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Breastfeeding promotion on Twitter: A social network and content analysis approach

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Abstract

The importance of breastfeeding for maternal and infant health is well-established, yet complex and intertwined sociocultural barriers contribute to suboptimal breastfeeding rates in most countries. Large-scale campaigns for evidence dissemination and promotion through targeted interventions on social media may help overcome some of these barriers. To date, most breastfeeding research on social media only focuses on content analysis, and there remains limited knowledge about the social networks of online communities (who interacts with whom), influencers in the breastfeeding space and the diffusion of evidence-based knowledge. This study, grounded in social network theory, aims to better understand the breastfeeding communication landscape on Twitter including determining the presence of a breastfeeding network, communities and key influencers. Further, we characterize influencer interactions, roles and the content being shared. The study revealed an overall breastfeeding social network of 3,798 unique individuals (users) and 3,972 tweets with commonly used hashtags (e.g., #breastfeeding and #normalizebreastfeeding). Around one third of users (n = 1,324, 34%) exchanged pornographic content (PC) that sexualized breastfeeding. The non-PC network (n = 2,474 users) formed 144 unique communities, and content flowing within the network was disproportionately influenced by 59 key influencers. However, these influencers had mostly inward-oriented interaction (% composition, E-I index: 47% professionals, −0.18; 41% interested citizens, −0.67; 12% companies, −0.18), limiting opportunities for evidence-based dissemination to the lay public. Although more tweets about peer-reviewed research findings were sent compared with tweets about nonevidence-based lay recommendations, our findings suggest that it is the lay public who often communicated findings, which may be overcome through a targeted social network-based intervention.

1 | INTRODUCTION

Every minute of the day, more than 500 h of YouTube videos are uploaded, 66,000 Instagram and 243,000 Facebook photos are posted and around 350,000 tweets are sent. This immense use of social media has turned these channels in general, and Twitter specifically, into a powerful platform that is being used by for-profit companies and others to influence behaviour through various data-driven targeted strategies (Appel, Grewal, & Hadi, 2020; Araujo, Neijens, & Vliegenthart, 2017). Indeed, more than $89 billion USD were spent

globally on social media alone in the year 2019, and a growth rate of 9% is estimated for 2020 (Guttmann, 2020).

From a public health perspective, interest in using social media to enhance health outcomes through awareness campaigns and support groups is on the rise (Dunn, Mandl, & Coiera, 2018; Giustini, Ali, Fraser, et al., 2018). There is significant potential in the maternal and child health space through supporting and promoting breastfeeding online (Perez-Escamilla, 2020), as well as addressing many other important public health priorities such as vaccination, opioid addiction and disease outbreaks (Brunson, 2013; Fan, Zhang, Ye, & Zheng, 2017; Vijaykumar, Nowak, Himelboim, & Jin, 2018). However, despite its growth, leveraging the full potential of social media to improve breastfeeding promotion and public health remains in its infancy with limited empirical research to guide decision making (Giustini et al., 2018; Moorhead et al., 2013).

Using innovative analytical tools grounded in theory, researchers can support stakeholders (e.g., governments, non-governmental organizations [NGOs] and health care providers) in strategically using social media to identify audiences-of-interest, define optimal patterns of message disseminations, develop targeted interventions and monitor impact (Rehm, Cornelissen, Notten, Daly, & Supovitz, 2020). In this paper, we focus on 'breastfeeding promotion' as an exemplar case to highlight theory-grounded research on social media coupled with advancements in data management and social network analysis. This combination has the potential to provide both valuable tools and improve public health in the 21st century.

The importance of breastfeeding for maternal and infant survival and health makes breastfeeding promotion, support and protection instrumental for achieving the World Health Organization (WHO) Global Strategy for Women's, Children's and Adolescents' Health (2016–2030) (Kuruvilla et al., 2016). The widely disseminated WHO breastfeeding guidelines include that infants be exclusively breastfed for the first 6 months of life followed by continued breastfeeding with food for 2 years or beyond (WHO, 2003). Yet breastfeeding initiation and exclusivity rates, as well as duration, continue to be suboptimal in most countries around the world (Victora et al., 2016). Successful breastfeeding practices may be hindered by complex and intertwined sociocultural factors. These constraining factors include inadequate implementation, or even lack thereof, of breastfeeding-friendly policies at the national level (i.e., paid maternity leave and regulation of marketing of breast-milk substitutes). At the community- and individual-level, factors include knowledge gaps, low-self efficacy, negative attitudes and lack of social and/or clinical support (Moukarzel et al., 2018; Moukarzel, Mamas, Farhat, & Daly, 2019; Rollins et al., 2016).

