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Fertility-Related Conversations in the Context of COVID-19 and Vaccinations

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Abstract. We used text analysis to examine trends and self-reporting in Twitter regarding COVID-19 disease and COVID-19 vaccines' effects on fertility. Trends and self-reporting related to COVID19 vaccines indicates that further research is needed to enable women to feel they have sufficient information to make decisions regarding vaccination, together with social listening and engagement with women's concerns regarding vaccination effects.

Keywords. Fertility, COVID-19, vaccination, social media, twitter, text analysis

1. Introduction

Potential fertility-related adverse events following immunisation (AEFI), in particular menstrual related AEFI, have been reported following COVID19 vaccines [1][2]. Conversely, there are studies that attribute declining fertility to the pandemic [3], or stress the consensus that there is no evidence to date for concern [4]. We have previously validated the use of social media (SM) conversations as a supplementary data source for vaccine post-licensure surveillance [5]. This study analyses SM to identify conversations on COVID-19 vaccines and associated discussions on menstruation, pregnancy, and fertility. We investigate fertility-related SM conversations in the context of COVID-19 disease and COVID-19 vaccinations, for trends over the course of the pandemic and vaccine rollout, and for the main topics of conversations, especially those that relate to personal health experiences. SM functions as a platform for people to describe their experiences, and an avenue to express their opinions, ideas, and observations in the public domain. Social media can be a valuable data source for health-related information [6], including vaccine safety information [5].

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2. Methods

Tweets were collected using the Twitter Research endpoint, from January 2020, shortly after the beginning of the pandemic, through to October 2022 – when vaccines had been rolled out to most of the world's population. The aim was to provide an entire pandemic context to the search, with a view to comparing volume and topic trends around both the pandemic and the rollout of vaccines. The search terms matched into a collection of COVID-19 disease, COVID-19 vaccine, or vaccination keywords, combined with lists of words pertaining to (a) menstruation, (b) birth (including premature birth), and (c) miscarriage. Additionally, (d) tweets were collected for mentions of children and illnesses. Menstrual-related posts were considered relevant because irregular menses could prevent normal rates of conception, and birth and miscarriage-related discussions could indicate unexpected outcomes of pregnancy. The investigation into illnesses in children was to track discussions about the effects of COVID-19 and vaccination on children, including illnesses linked to breastfeeding.

We excluded retweets from the search and removed duplicates of tweet ids or texts, resulting in around 3 million records. Other than separating URLs from the texts, they were left intact. We added attributes to indicate which of the vaccine and condition-related search terms existed in each text. We included users' fields to help identify any interplay between users in tweet traffic. Topic modelling was conducted using BERTopic [7]. We used a 100-topic model but created summary topic groupings to enable a higher-level analysis. We also performed classification to identify personal health mentions (PHM) using a RoBERTa [8] model trained to detect PHM and reactions related to COVID-19 vaccines [5]. Transformers-based language models were chosen for both topic modelling and classification for their proven capacity for discerning the textual features of personal health mentions [5].

We assessed the topics' information and the texts, to identify records for elimination, where they were not suited for the objective of the study. For instance, mischievous posts where the text is deliberately nonsensical and those matching the text search but not matching into our target data (e.g., the term "miscarriage of justice" matches to the search word "miscarriage" but not to our intended data). We were helped by the Twitter users' information, and the topic and personal prediction information in this process. There were around 2.2 million records remaining after this step. Geographic analysis showed large numbers of the tweets came from the US and from India. Finally, we created four views of the data for our target datasets – being menstrual-related, birth-related, loss-related (miscarriages), and child-sickness-related.

We looked at the four datasets over the three years interval, splitting our analysis between SM personal vs. non-personal posts, and building trends charts that showed the fluctuations in tweets over time. The charts include an *area plot* of the US 7-day average daily total vaccine doses, to aid understanding of any correlation between trends and the vaccine rollout.

