Extended abstract: Vaccinated vs. Unvaccinated: Women with Diverging Fertility Patterns

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Introduction

The global COVID-19 pandemic and the subsequent, rapid vaccination campaigns led to profound societal division, sustained by intense public debates regarding the potential adverse influence of vaccines on reproductive health. Despite robust clinical evidence consistently affirming vaccine safety, i.e., the metastudy of Zaçe et al. (2022) revealing no negative effect of the vaccine on female and male fertility (also Chen et al., 2021, Wang et al., 2023), the persistent discourse may have itself acted as a factor influencing reproductive decision-making among women of reproductive age (Bujard and Andersson, 2024). The core objective of this study is to compare fertility patterns between cohorts of vaccinated and unvaccinated women in Czechia. Crucially, our research aim is defined by the need to determine whether any observed divergence in reproductive behavior stems causally from the vaccination intervention or is merely an artifact of structural and behavioral selection already present before the COVID-19 vaccination campaign. By leveraging high-resolution, longitudinal data from health registries, we are uniquely positioned to assess the reproductive evolution of these two groups across the critical periods: before, during, and after the COVID-19 pandemic.

Data

We employed health registry data from the Czech National Health Information System. Specifically, we used a combination of the COVID-19 Module (which contains data on vaccination, positive test results, and hospitalizations due to COVID-19) and the Maternity Module (which includes information on births, birth outcomes, birth order, gestational age, and the mother's birth year). These data are available for selected birth cohorts of women (1976, 1979, 1982, 1985, 1988, and 1991) who gave birth in Czechia between the years 1994 and 2024. All events are recorded with monthly and yearly precision. Women were classified as vaccinated or unvaccinated according to their vaccination status at the end of 2023, with all women who had received at least one dose of a COVID-19 vaccine considered vaccinated.

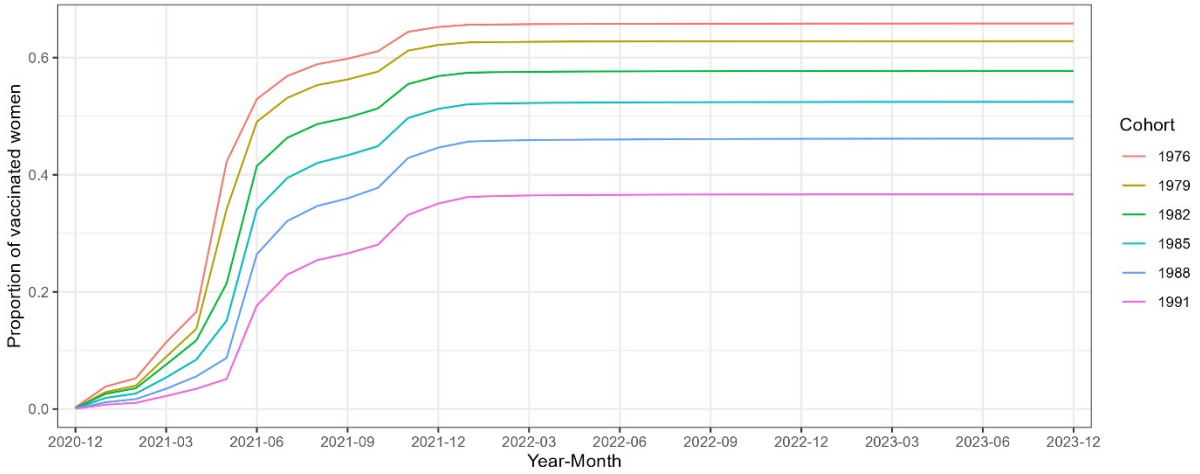
For further analyzes, it was necessary to determine the exposure for vaccinated and unvaccinated women. The overall exposure of all women was taken from the Human Fertility Database (HFD) as the value corresponding to the year 2020 for each of the studied cohorts (1976–1991), which represents a pre-pandemic baseline in the context of fertility research. Data on vaccinated women, both with and without children, can be considered relatively reliable. A limitation exists in the case of migrant women who had a birth abroad and became vaccinated after moving to Czechia. Similarly, data on unvaccinated women with children are expected to be of good quality, although a potential source of underestimation arises from women who might have been vaccinated outside Czechia.

