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It takes a community to conceive: an analysis of the scope, nature and accuracy of online sources of health information for couples trying to conceive

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Abstract This study examined the nature and accuracy of information available across online platforms for couples trying to conceive. A consumer simulation-based investigation of English websites and social media (Facebook, Twitter, Instagram) was undertaken using common search terms identified in a pilot study. Claims about fertility and pregnancy health were then extracted from the results and analysed thematically. The accuracy of each claim was assessed independently by six fertility and conception experts, rated on a scale of 1 (not factual) to 4 (highly factual), with scores collated to produce a median rating. Claims with a median score <3 were classified as inaccurate. The use of the terms 'trying to conceive' and '#TTC' were common identifiers on online platforms. Claims were extracted predominantly from websites ($n = 89$) rather than social media, with Twitter and Instagram

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comprising commercial elements and Facebook focused on community-based support. Thematic analysis revealed three major themes among the claims across all platforms: conception behaviour and monitoring, lifestyle and exposures, and medical. Fact-checking by the experts revealed that 40% of the information assessed was inaccurate, and that inaccuracies were more likely to be present in the conception behaviour and monitoring advice, the topics most amenable to modification. Since online information is a readily accessible and commonly utilized resource, there is opportunity for improved dissemination of evidence-based material to reach interested couples. Further cross-disciplinary and consumer-based research, such as a user survey, is required to understand how best to provide the 'trying to conceive' community with accurate information.

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Introduction

The increased accessibility of the internet, and the volume of information available, has changed the way in which individuals approach their health concerns, with the term 'Dr Google' now part of everyday language (Fox and Duggan, 2013; Gray et al., 2005). The internet is convenient, available 24/7 and affords a high level of privacy (Malik and Coulson, 2008; Weissman et al., 2000), and is commonly used in highly-stigmatized conditions such as infertility (Berger et al., 2005; Morahan-Martin, 2004; Slauson-Blevins et al., 2013), or even more private matters such as trying to get pregnant. In addition to using the internet to search for information about their condition, there is a steadily increasing trend for people to use social media to link to others in a type of 'online community' (Chung, 2013; Malik and Coulson, 2008). Access to the internet is considered to be extensive, with current estimates of 3.8 billion global internet users, of which 2.8 billion use social media (Greenwood et al., 2016; Kemp, 2017). With such reach, the future of health information transmission will clearly be through the internet in one form or another.

Given that the internet is so far reaching, and makes health information so readily accessible for people worried about health or seeking health advice, it is relevant to raise the question of the validity of information available online. Previous studies have found that infertile couples, particularly women, turn to online resources as an additional source of information about fertility and emotional support (Berger et al., 2005; Jansen and Saint Onge, 2015). A recent evaluation of clinical and university-affiliated fertility websites reported poor-quality content, as well as a failure to meet many of the American Medical Association guidelines, with websites found to be inadequate due to poor comprehensibility, readability and suitability for the general public (Huang et al., 2005). This is alarming given that qualitative research suggests that Google is used as a primary source of information for people seeking fertility and conception facts and figures before seeking professional health advice (Hammarberg et al., 2017a, 2017b). Furthermore, 84% of fertility clinic patients have reported searching websites for medical information related to fertility issues and 51% to evaluate fertility clinics (Weissman et al., 2000).

This study was designed to address whether there is readily accessible information for the public about conception and pregnancy on a variety of online platforms, and whether there is variable accuracy. While some research has

focused on couples with infertility, this likely represents only a small proportion of the total number of couples estimated to be 'trying to conceive' at any given time. This study strived to include the many people (possibly the majority) searching for information on getting pregnant rather than just in relation to infertility. This study aimed to undertake a more comprehensive analysis than previous research. We sought to evaluate not just the clarity and suitability of information (Huang et al., 2005; Robins et al., 2016), but also its accuracy. To date, no empirical analysis of both the nature of information and the level of accuracy in information relevant to trying to conceive has been undertaken. Finally, we sought to consider the relatively new phenomenon of social media. Increasingly, people are turning to communities to not only share their emotional experiences but also to gain information.

To address these aims, we simulated the user experience of an individual seeking information from English language online sources when using terms relating to conception and trying to get pregnant. The search output was analysed to identify the scope and size of available resources, and common and unique themes relating to conception across the platforms (websites, Twitter, Instagram and Facebook). The accuracy of the content found was assessed by experts in reproductive health.

With a clear shift towards the use of online resources and social media for the acquisition of health information (Orizio et al., 2010), and a majority of people of reproductive age being active online and in social media (Greenwood et al., 2016; Sensis, 2016), understanding the accessibility and accuracy of information available in online platforms is vital for improved dissemination of scientific knowledge to consumers. With this in mind, we aimed to understand the source, nature and accuracy of information available across a range of online platforms for couples 'trying to conceive'.

Materials and methods

Search strategy and data collection

A content analysis of websites offering guidance to lay people of reproductive age related to trying to conceive was conducted. The search strategy was developed to mimic the experience of a cohort of consumers, and included use of lay terms and simple search strategies (e.g. not a Boolean search) performed by multiple female and male authors.

