Association of COVID-19 mortality with COVID-19 vaccination rates in Rhineland-Palatinate (Germany) from calendar week 1 to 20 in the year 2021: A registry-based analysis

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1 Data Preprocessing

In the vaccination data set, individuals residing outside of Rhineland-Palatinate were excluded to calculate sex- and age-specific vaccination coverage relative to the resident population. Individuals with missing information on sex or age were excluded for the same reason. In addition, implausible entries were excluded, for example when vaccination dates preceded vaccine availability, or when age exceeded 112 years.

Out of all 1054339 at least partially vaccinated individuals from calendar week 1 to 20 in 2021, 1359 (0.13%) were excluded due to implausible entries for vaccination date or age. Furthermore, 20291 (1.92%) out-of-state residents, 7206 (0.68%) individuals with unknown sex, and 5 (0.00047%) individuals with unknown age were excluded.

2 Rationale for the Choice of Regression Model

The initial vaccination rollout for age group 80+ years and health care workers in early 20201 coincided with the decline of the COVID-19 wave from December 2020 during which the elderly bore the major burden of COVID-19 mortality. Similarly, excess mortality during December 2020 was superseded by undermortality in the beginning of 2021 [1], possibly due to mortality displacement effects.

The incidental timing of the vaccine rollout thus created the risk of a spurious association between vaccination coverage and COVID-19 mortality rate in a Poisson regression model. Therefore, we did not analyze the absolute level of COVID-19 mortality rates as an endpoint. Instead, we modeled the shift in the age distribution of COVID-19 fatalities using a binomial logistic regression model which used the weekly sex-specific binomial proportion of COVID-19 fatalities in each age group as the endpoint. A similar analysis strategy has been used in a recent related publication, as well [2].

3 Sample Calculations

Table S1 lists the raw data used for all analyses. The following sections provide examples of how to perform calculations for the proportion vaccinated, and for the regression model endpoints.

3.1 Age-specific Proportion Vaccinated

In the study period, the residential population of females 80 years and older was estimated as 173095. In calendar week 5, there were 17089 completely vaccinated persons in that group. Therefore, the proportion vaccinated was 17089 / 173095 = 9.87%.

3.2 Proportion of COVID-19 Fatalities Formed by Each Age Group

In calendar week 5, there were 0, 0, 4, and 25 COVID-19 fatalities among females in age groups 15-34, 35-59, 60-79, and 80+ years, respectively. The sex-specific proportion of COVID-19 fatalities formed by females in the 80+ age group was thus 25/29 = 86%.

3.3 Proportion of Reported SARS-CoV-2 Infections Formed by Each Age Group

In calendar week 5, there were 317, 472, 205, and 220 reported SARS-CoV-2 infections among females in age groups 15-34, 35-59, 60-79, and 80+ years, respectively. The sex-specific proportion of reported SARS-CoV-2 infections formed by females in the 80+ age group was thus 220/1214 = 18%.

3.4 Regression Model

For the observational unit of calendar week 5, female sex, and age group 80+ years, the value of the endpoint "share of COVID-19 mortality" was 25/29 = 0.86. Corresponding covariate values were 0 (sex female = reference group), 0 (age group 80+ = reference group), and 1254/173095 = 0.72% (proportion vaccinated using a time lag of 14 days). This observation had a weight of 29 since there were 29 COVID-19 fatalities for females in that calendar week.

For the observational unit of calendar week 5, female sex, and age group 80+ years, the value of the endpoint "share of reported SARS-CoV-2 infections" was 220/1214 = 0.18. Corresponding covariate values were 0 (sex female = reference group), 0 (age group 80+ = reference group), and 1254/173095 = 0.72% (proportion vaccinated using a time lag of 14 days). This observation had a weight of 1214 since there were 1214 reported SARS-CoV-2 infections for females in that calendar week.

4 Timeline Non-Pharmaceutical Interventions

Table S2 provides an overview when individual non-pharmaceutical interventions were enacted during the study period in Rhineland-Palatinate, Germany [3].

5 Timeline Vaccination Program

Table S3 depicts the COVID-19 vaccination prioritization policy in Rhineland-Palatinate, Germany, from calendar week 1 to 20 in 2021. Due to limited supply of vaccines, groups who were most at risk for exposure to SARS-CoV-2 or those who were most vulnerable to COVID-19 disease were eligible first. This group included residents of age 80 and above, as well as health care workers with direct contact to possibly infected patients.

A recent publication [4] reported vaccination data from private practices. There, the proportion of vaccinated individuals age 60 and older declined from 71% in week 15 to 31% in week 20. Private practices therefore seemed to largely follow the priority policy.

6 Vaccines Used

Table S4 shows absolute and relative frequencies of vaccines used in the first shot received by individuals in Rhineland-Palatinate, Germany, from calendar week 1 to 20 in 2021, stratified by age group.