The most challenging group to define consists of unvaccinated women without children, because this group of women is not part of the registry of the COVID-19 Module nor the registry of the Maternity Module. It is possible that some unvaccinated women distrust not only vaccination but also the healthcare system as a whole and therefore avoid any kind of medical care (whether in reproductive or general healthcare registries). Consequently, this group may be more likely to be underestimated. Therefore, the number of unvaccinated childless women was derived as the total number of women in 2020 based on HFD data, minus all vaccinated women and unvaccinated women with at least one child in 2020.

We define our two primary analytical groups based on their COVID-19 vaccination status: (1) Vaccinated women, i.e., those who received at least one dose of a COVID-19 vaccine (at any time—before or after births), and (2) Unvaccinated women, those who received no COVID-19 vaccination at

all. Information regarding vaccination is complete up to the end of 2023. Consequently, women who received their first dose in 2024 are currently classified as unvaccinated, though the number of such cases is considered likely negligible. The COVID-19 vaccination campaign in Czechia commenced in early 2021, initially targeting vulnerable groups, and became available to all population segments from May 2021 (Slabá & Šťastná, 2025). A significant age gradient in vaccine uptake was observed (see Figure 1): older women (e.g., cohort 1976), who reached the highest proportion of vaccinated women at 65.8%, were vaccinated earlier and at higher rates than younger women (e.g., cohort 1991), where the rate was 36.6% by the end of 2023. The proportion of women who had received at least one dose significantly increased between May 2021 and the end of 2021, but did not grow substantially in the following years (up to the end of 2023). Contextually, while the overall Czech vaccination rate (73% for at least 2 doses by the end of 2021, population 18+) was slightly below the EU average (77%), it exceeded the rates in most Central and Eastern European countries (OECD, 2022).

Figure 1: Proportion of vaccinated women, selected cohors, 2020/12-2023/12, Czechia



Note: Vaccinated women are defined as they received at least one dose of vaccination against covid-19.

Methods

Standard Age-Specific Fertility Rate comparisons are often biased when comparing structurally different groups. Since vaccinated and unvaccinated women exhibit differing baseline characteristics (e.g., age structure, actual parity, and socioeconomic profile), we must control for exposure heterogeneity.

To overcome this bias, we utilize the Parity-and-Vaccination Conditional Age-Specific Fertility Rate (vPASFR). This rigorous indicator is calculated as a conditional probability, where exposure *(P)* is structurally limited solely to women who are at specific risk of having a child of the given birth order *(i);* that is, only women who possess *i−1* children are included in the denominator. The numerator (B) represents the number of live births of order *i* to women within the specified age and vaccination status:

$$vPASFR_x^{vaccinated,i} = B_x^{vaccinated\ mother,i} / P_x^{vaccinated\ female,i-1}$$
$$vPASFR_x^{unvaccinated,i} = B_x^{unvaccinated\ mother,i} / P_x^{unvaccinated\ female,i-1}$$

Results

Utilizing the Parity-and-Vaccination Conditional Age-Specific Fertility Rate (vPASFR), we confirm that the reproductive behavior of vaccinated and unvaccinated women exhibits striking differences, but this pattern was clearly established long before the onset of the COVID-19 pandemic (Figure 2).

Focusing on entry into motherhood, the conditional probability of a first birth is consistently and robustly higher among vaccinated women. This heightened probability is observed across all selected cohorts, applying to both older cohorts (1976, 1979), who had largely completed their fertility already before pandemic, and younger cohorts (1982–1991), who were still actively making reproductive decisions during the vaccination phase. Furthermore, vaccinated women demonstrate a pronounced trend toward the postponement of the first birth into older ages, with the highest conditional probability observed after age 30. This trend of delayed childbearing is particularly notable in the younger cohorts.

Conversely, an analysis of higher parities reveals that the conditional probability of progressing to a second or subsequent child is consistently higher among unvaccinated women. This group exhibits significant timing disparities for second-order births, tending to have them at notably younger ages. This earlier timing suggests potential correlations with lower socioeconomic status (SES). Furthermore, the unvaccinated group exhibits a higher conditional probability of advancing to a third or subsequent birth order.

Crucially, the overall fertility decline observed in the period during and immediately following the pandemic (specifically highlighted during 2021–2024, see Figure 2 and Figure 3 detailing only period 2018–2024) is clearly evident in both the vaccinated and unvaccinated groups. This universal reduction strongly supports the conclusion that the aggregate fertility contraction is primarily driven by generalized macroeconomic and uncertainty factors related to the pandemic, validating that the decline is independent of the women's vaccination status (see also Jasilioniene et al., 2025).