3. Results

Trends: Figure 1 illustrates SM *menstrual-related* discussion trends for personal and non-personal tweets. Non-personal tweets about menstrual issues are reasonably constant with peaks throughout the pandemic, but personal tweets increase markedly from February 2021, and peak again in August 2021 and at the end of 2021. Two of these

peaks temporally echo the US primary and booster vaccine rollouts. Non-personal tweets' *topics* reflected concerns about the societal impacts of COVID-19 and public health policy, and COVID-19 disease and vaccination effects, but personal tweets were far more focused on vaccination or COVID-19 influences on health.

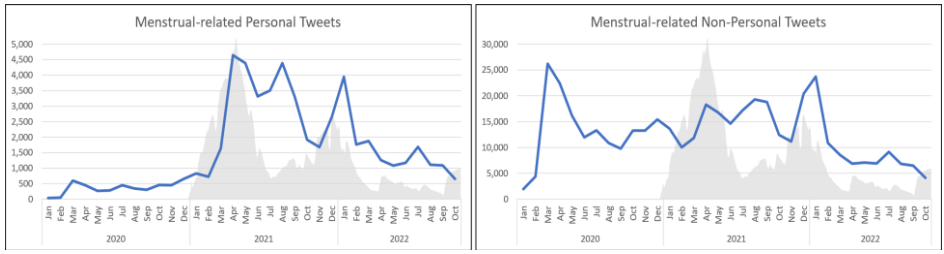

Figure 1. Menstrual-related tweets.

SM *Birth-related* mention trends also showed a difference between personal and non-personal tweets over time, with the *personal* showing significantly increased numbers from March to April 2021, with the later peaks in August and December that were also observed in the menstrual-related tweets — see Figure 2. We split this dataset into those relating to childbirth or to premature birth. There was virtually no mention for premature birth until upticks in personal conversations in April and August 2021, and in December 2021 to January 2022. The *topics* showed similar divisions to the menstrual-related topics, with the top 4 personal topics relating to COVID-19 or vaccination effects, but with the non-personal including concerns about the impact of the pandemic and public health measures.

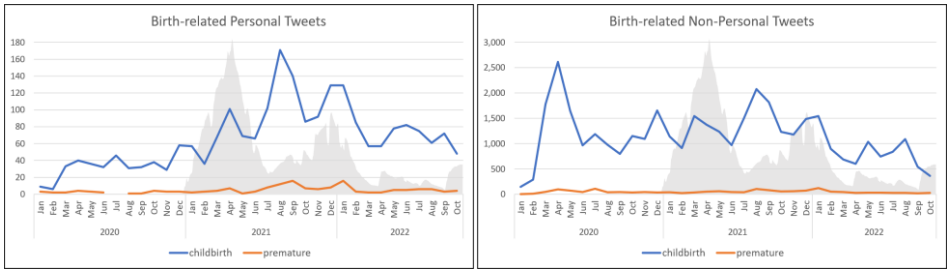

Figure 2. Birth-related tweets.

SM pregnancy *Loss* and *sickness-related* mention trends showed similar sudden upticks in personal reporting, and we present the personal reports together in Figure 3. The loss or miscarriage mentions start to climb in March 2021 and peak in August to September 2021, with a further peak in December 2021 to January 2022. These peaks lag the US vaccine and booster rollouts by 5 to 6 months. The first child-related sickness peak appears in July/August 2021 and is followed by a larger December/January 2021 peak. In the US, vaccinations began for 12-year-old children, and then for 5-year-old children, around two months before these 2 sickness-related peaks. These points are marked on the chart. Although not shown here, the non-personal loss and sickness-related tweets followed similar patterns, especially those relating to children's sickness, which indicates that COVID-19 related children's sickness was not much talked about during the pandemic, until later in 2021, after vaccines were introduced to children.