Breastfeeding promotion efforts to overcome identified barriers at large-scale continue to be limited in intensity, coverage, depth and breadth, especially in online spaces (Perez-Escamilla, 2020). For example, although World Breastfeeding Week, a major worldwide breastfeeding promotion campaign by the World Health Alliance for Breastfeeding Action (WABA), has gained visibility over years, it remains largely time-bound and its activities merit further strategic fine-tuning to improve impact (Perez-Escamilla, 2020). Indeed, breastfeeding promotion efforts are more likely to be successful when grounded in empirical research and when they extend beyond health communication campaigns to strategically target key stakeholders whose actions have critical impact on breastfeeding practices (i.e., mother's family and friends, providers of health care and childcare, employers and co-workers and policy makers) (Kim et al., 2018; Perez-Escamilla, Curry, Minhas, & Taylor, 2012).

Social media may provide fertile ground for breastfeeding promotion efforts as examined in other areas such as policy, teacher networks and flow of ideas (Greenhow & Lewin, 2016; Rehm et al., 2020; Rehm & Notten, 2016). However, much of the breastfeeding research on social media only focuses on content analysis, suggesting Instagram and Facebook can reflect supportive breastfeeding environments (Harding et al., 2019; Marcon, Bieber, & Azad, 2018; Bridges, Howell, & Schmied, 2018). To date, we have limited knowledge about the social networks of online communities, influencers in the space and the diffusion of evidence-based knowledge and practices. It is this gap we are exploiting in this work using unique theoretical and methodological grounding.

Social network theory (SNT) and analysis provide a theoretical framework and robust set of methods for examining the aforementioned gaps. The theory suggests that individuals are embedded in dense networks of social interactions where the pattern of these relations provides a flow of behaviour influence and ideas (Wasserman & Faust, 1994). Social networks are influential in a variety of social phenomena, including political processes, economic exchanges, and the sharing of knowledge, and other aspects related to health such as breastfeeding education in medical schools (Christakis & Fowler, 2009;

Key messages

- Breastfeeding promotion through targeted social media interventions may improve breastfeeding rates. Current research focuses on content analysis with limited knowledge about social networks of online communities (who interacts with whom), influencers, and diffusion of evidence-based knowledge.
- We found an interrelated social network totally 3,972 tweets and 3,798 unique individuals, 24% of whom exchanged pornographic content (PC) sexualizing breastfeeding.
- Non-PC content was disproportionately influenced by 59 influencers who had mostly inward-oriented interactions, limiting opportunities for evidence-based dissemination to the public.
- Although more tweets about research findings were sent than about nonevidence-based recommendations, it is the lay public who often communicated findings.

Moukarzel et al., 2018). SNT studies have shown how seemingly autonomous individuals are, in fact, embedded in social relations and that their interactions may have consequences for individual and collective behaviours (Daly, 2010).

This study was conducted to better understand the breastfeeding promotion, communication and knowledge landscape on Twitter by (1) determining the presence of an online breastfeeding network and communities, (2) characterizing users who engage in breastfeeding-related communication and knowledge sharing, (3) determining the existence and identification of key influencers and (4) describing the content being shared on Twitter around breastfeeding promotion.

2 | METHODS

2.1 | Data collection

We initiated our data collection process by focusing on the common hashtags #breastfeed, #breastfeeding, #normalizebreastfeeding, #Breastfeeding, #breastmilk, #breastfeedingmoms and #breastfeedingsupport, used during a 1-month period (December 18–January 18, 2020) that did not coincide with World Breastfeeding Week, as previously done in other social media research (Marcon et al., 2018). These hashtags were selected after an exploratory phase of receiving input from fellow researchers, clinicians and lay individuals active in the field. Using Twitter's application programming interface (API), we collected all tweets that included at least one of the previously mentioned hashtags. The raw data included information such as the author of a tweet, the tweet itself, the time stamp for each tweet, mentions and replies. On the basis of these data, we were able to identify the users within the overall dataset and harvest their available profile information, also using the applicable API.

