



Social Media Sensationalism in the Male Infertility Space: A Mixed Methodology Analysis

Kassandra E. Zaila^{1,2}, Vadim Osadchiy^{1,2}, Robert H. Shahinyan^{1,2}, Jesse N. Mills¹,
Sriram V. Eleswarapu^{1,2}

¹Division of Andrology, Department of Urology, ²Consortium for Health Activity on Social Media (CHASM), David Geffen School of Medicine, University of California, Los Angeles, CA, USA

Purpose: Infertile couples increasingly turn to the internet for medical guidance. The aims of this study were: (1) to identify popular male infertility content on social media, and (2) to assess the accuracy and quality of this content. We hypothesized that inaccurate/misleading information proliferates online.

Materials and Methods: We used the analytics module BuzzSumo to identify article links that were most shared on Facebook, Pinterest, Reddit, and Twitter related to male infertility during September 2018 to August 2019. We excluded articles with <100 engagements, defined as "likes," "comments," and "shares." Two researchers graded content as accurate, misleading, or inaccurate by comparing content to references cited and contemporary research. Inter-rater reliability was determined with Cohen's κ . Binary logistic regression was performed to compare user engagement with accurate versus inaccurate/misleading articles.

Results: Fifty-two unique article links were identified, with 421,004 total engagements. Thirty-four articles referenced 15 scientific studies; no reference was available for 18 links. Fifty-six percent of articles were accurate and 44% misleading/inaccurate ($\kappa=0.743$). No significant difference was found in total engagement between accurate vs. misleading/inaccurate links ($p=0.805$). Twenty-four percent of engagements referenced studies using non-human models, and 26% of studies had sample sizes <100.

Conclusions: Social media platforms foster engagement with male infertility information. However, sensationalism predominates, as patients are highly likely to encounter misleading/inaccurate information, articles that overstate implications of animal research, and conclusions made based on limited sample sizes. Urologists should consider adding social media to their armamentarium to stave off misinformation and engage proactively with patients.

Keywords: Infertility, male; Internet; Social media; Sperm

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INTRODUCTION

The internet has profoundly altered how individuals obtain information regarding their health [1], and

men's health is no exception. Although men are less likely than women to pursue preventative health care and more likely to develop chronic cardiovascular and metabolic disease [2,3], the rise of online social media

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Correspondence to: Sriram V. Eleswarapu <https://orcid.org/0000-0003-1852-4833>

Division of Andrology, Department of Urology, University of California, Los Angeles, 10945 Le Conte Avenue, Ueberroth #3361, Los Angeles, CA 90095, USA.

Tel: +1-310-794-3058, **Fax:** +1-310-206-2369, **E-mail:** seleswarapu@mednet.ucla.edu

platforms may play a role in challenging this disproportion.

Men contending with infertility increasingly turn to social media platforms for information, guidance, and discussion with peers. A male factor contributes to nearly 60% of all cases of infertility [4], yet cultural and societal constructs of masculinity create psychosocial barriers to consultation with a physician. Social media platforms enfranchise men to take an active role in understanding causes and treatments for infertility by providing anonymity absent from face-to-face encounters [5].

Although health information online is becoming more readily accessible, it escapes the scrutiny of scientific publication guidelines, allowing for the propagation of non-evidenced-based material. Social media tends to amplify the most sensational content and headlines. Literature assessing the quality of male infertility content available online remains scarce, although a recent review has shown that urological conditions as a whole suffer from a spread of misinformation on social media [6]. Social media analytics tools have emerged that provide detailed, quantitative metrics, but these tools have not yet been applied to content in the male infertility space.

Given the proliferation of sensationalism on social media, we hypothesized that content about male infertility shared on social media platforms may be largely inaccurate or misleading. Using a combination of an analytics tool and a quality rating system, we performed a quantitative and qualitative analysis of male

infertility content shared on social media. These data may inform how men's health specialists should approach patient education about male infertility, as well as ways in which they engage with social media in the future.