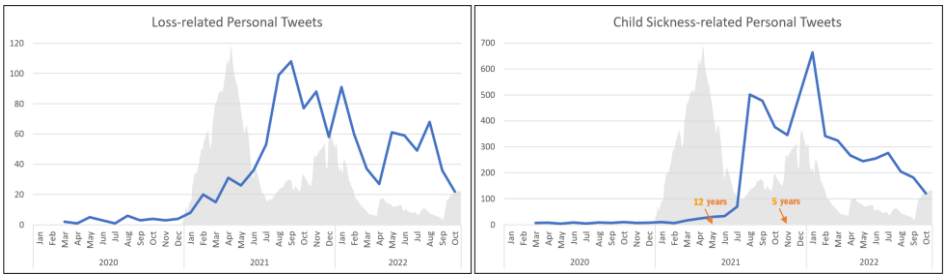

Figure 3. Loss and sickness-related personal tweets.

Conversations: The menstrual-related SM *personal tweets* show a range of experiences, almost all attributed to vaccination, some to COVID-19 itself, and in some cases from un-vaccinated women who reported being in proximity to recently vaccinated women. These include much heavier, very painful and longer lasting periods, with large clots - for example, "I bled for 4 months straight". Alterations of timing are frequently discussed - menses unexpectedly coming in the days after vaccination, shortened or irregular intervals between periods. There are a few reports of periods after menopause, and other reports of unexpected (or repeating of) perimenopausal conditions such as hot flushes. Conversations in the later peaks of August 2021 and December/January 2022 describe a second or booster vaccine dose. Notably, as time goes on, amenorrhea is described. E.g., "*My period stopped for 5 months after my second dose, and I think that does need to be researched further*"; "*My daughter's period has stopped after the 2nd Pfizer jab, 3 months now. She always had regular periods... she was planning on starting a family*".

Initially, birth-related personal tweets focused on general vaccination discussions like the MMR vaccine, or to birth experiences, then evolved to discussing the pros and cons of COVID-19 vaccinations. A few records indicated a temporal link to vaccination or to COVID-19 and premature birth. E.g., "*Two weeks after her vax, my niece gave birth to her son at 27 weeks. Her placenta all of a sudden stopped working. She said the nicu is full of newborns who are having unexplained seizures*".

Up until late July 2021 the loss/miscarriage-related tweets were general discussions about miscarriage, some relating to traditional vaccines administered in pregnancy or to a newborn, some in the context of COVID-19. From August 2021 numerous reports began to appear describing miscarriages or newborn deaths post vaccination. There were many third person reports of the "*I know someone who…*" variety, but there are equally many that seemed to be reliable personal reports, many describing miscarriages shortly after vaccination.

The sickness-related personal tweets had a lot of discussions where the children referred to were adults or children other than newborns, concerning both COVID-19-illness and from mid-2021 to vaccine booster-related adverse effects, including myocarditis. Explicit mentions of babies were mostly about regular childhood illnesses related to concerns about COVID-19, descriptions of illnesses after a range of vaccinations, and illnesses ostensibly arising because the mother had been vaccinated — either during pregnancy or while breastfeeding. These included sick newborns with issues like brain bleeding, unexplained illnesses, and breastfeeding babies developing severe rashes after their mother's vaccination.

4. Discussion

This study identifies social media discussions that report fertility related symptoms, especially menstrual disorders, associated with COVID-19 disease and more particularly with COVID-19 vaccinations. The conversations are predominantly from the US and India and are temporally aligned with vaccine rollouts in the US. However, preliminary studies have largely not supported a link between COVID-19 vaccines and fertility [4]. Investigating SM is important to identify potential increase in public concerns irrespective of scientific causality analyses, as these concerns have implications for vaccine confidence programs and uptake.

5. Conclusions

This study uses a social media data source to identify online public discussions reporting declining fertility following COVID-19 infection and vaccinations, and highlights the need to both research further and to listen to [1], validate, and engage constructively with the public about their concerns.

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