2.2 | Data analysis

We employed a mixed-method approach as follows:

2.2.1 | Social network analysis

We started with a social network analysis (SNA) to identify the overall network and underlying communication patterns. First, on the basis of the captured mentions and replies, we constructed the overall social network around breastfeeding and then computed the following centrality metrics: in-degree (incoming tweets, e.g., being mentioned or retweeted), out-degree (outgoing tweets, e.g., sending a tweet) and overall degree centrality (both ingoing and outgoing activity). These metrics provided an indication of how often an individual has been contacted or has contacted others, respectively. We also determined underlying community structures using the Louvain method (De Nooy, Andrej, & Vladimir, 2011). This particular clustering algorithm can be used to extract communities from large networks, and it optimizes the relative density within detected communities. In other words, it constructs communities wherein the majority of members are connected with all other members, therefore suggesting an active communication process.

We then identified key influencers with prominent social structural roles (top 5% of individuals based on overall degree centrality) in the network, not on traditional metrics of number of followers as we have done in our other work. Given the social structural position of these individuals, they are regarded as having disproportionate influence over content, information and ideas that flow in the breastfeeding network (Del Fresno, Daly, & Segado Sánchez-Cabezudo, 2016). We have used this same process in our other published work, which consistently suggested that taking the top 5% of actors in the network enabled us to look at the larger underlying pattern of ties (Daly, Delfresno, & Supovitz, 2018; Del Fresno et al., 2016; Supovitz, Daly, & Del Fresno, 2018).

We also calculated the degree of homophily between these highly influential actors (McPherson, Smith-Lovin, & Cook, 2001). Homophily is captured by the idea of 'birds of a feather flocking together' and is determined with the external–internal (E-I) index. In the context of social media, homophily has been referred to as supporting the notion of echo chambers, wherein individuals are predominately exposed to views and opinions similar to their own. In contrast, a potential absence of homophily suggests a more outwardly oriented focus, indicating a tendency towards exposure to differing viewpoints and information. The E-I index was based on qualitatively assigned codes to applicable key influencers. More specifically, identified users were categorized into (i) interested citizens, (ii) professionals and (iii) companies. Differences in E-I index between user types were analysed by ANOVA followed by post hoc LSD test using SPSS (version 26 for Mac), and $P < 0.05$ was set for statistical significance.

2.2.2 | Content analysis of user info and tweets

Content analysis was done for user info and tweets in the top 5% of overall degree network. We used inductive qualitative coding (Murphy, 2004) to categorize tweets into themes as well as describe users, based on their profiles and tweeting history (Lee, DeCamp, Dredze, Chisolm, & Berger, 2014). For this purpose, two researchers independently reviewed users' profiles, timelines and tweets to familiarize themselves with the content. The coders then collaboratively developed a codebook, allowing the categories to emerge 'out of the data rather than being imposed on them prior to data collection and analysis' (Patton, 1990).

2.3 | Ethical considerations

Ethics approval was not required as the study only uses publicly available data.

3 | RESULTS

1. There exists an interconnected network around breastfeeding.

An overview of the main results is available in Figure S1. Our analysis resulted in an overall social network around breastfeeding totaling 3,972 tweets and 3,798 unique individuals (users) whose overall activity is portrayed in the total complete network map (Figure 1a). The vast majority of users (n = 3,116, 82%) were part of an interconnected breastfeeding social network, and the remaining 18% only interacted once in the network—meaning a singular tweet, retweet or mention. As evidenced by the large standard deviations and wide ranges of in-degree and out-degree, there was considerable variance in users' contributions to the hashtag discussions around breastfeeding (Table 1).

2. References to pornographic material and websites were prevalent.

More than one third of the users (n = 1,324, 34%) in the network predominantly shared, mentioned or replied to others around pornographic content (PC) that sexualized breastfeeding. As our study focus was on breastfeeding promotion within the context of public health, we removed these data from further analyses (Figure 1b).

3. Distinct communities and categories of users exist in the network.

Once the PC-related users were removed, we were left with a non-PC network of 2,474 users who formed 144 unique communities in the overall network (Figure 2a). These communities were not identified a priori, but rather based on user behaviour on Twitter, whereby users who interact more frequently among each other compared with all other users form one community. This suggests that although there is a much larger interconnected system around the topic of breastfeeding, there are also unique groups of users that have patterns of interactions, which form a community.