During February and March 2017, the search terms 'trying to conceive', 'why am I not getting pregnant?' and 'trouble getting pregnant' were investigated on three English language search engines (Google, Yahoo!, Bing). Search terms were resolved through consultation between researchers to capture both a 'positive' cohort (those in the first stages of trying to conceive) and a 'negative' cohort (those who have been unsuccessful in achieving pregnancy to date), as we aspired to capture both individuals and couples in the earlier period of trying to conceive as well as later where there are more challenges and negative emotions surrounding the goal of pregnancy. Several authors (female and male) piloted terms and the initial search results were compared to determine consistency between users. This process was important to ensure that search results (or hits) were consistent between users to ensure that the user stimulation was not dictated by sex or search history. Websites were included if they were related to fertility/conception and were written in English, with all duplicates excluded. The first page of search results for each search term was extracted for each of the three search engines, with previous studies reporting that most consumers are unlikely to view search results beyond the first page (Morahan-Martin, 2004). The original search terms were adapted appropriately to investigate three social media platforms by using keywords, acronyms and hashtags: a text-based platform (Twitter), an image-based platform (Instagram) and a generalized mixed platform (Facebook). The utilization of hashtags (#) and the acronym for 'trying to conceive' (#TTC) were used as appropriate throughout the social media searches. Where required, search terms were removed or added to enable a suitable level of depth for each platform; for example, using #ttcsisters for Instagram, a tag identified as common across posts during the initial searches. The most recent 100 tweets were extracted for each search term, as was the first webpage of Instagram posts. For the purpose of this study, only Facebook groups were investigated, with all Facebook pages excluded as pages often related to commercial elements of the platform (e.g. businesses, organizations) (Hicks, 2010).

Data extraction

Descriptive statistics and demographics were extracted from each website and social media platform to determine the intended audience. Data were collected from websites including the website source (.com, .org, .gov, .co, .edu, .net), type of website (advice, information, home page, sales, forums, factsheet), target audience (female, male, both, broad), any acknowledgment of source, and preliminary coding and indexing of themes for each search term. Twitter data extraction included the timestamp, username, tweet text, whether it was related (included) or unrelated (excluded) to fertility/conception, number of retweets, number of likes, and any hashtags that were used. From Instagram posts, the username, likes, hashtags, description of image, caption and notable themes were extracted. Facebook groups were included regardless of whether they were 'closed' or 'open'. Two search terms were investigated for Facebook – TTC and the extension 'trying to conceive' – as other terms yielded very limited results. The following

data were extracted: group name, number of members, geographic boundaries, group type, group demographics (age, sex, ethnicity, sexuality), main objective, tags and accessibility (i.e. 'open' versus 'closed'). The majority of data were readily obtained from the 'description' section on the Facebook group's page. Any specific medical conditions associated with fertility/conception were also determined from this 'description', and these conditions were extracted where possible.

Our results identified mainly 'closed' Facebook groups, and it was evident from the descriptions that the foundation of the groups was support and information, with a desire for privacy, which we speculate is influenced by the social stigma associated with infertility (Epstein et al., 2002; Fisher and Hammarberg, 2012; Gonzalez, 2000). Therefore, it was only possible to extract limited information from this platform, which altered our original intentions to investigate this social media platform.

Thematic analysis

The content of websites was evaluated and examined through thematic analysis by one independent researcher (SGEK) in consultation with another researcher (HMB), with reference to an established method (Braun and Clarke, 2006). Thematic analysis was chosen as the method for data analysis as it allows flexibility in the approach to analysis, rather than being tied to a particular theoretical perspective, which is useful in the context of the broad nature of the information available on the webpages and within social media. First, all the webpages included in the dataset were read thoroughly to identify any recurring topics (or codes). Once there were consistent topics extracted from multiple websites with no new evidence, they were grouped into categories to reduce the amount of data to analyse. These were further combined to form potential themes, which helped to identify major elements of the entire dataset. Once the themes were confirmed, they formed the basis of a framework for systematically distributing content into appropriate categories and topics during data extraction for the remaining websites. These themes were then used to extract and classify data (claims) for the quantitative accuracy assessment [median accuracy rating (MAR)]. A subset of text was identified as a claim if it was phrased as a statement or advice regarding behaviours, causes and potential methods used to help conception.

Determining the accuracy (fact-checking) of content extracted from websites and social media

Using the categories and topics identified from the thematic analysis, all claims (information/advice) related to fertility/conception were extracted and accuracy was rated using a four-point Likert scale (1 = not factual, 2 = somewhat factual, 3 = quite factual, 4 = highly factual). The list of claims was analysed independently by a multidisciplinary group with expertise spanning male and female reproductive fertility, basic biological and clinical research in fertility and conception, public health and epidemiology ($n = 6$; HMB, ARR, KRD, MASP, MD, JES) by searching evidence-based, peer-reviewed scientific journals and fertility guidelines.

These experts were selected as they formed a part of the Conception Health Communication Consortium, with intensive background knowledge in their respective skills as well as being proficient at finding new and relevant information to support or oppose the claims. If the median group score was <3, the claim was classified as inaccurate.