MATERIALS AND METHODS

1. Study methods

We used the social media analytics tool BuzzSumo (www.buzzsumo.com, London, UK) to identify the most shared male infertility content from September 2018 through August 2019. BuzzSumo gathers data across the social media platforms Facebook, Pinterest, Reddit, and Twitter to generate a list of article links with the highest online engagement. Engagement is defined as the total number of interactions that users have with a particular article link, including actions, such as "liking," "commenting," and "sharing" on social media [7].

Two urologists with advanced fellowship training in male reproductive medicine initially screened a total of 20 search terms related to male infertility using BuzzSumo. Ten terms were then selected based on having the highest total engagements (1,000 or more engagements) for BuzzSumo interrogation: fertility in men, low sperm treatment, male fertility, male fertility testosterone, male infertility, semen analysis, sperm count, sperm motility, sperm quality, and sperm testosterone. Terms were further excluded if no associated article links generated sufficient engagement (100 or more engagements [8]).

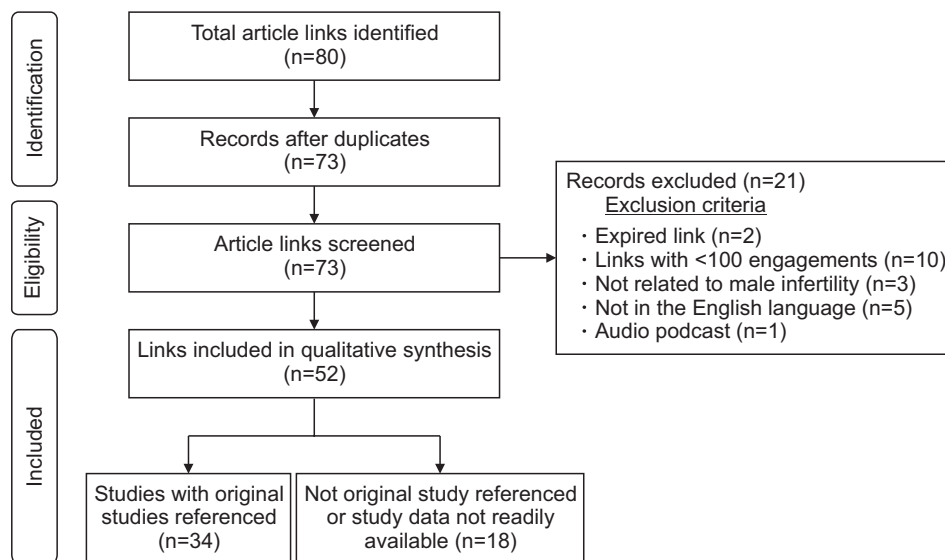


Fig. 1. Methodology for content assessment using a quantitative social media analytics tool.

Fig. 1 summarizes the workflow for selecting article links from final search term results. The most popular article links for each search term were identified, followed by analysis of social media engagement. Links were excluded if they were not written in the English language, were not related to male infertility, were audio podcasts, were broken/expired, or had fewer than 100 total engagements, a metric that has been used in prior investigations to exclude low impact content [8].

Two medical student reviewers with curricular training in critical evaluation of the literature independently graded content as accurate, misleading, or inaccurate by assessing references cited, as well as comparing the content to existing peer-reviewed literature (Supplement Table). Article links were classified as inaccurate if the content was not supported by scientific literature. Content was classified as misleading if it contained a combination of accurate and inaccurate information, or if it extrapolated animal data to make inappropriate conclusions about human fertility. The senior authors, two urologists with advanced fellowship training in male reproductive medicine, were blinded to the two reviewer decisions and adjudicated all discordances.

Cohen's κ was used to calculate inter-rater reliability between the two independent reviewers. Binary logistic regression was used to compare user engagement with accurate *versus* inaccurate/misleading article links; a separate regression was run for total engagement, to limit collinearity among variables. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using IBM SPSS ver. 25 (IBM Corp., Armonk, NY, USA).

2. Ethics statement

Consistent with previous investigations on social media data, this work was exempt by the Institutional Review Board of the University of California, Los Angeles as it involves publicly available data and does not involve human subjects.

