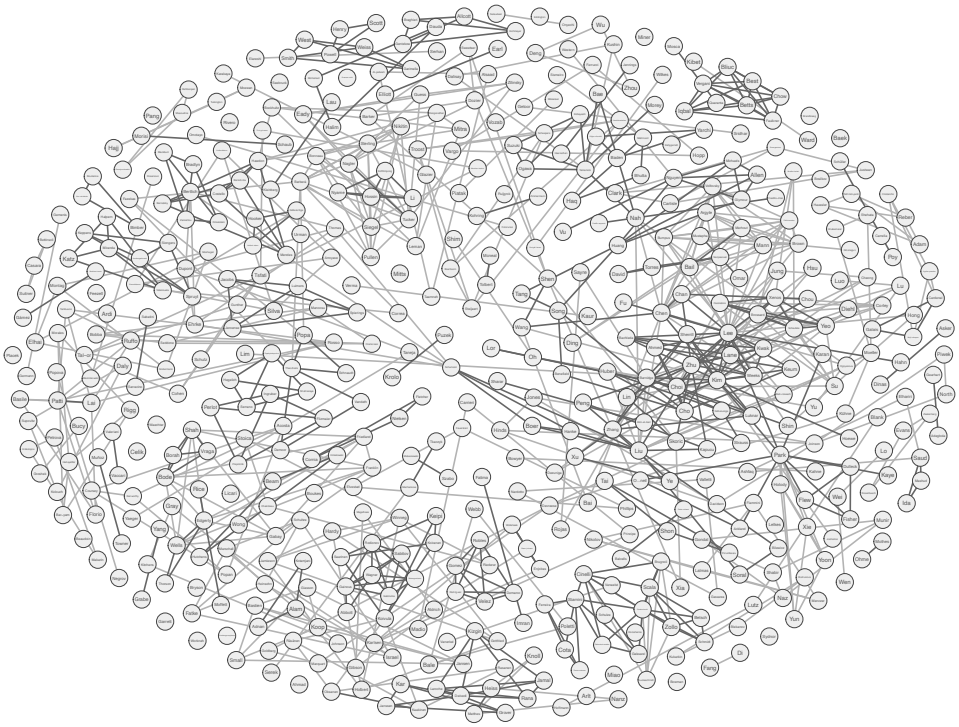

Figure S4: Co-author network from the sample, a link between two authors represents a co-authored paper in our sample. Visualization is using a spring-layout, showing authors spatially closer together when they are connected.

**Causality vs. Correlation: A Brief Primer**

The 'fundamental problem of causal inference' is the impossibility to observe the effects of a variable on a specific individual. To measure *individual* causal treatment effects, one would have to measure both, the actual state of an individual under treatment (the reality) but at the same time, the counterfactual — the state of the same individual had they not been treated [1]. Perfect experiments permit the observation of *average* causal treatment effects by comparing the outcomes of treatment and control groups, with the groups made equal on all variables other than the treatment through random assignment. Usually, in the absence of randomized treatment assignment with observational data, such as survey data, the identification of causal effects is impossible due to the fact that individuals differ systematically on variables other than the treatment (or independent) variable. For example, selection effects are among the most common sources of non-causal explanations of correlations. Selection bias means that as the treatment and control groups differ systematically because only specific individuals (e.g. those with a specific media preference, say, watching FOX ) select into the (not randomly selected) treatment group. Therefore, one cannot conclude much about the causal effects of watching FOX as people who do may differ on many other dimensions from people who prefer to watch, say, CNN. Issues of reverse causality (the outcome causing the independent variable and not vice versa) and heterogeneous treatment effect bias (the independent variable having differing effects for different groups of individuals) are other common threats to causal inference. Therefore, the interpretation of observational evidence needs to be more cautious as the observed associations can be bi-directional; they can be confounded by third variables or the associations can have other, unobserved causes. Yet, under certain conditions, it is possible to rule out non-causal explanations for associations, even in studies without random assignment that report observational data (see the work of this year's laureates of the Nobel Memorial Prize in Economics [2–4]. We summarize the fundamental logic of the dominant causal inference methods used in papers reported in this review in Fig. 2 of the main paper.

## References


1. Rubin, D. B. Causal inference using potential outcomes: Design, modeling, decisions. *Journal of the American Statistical Association* **100.** Publisher: Taylor & Francis, 322–331 (2005).
2. Of Sciences, T. R. S. A. *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2021* en-US. 2021. (2021).
3. Angrist, J. D. & Pischke, J.-S. *Mostly harmless econometrics* (Princeton university press, 2008).
4. Angrist, J. D. & Pischke, J.-S. The credibility revolution in empirical economics: How better research design is taking the con out of econometrics. *Journal of economic perspectives* **24,** 3–30 (2010).