Statistical analysis

For the online resources, the classifications and frequency of their content (e.g. source, theme, category, hashtags etc.) are summarized with raw numbers and percentages. Content accuracy is reported as the median (minimum–maximum) to display the variability between expert scoring. Data analysis was performed using Prism 7 (GraphPad Software, Inc., La Jolla, CA, USA).

Results

Size and demographics of conception and fertility online resources

The search strategy resulted in the identification of 89 websites, 300 tweets, 71 Instagram posts and 72 Facebook groups. After removal of duplicates and irrelevant sources (e.g. the use of #TTC for other unrelated acronyms), a total of 532 sources were analysed (41 websites, 169 tweets, 52 Instagram posts, 72 Facebook groups) (Supplementary Fig. 1).

Trying to conceive or TTC or #TTC consistently yielded the highest output across all the electronic platforms (websites, Twitter, Instagram and Facebook), and were also universally present across platforms for each search in relation to hashtag/tag frequency (Supplementary Table 1). For example, using Google, 18,100,000 results were returned using the term 'trying to conceive', versus 8,520,000 for 'why am I not getting pregnant?' and 4,000,000 for 'trouble getting pregnant'. Searching #TTC on Instagram revealed 604,852 posts, while the phrase 'trying to get pregnant' was used less frequently (2764 posts). The prompted search terms (terms that Instagram offers based on your search terms) included #ttccommunity and #ttcsisters (Supplementary Table 1). The total number of members for the groups extracted was 82,491 for TTC and 71,690 for 'trying to conceive', although privacy settings made it impossible to establish users common to both searches.

The purpose of each electronic platform varied, with websites structured as a source of 'information', Twitter comprised of facts and commercial advertising, Instagram included products and blog style interactions, and Facebook appeared as a platform for community-based support (which often includes community members providing information to each other). The majority of websites were commercial sites (.com, 86%) and half of the websites were categorized as 'advice articles' (49%) (Table 1). Of the tweets analysed, the accounts were either commercial (55%) or personal (40%), while 5% contained no identifying information. Commercial accounts included clinics, specialists, products (including apps), natural fertility assistance, hospitals and healthcare support. Instagram posts included shared stories of

Table 1 Description of the source, type, target audience, 'credibility' and main themes of the 41 websites identified from the combined searches. ^a

Characteristics	n = 41 (%)
Website source	
.com	35 (86%)
.org	2 (5%)
.gov	1 (2%)
.co	3 (7%)
.edu	0 (0%)
.net	0 (0%)
Type of website	
Advice	20 (49%)
Informative/educational	7 (17%)
Home page	7 (17%)
Sales	2 (5%)
Forums	4 (10%)
Factsheet	1 (2%)
Target audience	
Female only	6 (15%)
Male only	0 (0%)
Both sexes	3 (7%)
Female, mentioned males	26 (63%)
Broad	2 (5%)
N/A	4 (10%)
Website's acknowledgment of reference sources	
Reference to doctor/healthcare professional	12 (26%)
Cited (may include source list)	10 (21%)
Peer reviewed	2 (4%)
Factual (linked to org.)	1 (2%)
Advice/opinion	2 (4%)
No cited evidence	14 (30%)
N/A (e.g. personal blog)	6 (13%)
Frequency of themes identified within each search term	(presented as %)
'Trying to conceive'	
Conception behaviour and monitoring	89%
Lifestyle and exposure	67%
Medical	67%
'Why am I not getting pregnant?'	
Conception behaviour and monitoring	8%
Lifestyle and exposure	83%
Medical	67%
'Trouble getting pregnant'	
Conception behaviour and monitoring	64%
Lifestyle and exposure	73%
Medical	82%

N/A, not applicable.

^a Categories are not mutually exclusive, as some sites referenced more than one source. Theme frequency excluded home pages and sales websites.

conception (trying to conceive) and infertility, often including details of their assisted reproductive technology (ART) experiences. Common language unique to Instagram included the terms 'baby dust', 'angel baby' and 'rainbow baby', either as hashtags or comments from other users.

Table 2 Descriptive statistics and demographic information provided for social media platforms (Twitter, Instagram and Facebook).^a

Platform	Characteristics	%
Twitter	Users	
	Commercial	55%
	Personal	40%
	NA	5%
	Sex of users	
	Female	41%
	Male	8%
	NA	51%
	Geographical location	
	USA	48%
	UK	8%
	Australia	6%
	Asia	4%
Instagram		
Instagram	Sex of users	
	Female	69%
	Male	0%
	Other (product, NA)	31%
	Focus (frequency of themes)	
	Conception behaviour and monitoring	15%
	Lifestyle and exposure	12%
Facebook (<i>n</i> = 72)	Medical	42%
	NA	38%
	Sex of members	
	Female	97%
	Male	0%
	Both	3%
	Geographical location	
	USA	3%
	UK	7%
	Australia and New Zealand	5%
NA (worldwide)	85%	
Type of group		
Support	87%	
Family	3%	
Parents	1%	
LGBT	6%	
NA	3%	
Focus of group	(presented as <i>n</i>)	
Polycystic ovary syndrome	8	
Miscarriage	7	
Infertility	2	
Other conditions	5	
Combination of conditions	4	
ART	1	
Age	4	
LGBT	4	
Military	3	
General pregnancy	33	

ART, assisted reproductive technology; LGBT, lesbian, gay, bisexual and transgender; NA, not available.