We identified users either as health professionals including researchers and health care practitioners (e.g., lactation consultants and gynaecologists) (n = 769, 31.1%), interested citizens (n = 1,350, 54.6%) or for-profit company representatives (n = 355, 14.3%). This distribution remained consistent within the five largest communities (n = 1,390, 56.2%users), indicating that interactions do not seem to occur among professionals alone, but rather extend to lay individuals and companies as well.

TABLE 1 Descriptive SNA metrics

	In-degree	Out-degree	Overall degree
Mean	2.58	2.58	5.15
Median	0	1	1
Standard deviation	30.60	15.36	34.51
IQR	1	1	2
Range	0–1,368	0–374	1–1,368

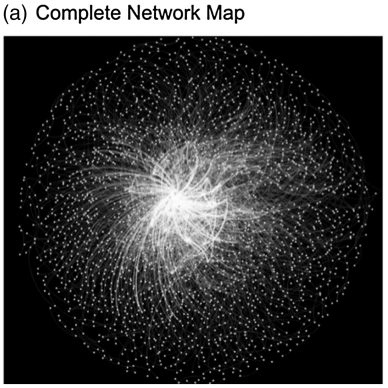
Note: n = 3,798 users.
Abbreviations: IQR, interquartile range; SNA, social network analysis.

4. There are a number of influencers from different backgrounds who tend towards in-group interaction.

The top 5% overall degree network analysis revealed 59 unique individuals (47% professionals, 41% interested citizens and 12% company representatives) with disproportionate influence on the content that flows within the network (Figure 2b and Table 2). In terms of testing for homophily between key influencers, the positive mean E-I index for professionals was significantly higher than that for interested citizens (P = 0.029) and companies (P = 0.036) indicating professionals have significantly more outward-oriented communication than others. However, this seems to be largely driven by the E-I index for NGO only and not by other groups, such as researchers who have the most inward-oriented interactions (E-I index = −1.00).

5. Commercial use of breastfeeding hashtags is common, but potential room for breastfeeding promotion and support is also apparent.

Content analysis of tweets from the top 5% of overall degree network (n = 711 tweets) resulted in eight identified categories (Figure 3, Table S1). Commercial use was the most common, pertaining to advertisements for a wide range of merchandise such as breast pumps, feeding bottles, breastfeeding-friendly clothing, maternal dietary supplements and food products marketed as galactagogues. Second in frequency were professional communications mostly



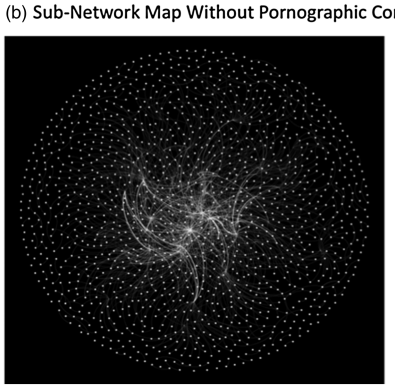


FIGURE 1 Social network maps. Each dot represents a unique individual that tweeted to the breastfeeding network, and the lines between the dots reflect exchanged tweets (tweets, retweets or mentions). (a) n = 3,798 users. (b) n = 2,474 users

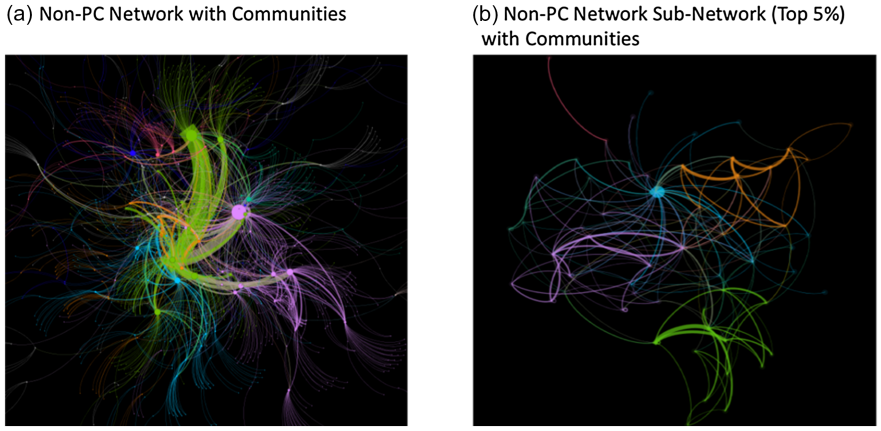


FIGURE 2 Social network maps by communities. Each dot represents a unique individual that tweeted to the breastfeeding network, and the lines between the dots reflect exchanged tweets (tweets, retweets or mentions). The size of the nodes is based on their overall degree centrality. The colour of the nodes represents the community to which they have been assigned. (a) *n* = 2,474 users. (b) *n* = 59 users

