

---

### Early adverse events and immune response following COVID-19 booster vaccination in pregnancy

Pregnant women with coronavirus disease 2019 (COVID-19) have been shown to be at increased risk of severe maternal outcome<sup>1</sup> and are recommended to get vaccinated with the first and second doses of the BNT162b2 vaccine, which has shown encouraging results in terms of its safety and effectiveness in pregnancy<sup>2,3</sup>. The administration of a third (booster) dose of the BNT162b2 vaccine following the emergence of the B.1.617.2 (Delta) variant has proved to be effective in lowering rates of confirmed infection, severe illness and COVID-19-related death<sup>4</sup> and is, therefore, also recommended for pregnant women. We report on the adverse events and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) immunoglobulin G (IgG) serum levels in pregnant women who received the third dose of the BNT162b2 vaccine.

This was a prospective cohort study between August and November 2021 of pregnant women who received the third dose of the BNT162b2 vaccine and were matched by age in a 1:1 ratio to a control group of non-pregnant women who received the third dose of the vaccine during the same time period. All women had received two doses of BNT162b2 vaccine at least 5 months earlier. Blood samples were collected and tested for SARS-CoV-2 IgG antibodies (in binding antibody unit (BAU)/mL) before and  $33 \pm 3$  days after the administration of the third BNT162b2 dose. Women with medical conditions,

**Table 1** Adverse events after the third (booster) dose of BNT162b2 vaccine in pregnant and non-pregnant women

| Adverse event                  | Not pregnant      |           | P       |
|--------------------------------|-------------------|-----------|---------|
|                                | Pregnant (n = 64) | (n = 64)  |         |
| Rash/local pain/local swelling | 48 (75.0)         | 62 (96.9) | < 0.001 |
| Diffuse rash                   | 0 (0)             | 1 (1.6)   | 0.315   |
| Fever                          | 5 (7.8)           | 10 (15.6) | 0.169   |
| Weakness                       | 24 (37.5)         | 42 (65.6) | 0.001   |
| Myalgia                        | 14 (21.9)         | 32 (50.0) | 0.001   |
| Axillary lymphadenopathy       | 4 (6.3)           | 18 (28.1) | 0.001   |
| Remote lymphadenopathy         | 4 (6.3)           | 3 (4.7)   | 0.697   |
| Paresthesia                    | 4 (6.3)           | 4 (6.3)   | 1       |
| Headache                       | 3 (4.7)           | 2 (3.1)   | 0.648   |
| Chest pain                     | 0 (0)             | 3 (4.7)   | 0.042   |
| Nausea                         | 0 (0)             | 5 (7.8)   | 0.08    |
| Bell's palsy                   | 0 (0)             | 0 (0)     | N/A     |
| Hospitalization                | 0 (0)             | 0 (0)     | N/A     |

Data are given as n (%). N/A, not applicable.

**Table 2** Blood serology for SARS-CoV-2-specific antibodies in pregnant and non-pregnant women

| Serology                 | Not pregnant      |                   | P     |
|--------------------------|-------------------|-------------------|-------|
|                          | Pregnant (n = 64) | (n = 64)          |       |
| Serum IgG (BAU/mL)       |                   |                   |       |
| Before third dose        | 104.05 ± 75.99    | 101.72 ± 57.44    | 0.845 |
| 33 days after third dose | 2092.61 ± 1602.14 | 2792.85 ± 1585.23 | 0.014 |

Data are given as mean ± SD. BAU, binding antibody unit; IgG, immunoglobulin G.

multiple gestation or previous preterm birth and those with positive polymerase chain reaction for SARS-CoV-2 before or during the study period were excluded. No woman was lost to follow-up during the study period.

Sixty-four pregnant women were included and compared with a control group of 64 non-pregnant women. There were no significant differences between the groups with respect to age, body mass index or underlying medical conditions. Several adverse events, including local rash/pain/swelling, weakness, myalgia, axillary lymphadenopathy and chest pain, were significantly less common among pregnant women compared with non-pregnant women (Table 1). None of the pregnant women experienced uterine contractions, preterm prelabor rupture of membranes or vaginal bleeding following vaccination. Blood serology for SARS-CoV-2-specific antibodies before the third dose of the vaccination did not differ significantly between the pregnant and non-pregnant groups (104.05 vs 101.72 BAU/mL;  $P=0.85$ ) (Table 2). However, SARS-CoV-2 IgG serum level 33 days after the third dose was significantly lower among pregnant women compared with non-pregnant women (2092.61 vs 2792.85 BAU/mL;  $P=0.01$ ).