^a Some groups have several focuses. Frequency of themes for Instagram exceeds 100% as posts occasionally displayed multiple themes.

Facebook groups often branded their identity with 'family', 'parent' and 'support' commonly listed in their description. The word 'support' was listed in 81% of groups identified by 'TTC' and 90% of groups identified by searching 'trying to conceive' (Supplementary Table 1). Within the Facebook groups, a pattern emerged with general groups as well as groups dedicated specifically to one medical condition (e.g. polycystic ovarian syndrome, miscarriage etc.) associated with fertility and conception.

Collectively, websites were deemed more likely to cater towards a heterosexual female audience, with the highest percentage of websites (63%) appearing to be female orientated and with reference to a male partner either as 'your partner' or 'his sperm'. This sex bias was also apparent on social media, with Twitter users being predominantly female (41%) or not applicable due to being a product/clinic (51%), and the majority of posts extracted from Instagram were generated by women (69%) (Table 2). Of the 72 Facebook groups, none were exclusively for men but 70/72 were women-specific where male members would not be accepted, as reported in the group's description.

Emergence of themes and language across resources

Three prominent themes were identified across the website search – conception behaviour and monitoring, lifestyle and exposure, and medical – with content readily distinguishable through the use of categories and topics (Table 3). The conception behaviour and monitoring theme was distributed into three categories (self-monitoring, copulation behaviour and products), with topics related to actions that a person could undertake to 'boost' the likelihood of conception. These topics included monitoring cervical mucus and basal body temperature to determine the 'fertile window', as well as recommendations for optimal timing and frequency of intercourse resulting in conception. The lifestyle and exposure theme encompassed two categories (non-

modifiable and modifiable), with topics ranging from age, weight and exercise to chemical and mobile phone exposure. The medical theme was comprised of three categories (screening, management and other), and addressed a range of advice on when and where to seek help, traditional and alternative therapies, and infertility demographics. The frequency of claims (statements/recommendations from the platform) per category and topic was variable. For example, there were 42 claims for copulation behaviour compared with seven claims related to age (Table 3).

The frequency with which each theme was explored differed across the three search terms. The 'trying to conceive' search results emphasized the conception behaviour and monitoring theme (89%), followed by the lifestyle and exposure, and medical themes (both 67%) (Table 2). 'Why am I not getting pregnant?' most frequently identified information classified as the lifestyle and exposure theme (83% of resources), with the conception behaviour and monitoring, and medical themes comprising 8% and 67% of resources extracted, respectively. 'Trouble getting pregnant' was predominantly classified as the medical theme (82%), with the majority of information related to ART and medical procedures. Themes were difficult to determine across Twitter and Facebook due to the structure of short tweets and privacy related to Facebook groups. However, the medical theme was predominant for Instagram (42% of posts), with procedures mentioned including oocyte collection and frozen embryo transfer (Table 2).

Accuracy of online conception resources

Claims were extracted from websites and social media resulting in 135 claims (121 from websites, 14 from social media), which were then distributed into themes, categories and topics (Table 4). Overall, 60% of all claims (81/135) were classed as 'accurate' (median score of 3–4) by the four-point Likert scale. The remainder of this section will focus entirely

Table 3 Summary of content analysis themes, categories and topics generated from resulting websites of the three search terms ('trying to conceive', 'trouble getting pregnant' and 'why am I not getting pregnant?').

Themes	Categories (<i>n</i> = number of claims)	Topics
Conception behaviour and monitoring	Self-monitoring (7)	Cervical mucus, basal body temperature, ovulation predictor kits, menstrual cycle
	Products (2)	Assisting conception
	Copulation behaviour (42)	Timing (conception and sex selection), frequency, gamete survival, sexual position, copulation behaviour, lubricant, gravity, ejaculation
Lifestyle and exposure	Non-modifiable (7)	Age
	Modifiable (34)	Weight (loss or gain), exercise, unhealthy habits (smoking, caffeine, alcohol), healthy habits (supplements), sleep and sunlight, chemical exposure, medication altering conception capacity, other: clothing, technology (e.g. mobile phone exposure)
Medical	Screening (8)	Preconception check-up, timing to seek help, reasons to seek help
	Management (0)	Types of help, assisted reproductive technology (in-vitro fertilization, intracytoplasmic sperm injection, intrauterine insemination), alternative and complimentary therapies (e.g. acupuncture), contemporary medicine, surgical, pharmaceutical
	Other (21)	Medical conditions causing infertility, prevalence of infertility

n = number of claims per category presented in the claims list (Table 4).