TABLE 2 E-I index for key influencers by user type

Type of user	*n* (%)	Mean	SD	Min	Max
Professionals	28 (47.4)	−0.18	0.82	−1.00	1.00
Researcher	4 (6.8)	−1.00	0.00	−1.00	−1.00
Researcher and HCP	4 (6.8)	−0.64	0.45	−1.00	−0.08
HCP	9 (15.3)	−0.57	0.41	−1.00	0.00
Academic journal	2 (3.4)	−0.60	0.57	−1.00	−0.20
NGO	9 (15.3)	0.88	0.21	0.43	1.00
Interested citizens	24 (40.7)	−0.67	0.32	−1.00	0
Pro BF	14 (23.7)	−0.82	0.26	−1.00	−0.11
Against BF	10 (17.0)	−0.47	0.29	−1.00	0.00
Companies	7 (11.9)	−0.18	0.32	−1.00	−0.20

Note: The E-I index ranges between −1 (all connections are within one user category) and +1 (all ties are outside the user category). *n* = 59 influencers.
Abbreviations: BF, breastfeeding; HCP, health care practitioner; NGO, non-governmental organization.

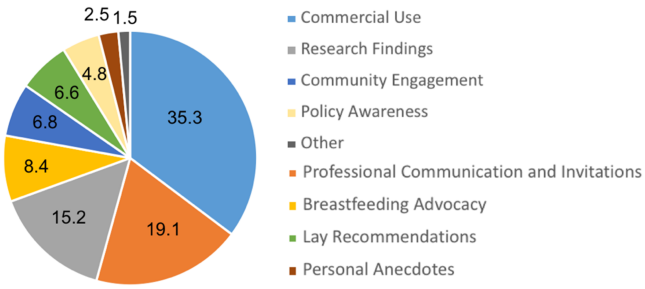


FIGURE 3 Content analysis of influencer tweets (*n* = 711 tweets)

from/to academics sharing invites and details (e.g., location, dates and themes) about research talks, symposia, conferences and workshops as well as clinical training events. Interestingly, tweets based on peer-reviewed research findings mostly as recent publication announcements were more than double those from nonevidence-based lay recommendations (15 vs. 7%). We also identified three other categories of tweets related to breastfeeding promotion and support, which consisted of those advocating public breastfeeding and establishment of public breastfeeding rooms (8%), those engaging the community such as invites to join parent support groups (7%) and those raising awareness about breastfeeding-friendly policies and laws (5%).

4 | DISCUSSION

This research was undertaken to better understand breastfeeding promotion through communication and knowledge sharing on Twitter. We drew on Twitter data as it is a major global social media platform, largely understudied within the breastfeeding research field. The overarching goal was to identify opportunities for more strategic, targeted and effective breastfeeding promotion in the future. As far as we know, this is the first published study that uses SNA to better understand the underlying breastfeeding-focused interactions on Twitter coupled with a qualitative examination of these interactions. Here, we draw attention to an existing network of individuals that holds potential to promoting, supporting and enhancing knowledge exchange around breastfeeding on Twitter (Figure S1).

The opportunity present in this work stems from the identification of a dynamic online social system in the context of public health and breastfeeding on Twitter. In a short 1-month time period, we identified close to 3,200 unique users with approximately 2,500 active individuals focused on breastfeeding. These breastfeeding focused users formed distinct identifiable communities, which hold the latent potential to be leveraged so that evidence-informed knowledge may be more efficiently and effectively moved in the

network (Getchell & Sellnow, 2016; van Zoonen, Verhoeven, & Vliegenthart, 2016). The potential of social influence in the social media space around breastfeeding is also reflected in some of our work in face to face social networks.