RESULTS

After applying exclusion criteria, eight search terms and 52 article links remained. Of the original ten search terms, the two exclusions due to insufficient engagement were "male fertility testosterone" and "low sperm treatment." The 52 article links were stratified

into four categories: (1) scientific peer-reviewed journal, (2) medical center or hospital affiliated website, (3) news organization website, and (4) alternative media (e.g., blog, marketing agency). Overall, the majority of links came from websites in the alternative media category (54%), followed by news organizations (37%). Scientific peer-reviewed journal websites and medical center websites comprised the fewest article links, at 8% and 2%, respectively. High-engagement articles hosted on alternative media websites were more accurate (57%) compared to misleading/inaccurate (43%). Articles from each remaining category tended to have similar user engagement between accurate and misleading/inaccurate content (Table 1).

Table 2 outlines engagement data stratified by search term and social media platform. "Sperm count" emerged as the most popular search term, capturing 50% of the total engagement across all platforms. Facebook was the most popular platform for sharing male infertility content (average of 6,297 engagements per link), followed by Reddit (1,687), Twitter (113), and Pinterest (0.5). All search terms experienced highest engagement on Facebook, with the exception of "fertility in men," which was most popular on Reddit.

Overall, 56% of articles were graded as accurate and 44% as misleading or inaccurate ($\kappa = 0.743$). No significant difference was found in engagements between accurate *versus* inaccurate/misleading links (Table 3).

Fifteen peer-reviewed research studies comprised the primary citations used by 34 of the 52 total article links (Table 4) [9-22]. The remaining 18 links did not cite original peer-reviewed scientific studies, or purported study data were not accessible. Of the 34 links with scientific evidence, 17 (50%) referenced the same two original research studies and captured twice as many engagements as the remaining 13 studies combined. Studies relying upon animal or insect models

Table 1. Article link sources and accuracy

Source website	Misleading/ Inaccurate	Accurate	Total
Scientific peer-reviewed journal	2	2	4
Medical center or hospital	0	1	1
News organization	9	10	19
Alternative media (e.g., blog)	12	16	28

A total of 52 article links were identified. Accuracy of article links were graded by two separate reviewers based on scientific studies referenced within the article.

Table 2. Search term engagements by social media platform

Search term	Number of engagements				
	Facebook	Twitter	Pinterest	Reddit	Total
Sperm count	173,600	2,005	4	34,210	209,819
Sperm quality	57,010	247	0	7,400	64,657
Male fertility	61,300	1,261	8	417	62,986
Fertility in men	7,386	391	8	45,620	53,405
Male infertility	18,200	1,209	1	27	19,437
Sperm testosterone	7,261	594	3	4	7,862
Semen analysis	1,652	28	3	0	1,683
Sperm motility	1,011	121	0	23	1,155
Total	327,420	5,856	27	87,701	421,004

Engagements – defined as the sum of “likes,” “comments,” and “shares” of given article.

Table 3. Statistical comparison of engagement by platform with graded accuracy of article links

Engagement by platform (accurate vs. misleading/inaccurate)	OR	p-value
Facebook	0.746	0.388
Twitter	0.507	0.477
Pinterest	2.624	0.105
Reddit	0.071	0.789
Total	0.061	0.805

A separate regression was run for total engagement, to limit collinearity among variables. Odds ratios (OR) were calculated. No association was found between article accuracy and engagement.

comprised 24% of total engagements, and 90% of these links were graded as misleading. Among all 15 peer-reviewed studies, 26% had sample sizes <100 subjects. The highest user engagement was found for article links discussing the effects of cannabis and chemical contaminants on sperm characteristics.

DISCUSSION

Though male infertility content proliferates on the internet, little is known about the sources and quality of information encountered by users who may make health care decisions based on what they read online. Prior work has shown that misinformation about urological conditions thrives on social media [6], but an in-depth analysis of male infertility content has been lacking. To this end, we quantified internet user engagement with male infertility content across a variety of social media platforms, then evaluated the accuracy of information shared on these platforms.