Table 4 (continued)

Platform	Theme	Category	Topic	Claim(s)
		Other	7. 20% chance of falling pregnant each month in a fertile couple 8. Couples can have 'low' or 'high' monthly fertility 9. 90% of couples will conceive, without medical assistance, within 18 months Gravity 1. Remain lying for half an hour post sex 2. Do not 'clean up' straight after sex: wash or wipe 3. It is not important to remain lying post sex Lubricant 1. Negative effect on sperm: slows motility Sex position 1. Do not use same position 2. Best position = deep penetration: closer to the cervix	3. Female orgasm: causes mucus to become alkaline
	4. Female orgasm: contractions help move sperm 5. Any position is fine			
	Sex selection 1. Having man ingest caffeine before sex to give Y sperm a boost (Y sperm have short bursts of power – sprinters) 2. X sperm: less nurturing needed (more resilient) 3. X sperm: move slower but retain energy 4. Chances of having boy increased when conception occurs closer to ovulation			
	Lifestyle and exposure 2. Over/under can result in ovulatory disorders	Modifiable	Weight	1. Maintain healthy weight
	Exercise		1. Strenuous exercise impacts negatively on female fertility (decreased ovulation) 2. Regular and moderate exercise improves fertility	
	Unhealthy habits		1. Quit smoking: female a. Higher miscarriage rate b. Earlier onset menopause c. Results in SGA d. Premature e. Still birth f. SIDS 2. Quit smoking: male a. Reduced sperm count/quality	

(continued on next page)

Table 4 (continued)

Platform	Theme	Category	Topic	Claim(s)
	Healthy habits		<ul style="list-style-type: none"> b. Higher impotence rates c. Asthma rates in children 3. Stop drinking <ul style="list-style-type: none"> a. Causes infertility b. Impairs ovulation c. Impacts on sperm production 4. Women should reduce caffeine intake	
	Sleep and sunlight		1. 'Fertility diet'. Reduce: saturated fat, fast food, chem produced, excessive red meat, refined sugars/carbohydrates. Increase: monosaturated fats, wholegrains, fresh fruit/vegetables, full cream dairy 2. Men: increase intake of zinc 1. Deficiency in vitamin D results elevated FSH 2. Require 6–8 h of sleep Other	Clothing 1. Men: tight underwear = overheating of testes
	Technology		1. Men: electromagnetic radiation from phone/laptop causes poor motility and DNA damage to sperm	
	2. Anti-inflammatories		Medications	Female fertility affected by: 1. Antidepressants
	Male fertility affected by:			
	1. Antihistamines			
	2. Androgens and beta blockers			
	Chemical exposure		Female 1. Bisphenol A: produce 24% fewer eggs than average, 27% fewer fertilize and fewer implant 2. Polychlorinated biphenyls: chances to get pregnant decrease by 20% when either partner's blood tested high 3. Reduce exposure to: <ul style="list-style-type: none"> a. Toxins b. Heavy metals c. Organic solvents Male 1. Avoid pesticides 2. Avoid work with chemicals/radiation	
	Unmodifiable	Age	1. Age impacts number and quality of eggs 2. Egg quality/number declines rapidly after 35 years of age 3. Fertility peaks: <ul style="list-style-type: none"> a. In 20s and 30s b. 20–24 years 4. Fertility declines: <ul style="list-style-type: none"> a. ≥ 35 years b. Steadily after 40 years 	

Table 4 (continued)

Platform	Theme	Category	Topic	Claim(s)
	Medical	Screening	<p>Male</p> <ol style="list-style-type: none"> 1. can remain fertile into their 60s/70s <p>Preconception check-up</p>	<ol style="list-style-type: none"> 1. If there are questions about medication
	<ol style="list-style-type: none"> 2. Recommendation of folic acid 3. Necessary when pre-existing condition (e.g. polycystic ovary syndrome) <p>Timing to seek help</p> <p>Reasons to seek help</p>		<ol style="list-style-type: none"> 1. Under 35 years of age, wait for 12 months of trying 2. Over 35 years of age, wait for 6 months of trying <ol style="list-style-type: none"> 1. Problem with sexual function or libido 2. Belief of possible fertility problem 3. Genetic counselling: to avoid passing on a genetic disorder 	
	<ol style="list-style-type: none"> 2. Affects men and women roughly equally 3. 40% women, 40% men, 20% unexplained 4. 1/3 female fertility problems, 1/3 male, 1/3 both partners or unexplained 5. 50% women, 40% men, 10% both or unexplained 6. 12–15% of fertility issues are unexplained 7. 1 in 5 infertile couples have male factor <p>Conditions that impact fertility</p>	Other	<p>Prevalence of infertility</p> <p>Female</p> <ol style="list-style-type: none"> 1. Blocked tubes 2. Polycystic ovary syndrome 3. Irregular and painful menstruation 4. Endometriosis 5. Pelvic inflammatory syndrome (potential for ectopic pregnancy) 6. Poor egg quality 7. Autoimmune diseases (e.g. thyroid) 	<ol style="list-style-type: none"> 1. 15% of couples <p>Male</p> <ol style="list-style-type: none"> 1. Poor sperm parameters
		<ol style="list-style-type: none"> 2. Tubal disorders 3. Overheating of testes (sitting down for long periods, hot 		

