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Beta SARS-CoV-2 variant and BNT162b2 vaccine effectiveness in long-term care facilities in France

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Variants of SARS-CoV-2 have emerged that are more transmissible than the original virus or that exhibit some properties of immune escape, or both. The beta (B.1.351) variant has shown abrogated neutralising capacity[1–4] and has circulated widely in eastern France in the first months of 2021.[5,6] As residents of long-term care facilities are at high risk of severe COVID-19, we did a retrospective cohort study from Jan 15 to May 19, 2021, in eastern France to assess the association between BNT162b2 mRNA vaccination (Pfizer-BioNTech) and incidence of infection with the beta variant among residents of long-term care facilities.

In France, SARS-CoV-2 surveillance in long-term care facilities is organised through RT-PCR testing whenever a resident or health-care worker has symptoms suggestive of COVID-19. A second round of RT-PCR screening is then implemented on positive specimens to identify SARS-CoV-2 variants of concern, initially focusing on the detection of the alpha (B.1.1.7), beta, and gamma (P.1) variants,[7] via the N501Y (23063A→T, Asn501Tyr) mutation shared by these three variants of concern. Additional targets were the del69–70 HV (21765_21770del), A570D (23271C→A, Ala570Asp), and P681H (23604C→A, Pro681His) mutations for the alpha variant, and K417N (22813G→T, Lys417Asn) and E484K (23012G→A, Glu484Lys) mutations for the beta and gamma lineages. In addition to RT-PCR screening, whole-genome sequencing is done periodically on a nationwide representative sample of positive specimens. This whole-genome sequencing indicated that, during the study period, the beta lineage represented 95% of all lineages containing mutations at positions 417 and 484 in the Spike glycoprotein, and that it was the beta lineage that was circulating in eastern France, rather than the gamma lineage.[6] In addition, 17 of 20 specimens obtained from long-term care facilities with a positive RT-PCR for mutations at positions 417 and 484 underwent whole-genome sequencing and were all confirmed to be beta. As such, all targets identifying beta or gamma lineages were considered to be beta.

We reviewed surveillance data from all 58 long-term care facilities in three departments (geographical administrative unit) in eastern France and selected five facilities in which a SARS-CoV-2 outbreak that implicated the beta variant had been documented between Jan 15 and April 16, 2021. In each selected facility, all residents (378 in total) were included in the study and the surveillance data collected by medical personnel included age, sex, history of SARS-CoV-2 infection identified by a positive RT-PCR result, and history of COVID-19 vaccination (appendix).

See Online for appendix

SARS-CoV-2 infections were categorised as mild if the resident had no symptoms (or symptoms that did not require oxygen support) and remained in the facility; and severe if the resident had symptoms that required oxygen support, was transferred to a hospital, or died. Overall, 145 (38%) of 378 residents were infected during the study period. Of these residents, 53 (37%) had severe infections, including 37 (26%) deaths.

The primary objective was to determine the effectiveness of the BNT162b2 mRNA vaccine against infection with the beta variant and severe disease. Residents contributed weeks of observation to the population at risk (person-time) from Jan 15, 2021, onwards, until either the resident tested positive by RT-PCR for SARS-CoV-2 infection, or the period of data collection in the long-term care facility ended (whichever occurred first). To reflect the effect of vaccination on the time each resident contributed to the population at risk, each participant contributed person-time as: non-vaccinated until 13 days after the first dose; vaccinated with one dose of the vaccine until 6 days after the second dose; and vaccinated with two doses of the vaccine from 7 days after the second dose. Incidence rates, incidence rate ratios (IRRs), and their 95% CIs were calculated assuming a Poisson distribution of events. A random effect was added to the model to account for any centre effect. Vaccine effectiveness was calculated as 1 minus the adjusted IRR.

Overall vaccine effectiveness was estimated to be 49% (95% CI 14–69) against all forms of beta infection, and 86% (67–94) against severe forms of disease at least 7 days after the second dose of the BNT162b2 mRNA COVID-19 vaccine. These figures were lower than those in a test-negative case-control study earlier this year in

	Person-years (n=81·6)	Infection		Severe COVID-19	
		n=143	Adjusted IRR (95% CI)*	n=52	Adjusted IRR (95% CI)*
Sex					
Male	18·7	41	1 (ref)	23	1 (ref)
Female	62·9	102	0·73 (0·50–1·06)	29	0·35 (0·20–0·63)
Age (years)					
55–84	24·5	46	1 (ref)	13	1 (ref)
85–94	47·2	82	0·86 (0·59–1·25)	36	1·39 (0·72–2·68)
94–104	9·9	15	0·79 (0·44–1·43)	3	0·35 (0·09–1·30)
History of past SARS-CoV-2 infection					
No	76·7	143	1 (ref)	52	1 (ref)
Yes	4·9	0	Undetermined	0	Undetermined
BNT162b2 mRNA COVID-19 vaccination					
No vaccination	27·5	73	1 (ref)	39	1 (ref)
One dose†	13·0	15	0·45 (0·24–0·87)	2	0·14 (0·03–0·68)
Two doses‡	41·1	55	0·51 (0·31–0·86)	11	0·14 (0·06–0·33)
Vaccine effectiveness of one dose†	..	..	55% (13–76)	..	86% (32–97)
Vaccine effectiveness of two doses‡	..	..	49% (14–69)	..	86% (67–94)

IRR=incidence rate ratio. *Adjusted for calendar week and all variables shown in the table. †Includes only those who have received one dose of BNT162b2 mRNA COVID-19 vaccine at least 14 days previously. ‡Includes only those who have received a second dose of BNT162b2 mRNA COVID-19 vaccine at least 7 days previously.

Table: **Association between resident characteristics and infection with the beta variant and severe COVID-19**

Qatar, in which effectiveness against any beta infection was 75% (71–79) and effectiveness against severe disease due to beta infection was 97% (92–100).[8] The differences in effectiveness between that study and our one might be explained by the older age of our study population (median age of 33 years *vs* 89 years, respectively). We found that women were less likely to develop severe forms of COVID-19 disease than men (IRR 0·35 [0·20–0·63]; table).

In two long-term care facilities, both with more than 70% of residents fully vaccinated, outbreaks of the beta variant were reported 4 and 6 weeks after the completion of the vaccination campaign, respectively (appendix). In one of them, 35 (36%) of 97 residents were infected, including 26 (27%) who were fully vaccinated; among these 26, four had severe disease, including two deaths. In the other facility, 37 (37%) of 100 residents were infected, including 28 (28%) who were fully vaccinated; among these 28, seven had severe disease, including four deaths.

Our findings provide an important contribution to understanding the effect of the beta lineage on the effectiveness of the BNT162b2 mRNA COVID-19 vaccine in long-term care facilities. In line with studies from the past year,[9,10] we showed reduced vaccine effectiveness against the beta variant, and we observed outbreaks of this variant with severe forms of disease among fully vaccinated individuals in two long-term care facilities with high vaccination coverage. Our findings highlight the need to maintain SARS-CoV-2 surveillance in these high-risk settings beyond the current COVID-19 mass vaccination campaign. As vaccine-related immunity is expected to decline more quickly in older populations,[11] these breakthrough events advocate for the administration of a third vaccine dose in this high-risk group.

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