We found that social media users encounter misleading or inaccurate information about male infertility at similar rates to accurate content. Nearly a quarter of user engagement focused on article links reporting on experimental results in non-human models, and 90% of these articles were determined to be misleading – the original studies were routinely misinterpreted as having immediate implications for human fertility, then amplified on social media. For example, in a study by Sales et al [23], male insects exposed to increasing heatwave conditions (thermal incubation) had significantly lower sperm function and offspring production, and this effect showed transgenerational impact. The study draws no conclusions about human fertility, yet an article in USA Today reported, “[T]he scientists used beetles to test their theory. But researchers say the insects can be used as a proxy for people,” [24] and concluded that human fertility is directly impacted by climate change. Despite the inappropriate extrapolation, the USA Today link alone received a total of 21,812 social media engagements.

We found that over 90% of male infertility content online comes from non-peer-reviewed sources, such as news organizations and alternative media (e.g., blogs and marketing websites). These data suggest that the scientific and medical establishment have limited traction with an increasingly sensationalized consumer culture. Scientific journal and medical center websites typically target their male infertility content toward scientifically literate health care professionals, rather than the general public. A potential way to mitigate the misinterpretation of scientific research may be for academic institutions to take a greater role in creat-

Table 4. Characteristics of studies referenced online

Study	Main study finding	Study population; sample size	Engagements	References to article
Nassan et al [10]	Marijuana smokers had higher sperm counts than non-users	Men presenting to a fertility center; n=662	140,926	11
Sumner et al [9]	Two common industrial chemicals found in the environment caused deleterious effects in sperm	Human (n=9) and canine (n=11) males	73,024	6
Tiegs et al [11]	Sperm counts have declined over time	Men presenting to fertility center; n=119,972	19,636	2
Sales et al [23]	Increasing temperatures negatively affect fertility in ectotherms	Male flour beetles; n=51 (treatment group)	25,120	2
Yildirim et al [12]	Duration of cell phone use did not affect sperm parameters	Men presenting for semen analysis; n=1,031	15,217	1
Chang et al [13]	Decline in sperm quality had geographic variations	Semen analysis specimens; n=124,107	6,010	1
Shen et al [14]	Short ejaculatory abstinence improved sperm quality and <i>in vitro</i> fertilization outcomes	n=167 couples (experimental); n=361 couples (control)	4,636	1
Murphy et al [15]	Cannabis exposure in humans and rats resulted in lower sperm concentrations due to changes in DNA methylation	Human (n=24) and rodent (n=16) males	4,415	1
Nassan et al [16]	Healthy diet increased sperm count and sperm function	Danish men presenting for military service medical testing; n=2,935	41,749	2
Rahban et al [17]	Significant proportion of young Swiss men have suboptimal semen quality	Military conscripted men from all regions of Switzerland; n=2,523	2,996	1
Hamilton et al [18]	Heat stress on sperm may be due to mitochondrial alterations	Santa Ines rams; n=6 (treated) and n=6 (control)	2,336	1
Umehara et al [19]	Activation of toll-like receptors 7/8 in sperm can preferentially result in male offspring sex selection	Variable numbers of mice in numerous experiments	348	1
Lee et al [20]	Systematic review and meta-analysis showed that weight loss from bariatric surgery increased male sex hormones	Men who underwent bariatric surgery in 28 studies; n=1,022	155	1
Arafa et al [21]	Poster on a marketing website showing that an oral antioxidant ("FH Pro") decreased seminal oxidative stress.	Infertile men; n=101	131	1
Hosseini et al [22]	Systematic review and meta-analysis showed that omega-3 fatty acids improved sperm motility	Human males; n=147 (treated) and n=143 (control)	127	1

Male infertility online content with the highest social media engagement referenced 15 scientific studies, with two studies predominating. Studies varied by use of human subjects or non-human subjects, and sample sizes ranged from vary few to very many. Despite the limitations of subject type or limited sample size, popular online content tended to extrapolate results to arrive at inappropriately generalized conclusions.

ing press releases or making researchers available for news media comment.

The proliferation of misleading conjectures about scientifically sound research becomes subjected to the "illusory truth effect," the tendency to believe false information to be accurate due to repeated exposure [25]. Sensationalism on social media perpetuates unrealistic expectations of fertility treatments and can have significant economic implications for infertile couples, whose out-of-pocket expenditures related to male factor infertility may reach \$15,000 in their quest to conceive

a pregnancy [26]. Indeed, a thriving market for male fertility vitamins and nutritional supplements has emerged online despite a paucity of evidence for a positive effect on semen analysis parameters [27].