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Table 4 (continued)

Platform	Theme	Category	Topic	Claim(s)
		tubs/saunas, cycling) 4. Sperm antibodies can affect fertilization 5. Injury to testes 6. STIs (chlamydia and gonorrhoea) 7. Sperm allergy: allergic reaction to self		1. Having trouble getting pregnant? Don't fret, only 57% of couples become pregnant after trying for 3 months!
Social media	2. Approximately one in four women age 35 years or older have trouble getting pregnant. 3. 1 in 8 couples have trouble getting pregnant or sustaining a pregnancy (2006–2010 National Survey of Family Growth, CDC) 4. 1 in 8 couples have trouble getting pregnant, and in 1 out of every 3 cases, the problem is on the guy's end	Fertility	Rates of difficulty getting pregnant	5. More than six million women in the USA have trouble getting or staying pregnant. You're not alone
	Benefits of pharmaceuticals		1. Women who take oral birth control have a lower risk of endometriosis and PID 2. Aspirin may help prevent miscarriages 3. 'Experts have found...no link between taking birth control and having trouble getting pregnant later on'	
	Natural remedies		1. Acupuncture which can help improve infertility 2. 'Since my sil and bro are having trouble getting pregnant, I'm sending her ylang-ylang. It's supposed to help infertility. So fingers crossed'	

Table 4 (continued)

Platform	Theme	Category	Topic	Claim(s)
	Other		1. Losing 5% of body weight can restore regular menstrual cycles for women with polycystic ovary syndrome 2. Few transgender teens opt for fertility preservation	3. A physically demanding job or erratic work schedules may increase fertility issues in women trying to conceive.
	IVF	1. Did you know 70% of couples do not get pregnant the first cycle?		

LH, luteinizing hormone; SGA, small for gestational age; SIDS, sudden infant death syndrome; FSH, follicle-stimulating hormone; STIs, sexually-transmitted infections; PID, pelvic inflammatory disease; IVF, in-vitro-fertilization.

on claims from the websites due to the small number extracted from social media.

Specifically for the website claims, the overall percentage that were classed as accurate for the conception behaviour and monitoring theme was 37% (19/51). Topics with MAR <3 were considered inaccurate. Therefore, a

substantial proportion of claims in the following topics were considered to be inaccurate: basal body temperature, timing, frequency, gamete survival, ejaculation and other (Fig. 1). For example, one claim that consistently received the lowest rating related to male gamete survival, and stated that ‘Y chromosome sperm do not last as long (24 h)

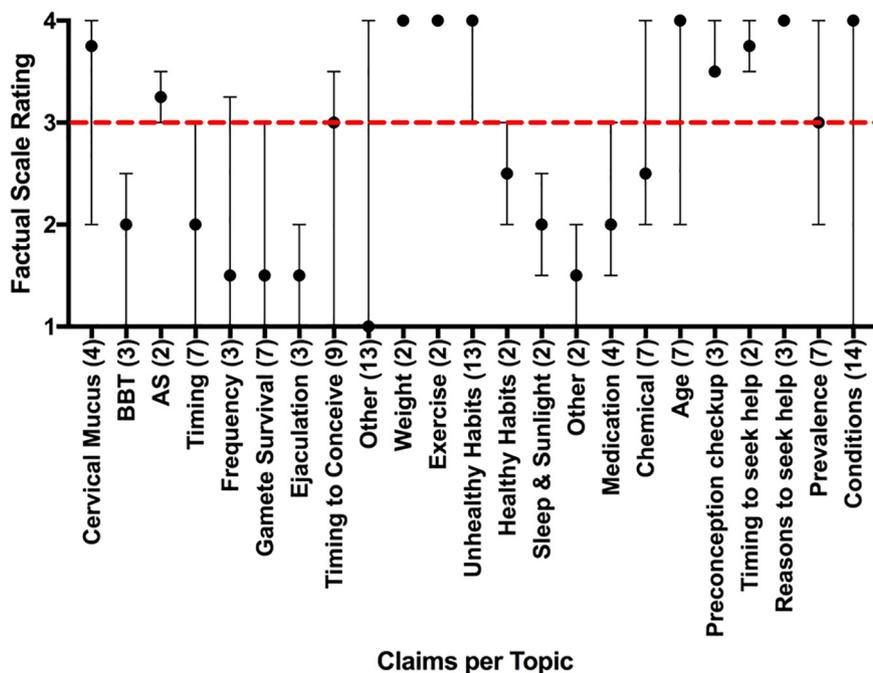


Fig. 1 Fact-checking rating of claims displayed as topics. Data are presented as median (minimum–maximum). Different categories had varying amounts of claims. Self-monitoring: cervical mucus, basal body temperature (BBT). Products: assisted conception. Copulation behaviour: timing, frequency, gamete survival, ejaculation, timing to conceive, other sex claims. Modifiable: weight, exercise, unhealthy habits, healthy habits, sleep and sunlight, other, medications, chemical exposure. Unmodifiable: age. Screening: preconception check-up, timing to seek help, reasons to seek help. Other: prevalence of infertility, conditions that impact fertility. AS, assisted conception. Factual rating scale score: 1 = not factual, 2 = somewhat factual, 3 = quite factual, 4 = highly factual. Fig. 1

as X chromosome sperm (4–5 days) in the [female reproductive] tract' (Table 4).