In our previous work, we have shown that the composition of one's social network explains the extent of evidence-informed knowledge and level of efficacy trainees have to support and promote breastfeeding (Moukarzel et al., 2018; Moukarzel, Abou Jaoudeh, et al., 2020). In Pre-K12 education, our findings highlight that knowledge dissemination alone is unlikely to be effective in changing mindsets about breastfeeding without attending to students' social networks within and outside the school setting (e.g., teachers' and parents' perspectives on breastfeeding and level of influence on child behaviour) (Moukarzel et al., 2019; Moukarzel, Mamas, Farhat, Abi Abboud, Daly, 2020). Findings from these study suggest that we may be better able to identify individuals and pathways to improve evidence-informed knowledge dissemination through networks of key influencers.

In this study, we identified 59 key influencers from an SNT perspective. Half of these influencers have professional careers in either breastfeeding research, practice or advocacy. As these individuals wield the largest influence on the breastfeeding network, identifying these users may provide the potential for targeted communication and knowledge-sharing strategies—in effect, engaging in network interventions. Traditionally, influencers on social media are identified based on number of followers. However, our work, grounded in SNT and analysis, suggests that social structural position in a network (e.g., being more central) is related with influence and action in a space (Daly, 2010). If we or the field rely on number of followers as the only metric of influence, many of the individuals we identified would have been passed over. Overlooking these socially influential actors may have resulted in missing out on strategic opportunities with high latent potential for impact.

Although Twitter holds the possibility to be an effective platform for breastfeeding promotion efforts (i.e., time-bound campaigns, continuous clinical and community support, and academic outreach), several constraining factors should be noted and addressed. First, the amount of PC around breastfeeding may significantly hinder lay individuals access to evidence and recommendations. By using #breastfeeding as a search term, our results suggest that one third of the material would be pornographic in nature, which may inhibit or even alienate those seeking breastfeeding advice or support. This can be problematic for breastfeeding promotion particularly as increasing numbers of individuals are using social media to seek health information and support (Caulfield et al., 2019). Moreover, health misinformation on social media are known to diffuse much 'farther, faster, and deeper' than often scientifically sound information (Vosoughi, Roy, & Aral, 2018). One way to overcome this issue is to raise awareness among the public about breastfeeding-friendly hashtags. If the goal is breastfeeding promotion, then creating and promoting new hashtags to targeted communities and influencers would support promotion and the movement of accurate and timely information.

Another challenging factor lies in the number of current key influencers and in their mode of interaction. In this theory building/proof of concept study, we captured interactions during a 1-month period only and therefore identified only a narrow band of key influencers. A longer study period (e.g., 6 months) would yield additional influencers and prevent only a few users from dominating the discussions, ultimately improving the 'novelty' available to the system. Not only were the key influencers limited in number, but researchers in that group were communicating only to one another and in some way creating an echo chamber (Supovitz et al., 2018). An E-I index of −1 is a perfect inward communication pattern meaning these researchers, while active on Twitter, are only communicating with each other and not spreading any knowledge to others, limiting opportunities for evidence-based dissemination.

Although we found more tweets about peer-reviewed research findings being sent compared with tweets about nonevidence-based lay recommendations, our data suggest that it is the lay public who 'carries the burden' of translating findings into practice and use and as such the translation activity is held in the hands of the informed public, not the research community. As such, findings gleaned and shared by the public may not be accurately reported, taken out of context, and not attending to the nuance that is common with research findings. This may lead to an unintentional spread of misinformation and nonevidence-based practices, which have a kernel of truth but are blunted by interpretation by an informed lay audience.

In sum, as social media continues to grow in use and scale, better tools and approaches to leverage this powerful new medium are indicated. Moreover, taking a social network perspective provided us with the theoretical and analytic purchase to better understand the social structure and set of users that drive influence in the breastfeeding promotion space. This work reflects a unique opportunity to draw on a growing set of sophisticated, but intuitive measures, in identifying networks, communities and influencers to improve breastfeeding promotion efforts at scale. Our work suggests the potential for network interventions that expands the arsenal of strategies currently available to those who work with breastfeeding promotion. As this work indicates, the field of public health has access to a new intellectual and empirical set of theories and tools to address the growing, complex and interconnected social worlds in which people now live and are influenced.

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CONFLICTS OF INTEREST

The authors declare that hey have no conflicts of interest.

CONTRIBUTIONS

SM and AJD designed the study. SM, AJD and MR performed the research. SM and MR analysed the data. SM, AJD and MR wrote the first draft of the manuscript. All authors have reviewed and approved the final manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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