Our findings indicated no additional early adverse events in pregnant compared with non-pregnant women. Short-term obstetric complications in pregnant women

were negligible. The third dose of the BNT162b2 vaccine generated humoral immunity in both groups, although the SARS-CoV-2 IgG levels were lower in pregnant compared with non-pregnant women. The lower humoral response among pregnant women, which may be attributed to their relative immunomodulated state<sup>5</sup>, may explain the lower rates of adverse events following vaccination in pregnant compared with non-pregnant women. The clinical significance of the lower humoral response among pregnant women is still uncertain.

In conclusion, this study confirms the safety, in terms of early adverse events, immunogenicity and early obstetric complications, of the third dose of the BNT162b2 vaccine in pregnant women.

S. Toussia-Cohen<sup>1,2</sup>, R. Peretz-Machluf<sup>1,2</sup>,  
S. Bookstein-Peretz<sup>1,2</sup>, O. Segal<sup>1,2</sup>, K. Asraf<sup>3</sup>,  
R. Doolman<sup>3</sup>, Y. Kubani<sup>3</sup>, T. Gonen<sup>4</sup>,  
G. Regev-Yochay<sup>2,4</sup> and Y. Yinon<sup>1,2\*</sup>

<sup>1</sup>Department of Obstetrics and Gynecology,  
Chaim Sheba Medical Center, Tel-Hashomer,  
Ramat-Gan, Israel;

<sup>2</sup>Sackler Faculty of Medicine, Tel-Aviv University,  
Tel-Aviv, Israel;

<sup>3</sup>Dworman Automated-Mega Laboratory, Chaim Sheba  
Medical Center, Tel-Hashomer, Ramat-Gan, Israel;

<sup>4</sup>Infection Prevention & Control Unit, Chaim Sheba  
Medical Center, Tel-Hashomer, Ramat-Gan, Israel

\*Correspondence.

(e-mail: yoav.yinon27@gmail.com)

DOI: 10.1002/uog.24926

## References

- Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T, Debenham L, Llavall AC, Dixit A, Zhou D, Balaji R, Lee SI, Qiu X, Yuan M, Coomars D, Sheikh J, Lawson H, Ansari K, van Wely M, van Leeuwen E, Kostova E, Kunst H, Khalil A, Tiberi S, Brizuela V, Broutet N, Kara E, Kim CR, Thorson A, Oladapo OT, Mofenson L, Zamora J, Thangaratnam S; for PregCOV-19 Living Systematic Review Consortium. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. *BMJ* 2020; 370: m3320.
- Goldshstein I, Nevo D, Steinberg DM, Rotem RS, Gorfine M, Chodick G, Segal Y. Association Between BNT162b2 Vaccination and Incidence of SARS-CoV-2 Infection in Pregnant Women. *JAMA* 2021; 326: 728–735.
- Bookstein Peretz S, Regev N, Novick L, Nachshol M, Goffer E, Ben-David A, Asraf K, Doolman R, Levin EG, Regev Yochay G, Yinon Y. Short-term outcome of pregnant women vaccinated with BNT162b2 mRNA COVID-19 vaccine. *Ultrasound Obstet Gynecol* 2021; 58: 450–456.
- Bar-On YM, Goldberg Y, Mandel M, Bodenheimer O, Freedman L, Kalkstein N, Mizrahi B, Alroy-Preis S, Ash N, Milo R, Huppert A. Protection of BNT162b2 Vaccine Booster against Covid-19 in Israel. *N Engl J Med* 2021; 385: 1393–1400.
- Alberca RW, Pereira NZ, Oliveira LMDS, Gozzi-Silva SC, Sato MN. Pregnancy, Viral Infection, and COVID-19. *Front Immunol* 2020; 11: 1672.