For the lifestyle and exposure theme, 63% (26/41) of claims were classified as accurate, with the least accurate topics including healthy habits, sleep and sunlight, other, medication and chemical (Fig. 1). Age was the only topic classed within the non-modifiable category: 83% of claims about female age were considered accurate (5/6; Supplementary Fig. 2C), and the one point addressing the impact of male aging was considered inaccurate (Supplementary Fig. 2C) (i.e. '[Men] can remain fertile into their 60s/70s', which is a highly variable claim that is dependent on factors beyond a man's age and consideration for the health of offspring was not mentioned).

The MAR for the medical theme was 4, classifying it as generally being accurate; specifically, 90% of the claims were considered to be accurate. All of the topics (preconception check-up, timing to seek help, reasons to seek help, prevalence and conditions) were within the cut-off for accuracy. The few inaccurate claims related to the prevalence of conception and fertility problems, and male factor infertility (Fig. 1, Supplementary Fig. 2E, F). For example, one website claimed that infertility 'affects men and women roughly equally', whereas another stated that '1 in 5 infertile couples have male factors'.

The median ratings for the male-related claims across all themes demonstrated that half (50%) of these statements were under our acceptable value for accuracy, while data relating to women were more likely to be accurate (71%) (data not shown).

Discussion

Couples experiencing infertility turn to the internet to seek information and emotional support (Slauson-Blevins et al., 2013; Weissman et al., 2000), but whether or not this also applies to couples trying to conceive has only recently gained attention (Hammarberg et al., 2017a, 2017b). We found there was a large group of people searching the internet more generally, but particularly using social media sites, who can be characterized as those 'trying to conceive'. This is a group distinct from those that would class themselves as 'infertile', either through medical diagnosis or through self-diagnosis. Previous research related to the nature and quality of internet resources has mostly focused on infertility (Robins et al., 2016), and as such, there is a clear need for studies such as the present study that include a much larger number of people seeking, and in need of, high-quality information on reproduction.

Along with broadening the search terms to include what is most likely the majority of those searching for information about conception, we also undertook a far more comprehensive analysis of the content found in searches related to wanting/trying to conceive. Using a consumer simulation-based approach, we tested a range of search terms across online platforms to explore the nature and accuracy of resources. Thematic analysis revealed information ranging from sexual position and frequency of intercourse, to when and where to seek medical help. We were able to classify this information into three themes: conception behaviour

and monitoring (e.g. sexual position), lifestyle and exposure (e.g. weight), and medical (e.g. ART).

Fact-checking of resources revealed that more than 40% of claims were inaccurate, with the major inaccuracies skewed towards conception behaviour and monitoring, with information often based on very low or nil evidence. For example, many conflicting claims were made about the intercourse position in which conception was best achieved (1. Any position is fine, 2. Do not use the same position, 3. Best position = deep penetration: closer to the cervix), none of which are supported by any evidence in the academic literature. This is concerning as research from other fields supports that people are likely to attempt simple changes, despite there being no evidence for their efficacy, before more difficult changes which are proven to be more effective [e.g. losing weight or ceasing smoking (Bouton, 2014; Kelly and Barker, 2016)]. If the information on which people rely is not accurate, there may be a wasted opportunity or a delay in helping people to achieve successful and healthy pregnancy.

The lifestyle and exposure theme was more accurate than the conception behaviour and monitoring theme. Claims related to the negative impact of smoking on male and female fertility were generally accurate (e.g. smoking in females is associated with a higher miscarriage rate), and are supported by extensive research (Curtis et al., 1997; Lassi et al., 2014). However, data indicate that even the desire to start a family is not sufficient motivation to make significant lifestyle modifications (Sui et al., 2013a, 2013b). Similar to the pattern found with the conception behaviour and monitoring theme, information about the most achievable of changes (e.g. increasing sunlight exposure and sleep) were the most inaccurate in this theme.

Optimistically, information classified in the medical theme around preconception screening and seeking medical support was overwhelmingly accurate. While this does reflect the presence and availability of accurate resources for couples trying to conceive, research suggests that people are more likely to attempt to rectify behaviours from internet-sourced information prior to seeking medical help (AlGhamdi and Moussa, 2012; Gualtieri, 2009; Powell et al., 2011). This reiterates the problematic nature of the inaccurate information found in the other themes; in particular, people will be more likely to try to time intercourse (based on largely inaccurate information on the internet) rather than seek medical advice (which is largely accurate). This is the first study to classify the type and degree of inaccuracy in information related to peri-conception; however, researchers investigating other pregnancy and infant health questions also report that online information is highly inaccurate or irrelevant, and share concerns for the consumer (Chung et al., 2012).