Figure 2: Conditional probability that a woman gives birth to a child of a specific order, vaccinated and unvaccinated women, Czechia, selected cohorts

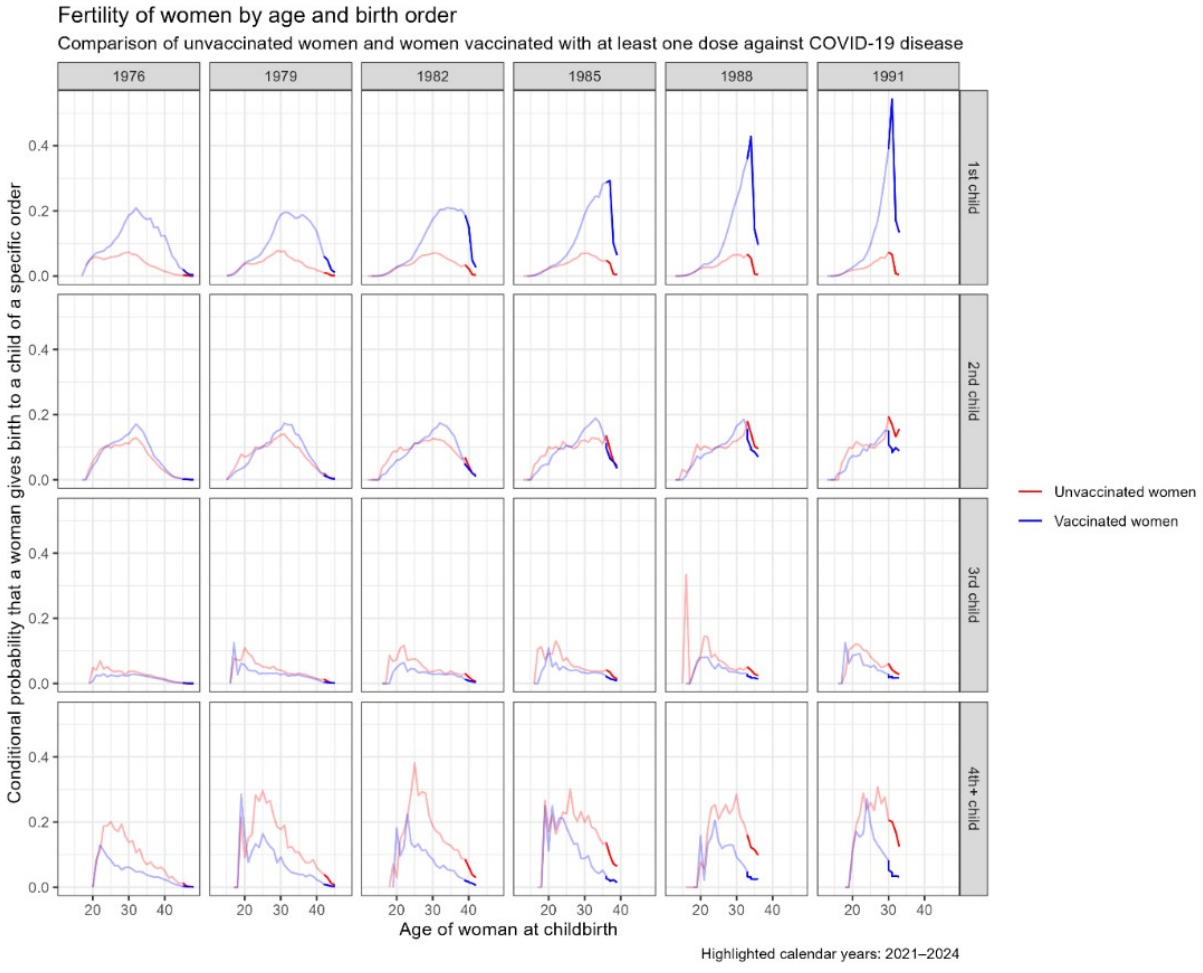
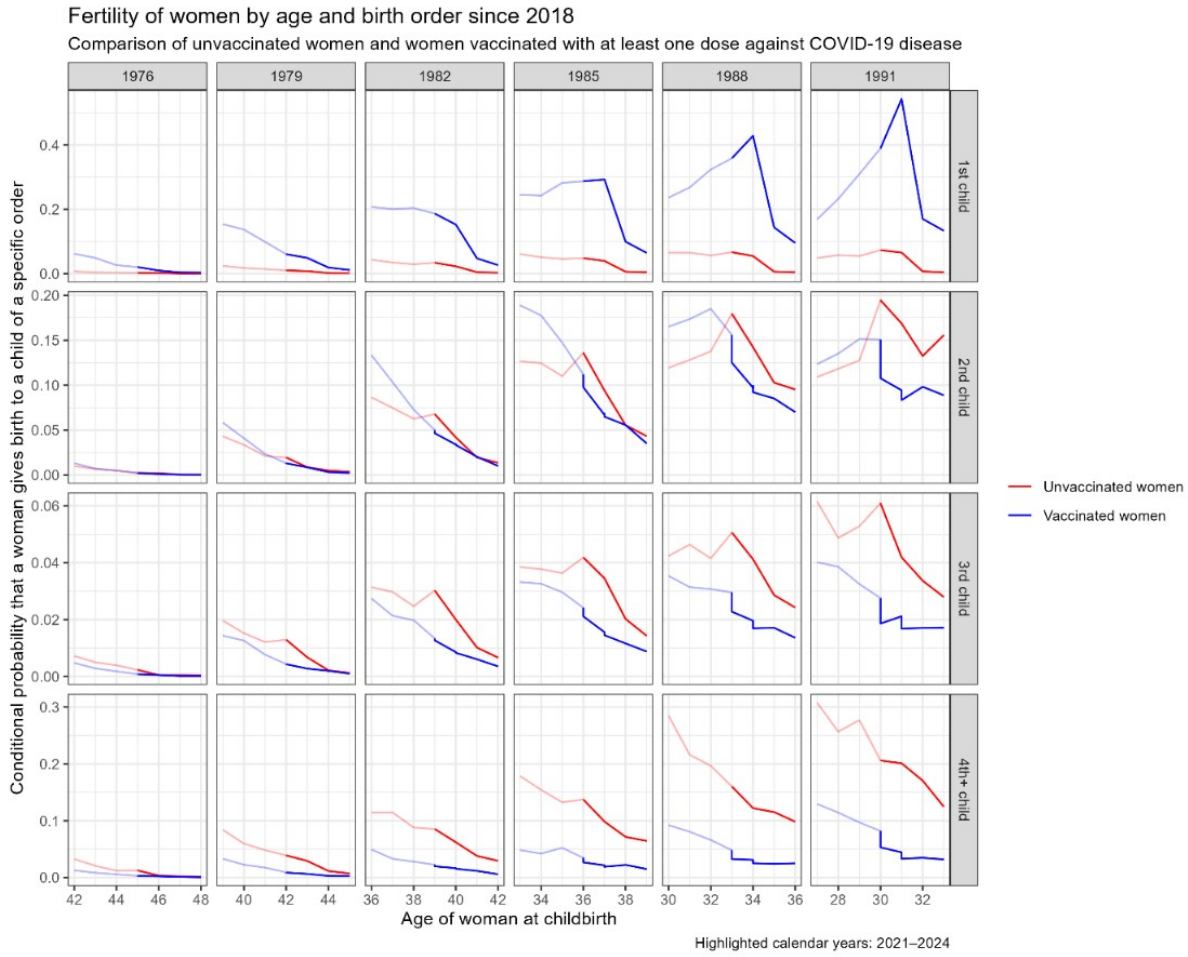


Figure 3: Conditional probability that a woman gives birth to a child of a specific order, vaccinated and unvaccinated women, Czechia, selected cohorts, 2018-2024



Conclusion:

The evidence from the vPASFR analysis demonstrates that the observed divergence in fertility patterns of women in Czechia is attributable to a selection effect and differences in reproductive timing and behavior that existed already before the pandemic. The vaccinated population is demographically distinct, characterized by a postponement effect leading to higher conditional probability of giving birth to a first child in later ages. Conversely, unvaccinated women are more likely to achieve second and higher parities at younger ages, suggesting underlying socioeconomic disparities. We conclude that the observed divergence is driven by structural factors differentiating these two groups prior to the COVID-19 period. At the same time, the fertility decline after the period of the COVID-19 pandemic can be observed among both vaccinated and unvaccinated women. These findings underscore the critical need for robust methodological control. Without measures such as vPASFR to identify and control for these structural differences, it is not possible to reliably assess the relationship between COVID-19 vaccination and reproduction, leaving any direct association inconclusive.

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