Although 15 research studies were cited in article links over the one-year study period, just two of these studies drew 50% of citations [9,10]. The most popular study (140,926 engagements) focused on the effect of marijuana smoking on sperm parameters and reproductive hormones, and the authors of this study cautioned that their data may not be generalizable to men

from the general population [10]. The other study that drew the second highest engagements (73,024) examined the effect of chemical exposures on sperm function using a limited sample size of only nine humans and a comparison group of eleven canines [9], yet was featured in an article link that inappropriately generalized the data to imply wide translatability of the results [28]. Our findings suggest that a few studies are tokenized and amplified to guide discussion about male infertility on social media, despite having crucial limitations that are overlooked.

We also found that the most popular social media platform to share male infertility content was Facebook with 3× more engagements than Reddit and 56× more engagements than Twitter (Table 2). Facebook's higher level of engagement may be attributed to its in-depth engagement dimensions and primary purpose of connecting with friends and family. For example, Facebook has a larger audience of various age ranges and users have the ability to share videos and engage with posts on a longer-term basis [29]. This is in stark contrast to Twitter, whose primary purpose is to share ideas in 140 characters or less in a fast-paced nature making it difficult for posts to gain traction for very long as posts become quickly buried by new Tweets [29]. Reddit is another platform which allows for longer-term engagement with conversations within Reddit subforums, which may account for it being the platform with the second highest engagements. Our findings suggest that platforms with the ability to keep posts visible to users for longer periods of time plays a role in overall engagements.

Overall, our study findings highlight the need to facilitate online health interventions designed to offer users men's health information that is both accurate, engaging, and tailored to the general public. Discussions about male infertility are no longer occurring in the confines of medical offices and urologists should consider adding social media to their armamentarium to stave off misinformation and engage proactively with patients.

The present study is not without limitations. This study focuses only on the accuracy and engagement of male infertility content; little is known on how that engagement directly influences an individual's behaviors beyond the act of "sharing," "liking" or "commenting" on social media. We acknowledge that engagement with the content on social media does not equate to at-

tributing the links content to be accurate by the user. Additionally, our study has the underlying assumption that all social media platforms allow users to engage similarly without accounting for the unique experience and engagement dimensions each platform offers. Further investigation into this topic may allow for better stratification of how users engage with male infertility content.

CONCLUSIONS

Male infertility content on social media is widely shared, but sensationalism predominates, as misleading and inaccurate information tends to be amplified by user engagement. To our knowledge, this is the first study to use social media analytics in the male infertility space. Overall, implementing the use of social media metrics allows for better understanding of how internet users engage with male infertility content and may aid urologists in creating content that is tailored to men's needs and ensures a wider audience reach.

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Conflict of Interest

Sriram V. Eleswarapu is a consultant for Metuchen Pharmaceuticals. Jesse N. Mills is a consultant for Antares Pharma, Boston Scientific, and Endo Pharmaceuticals. The other authors have nothing to disclose.

Author Contribution

Conceptualization: KEZ, VO, RHS, SVE. Data curation: KEZ, VO, RHS, SVE. Formal analysis: KEZ, VO, RHS, JNM, SVE. Funding acquisition: SVE. Investigation: KEZ, VO, RHS, SVE. Methodology: KEZ, VO, RHS, JNM, SVE. Project administration: JNM, SVE. Resources: JNM, SVE. Software: KEZ, VO, RHS,

SVE. Supervision: JNM, SVE. Validation: VO, SVE. Visualization: JNM, SVE. Writing – original draft: KEZ. Writing – review & editing: KEZ, VO, RHS, JNM, SVE.

Supplementary Materials

Supplementary materials can be found *via* <https://doi.org/10.5534/wjmh.200009>.

Data Sharing Statement

The data analyzed for this study have been deposited in HARVARD Dataverse and are available at <https://doi.org/10.7910/DVN/H4ASMP>.

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