In broadening our analyses beyond infertility, we found that common language and identifiers used by couples seeking conception information, namely 'trying to conceive' and #TTC, was used by active, multiplatform online communities. Facebook emerged as a particularly active online community, which is probably not surprising as this is not a new phenomenon, with studies across an array of medical conditions showing the structure and benefits of

these online communities (Alotaibi et al., 2017; Bartlett and Coulson, 2011; Oh et al., 2013). However, almost all groups on Facebook were closed. In other medical disciplines, researchers report that participants use these groups to exchange information, find recognition, exchange emotional and social support, and share personal experiences (Antheunis et al., 2013; Malik and Coulson, 2010; van Uden-Kraan et al., 2009). The privacy component of Facebook provides further appeal for these groups as a safe environment removed from societal pressures and stigma associated with coping with fertility issues (Berger et al., 2005; Malik and Coulson, 2010), whilst still allowing for targeted and personalized exchange. Despite the limitation regarding accessibility to closed communities, we speculate that the inaccuracies found in open-source information extends to closed spaces, particularly given the known utilization of Facebook groups as a setting for information exchange (Griffiths et al., 2012; Oh et al., 2013). We note that groups often catered specifically to location (a specific clinic), medical condition (e.g. polycystic ovary syndrome, endometriosis) or a cluster of individuals (e.g. the lesbian, gay, bisexual and transgender community), consistent with the growing global demand for personalized medicine (Swan, 2009). Finding strategies to actively engage with a diverse range of communities in a non-disruptive manner will be essential for the dissemination of accurate health messages and information.

Although outside the scope of this paper, the data provide directions for future investigations considering sociological perspectives related to online communities that are 'trying to conceive'. Firstly, there was an apparent gender bias with social media and websites much more likely to be targeted to and accessed by women. Further, the claims related to male health were more likely to be inaccurate compared with female-fertility-related claims. Previous research has found that women in general seek medical information online more actively than men (Warner and Procaccino, 2007), and that women undergoing ART procedures are more likely to seek information than men, regardless of who is affected by infertility (Weissman et al., 2000). Nevertheless, the clear targeting of women identified in information sources in this study only serves to reinforce the outdated notion that women are responsible for fertility management (and associated blame for fertility issues). In addition, this bias towards women reduces the availability of informational and emotional support for men experiencing fertility concerns (Culley et al., 2013). Improving the accessibility of fertility information for men should be a priority for future research, with clear evidence that men aspire to parenthood as much as women, yet remain neglected in research and public discourse on this topic (Hammarberg et al., 2017a, 2017b).

There was also a notable lack of claims identified regarding the impact of age on fertility (Balbo et al., 2013). We identified six claims relating to maternal age and one relating to paternal age, compared with 42 claims regarding copulation behaviours which have a much weaker evidence base. While this may reflect a focus on factors that are more amenable to change and commercialization than age, this does highlight the general lack of discussion in the public arena surrounding the importance of age to fertility, as well as the social

and structural factors that contribute to delayed child bearing, such as financial instability. Understanding the best ways to engage both women and men in discussions surrounding the consequences of delayed child bearing would be a fruitful area for further research.

We used a comprehensive approach utilizing common search engines and social media platforms in order to simulate the actual experience of individuals seeking fertility information. To enhance the reliability of findings, search terms were used across the different platforms by a range of users. Despite the strengths in our design, there are several limitations. We searched English sites alone, so the information may not be generalizable to non-English-speaking individuals. Another limitation is that the content of online information can change quickly, so it is possible that some of the claims made have changed since undertaking this review. Further, the accuracy of claims was assessed by individual ratings, which may be subjective. Although we included a panel of experts to attempt to overcome issues with subjectivity, there was still variation in ratings between assessors. We believe this was mostly due to the nature of some of the claims being partly true and therefore difficult to rate; for example, there was a claim that the best day for conception was 14 days prior to the beginning of your menstrual cycle, which is accurate for some, but not all, women (Table 4). Despite some inter-rater variability, there remains no standardized approach for assessing the quality of health information in both websites and social media platforms (Kim et al., 2016). In addition, previous research has shown that existing criteria and tools designed to assist consumers to appraise the quality of websites do not reliably identify inaccuracies in online health information (Bernstam et al., 2005, 2008). Thus, there is a continued need to improve quality assessment and reporting standards for online data (including social media).

Conclusion

The major finding to emerge from this study is the large volume of inaccurate information online in relation to 'trying to conceive'. The information deemed to be the most inaccurate (conception behaviour and monitoring) contained some of the simplest and cheapest options for modification, such as monitoring basal body temperature (observing fluctuations of body temperature prior to ovulation). It is concerning that inaccurate and non-evidence-based statements are frequently put forward in online websites which are readily accessible to people trying to conceive, who may partake in online communities and distribute this information.

We also found that much (in fact, the majority) of this information existed in multiplatform, online communities, with Facebook being the most dominant platform. Understanding how online communities support couples and individuals trying to conceive will require further research, and extensive engagement with consumers will be required to develop effective strategies for dissemination of appropriate and scientifically correct content.

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