Table S5 shows absolute and relative frequencies of vaccines used in the second shot received by individuals in Rhineland-Palatinate, Germany, from calendar week 1 to 20 in 2021, stratified by age group.

7 Timeline Testing Capacity

Figure S1 shows the number of SARS-CoV-2 tests in Germany from calendar week 1 to 20 in 2021 as reported to the Robert Koch Institute [4].

Testing capacity increased during the first 6 calendar weeks and remained largely constant until week 20. Testing activity increased from week 9 to 12, then dropped in week 13 and 14 during school holidays around Easter. Testing activity subsequently increased towards week 16 before dropping toward week 20.

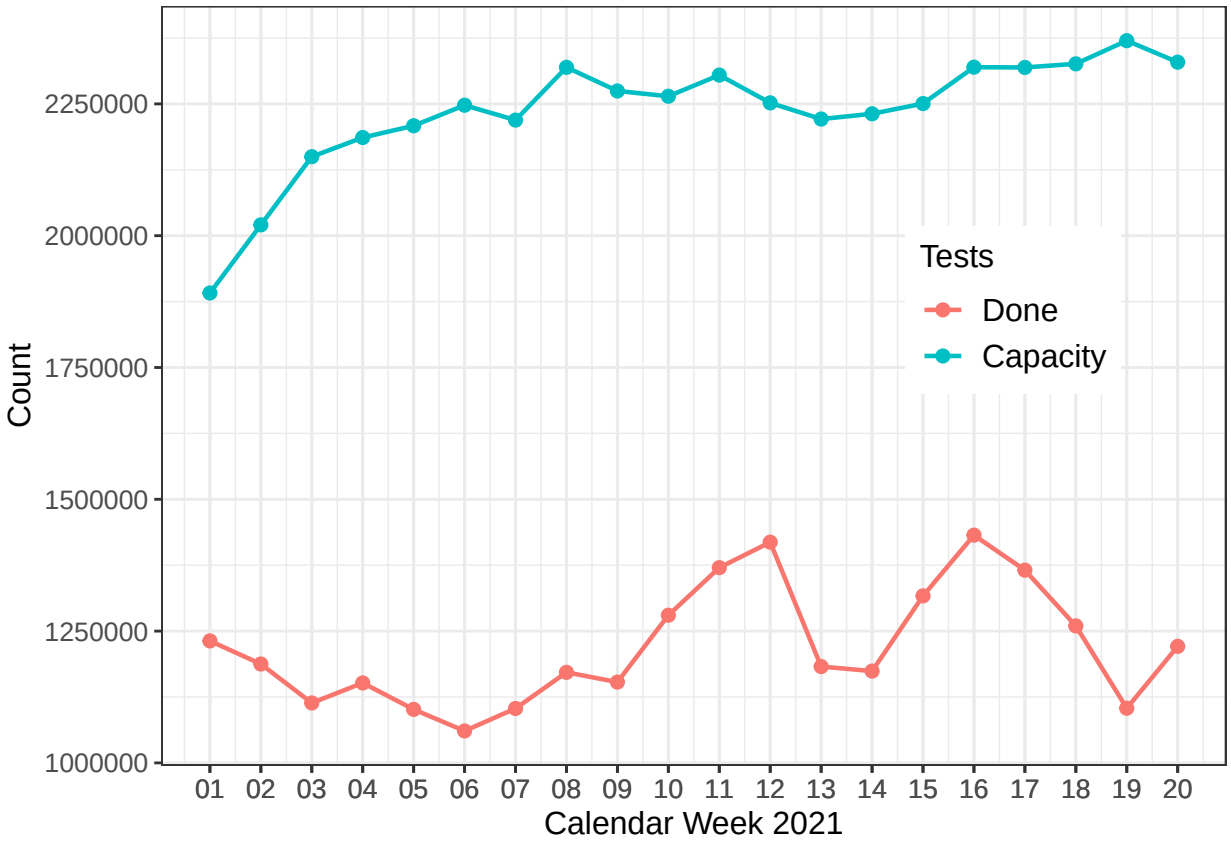
8 Sensitivity Analysis: Logistic Regression All-Cause Mortality

As a sensitivity analysis, a multivariable binomial logistic regression model was used to examine the association between the time-lagged vaccination coverage and the sex-specific proportion of weekly all-cause mortality formed by each age group while adjusting for sex and age group.

Adjusted odds ratios (OR) together with corresponding 95% confidence intervals (CI) and p-values are presented in Tab. S6. Results indicate that there was no statistically significant association between the age-specific share of all-cause mortality and vaccination coverage (adjusted OR = 0.996, 95% CI = [0.991; 1.001], p = 0.16).

9 Figures

Figure S1. SARS-CoV-2 tests and testing capacity in Germany from calendar week 1 to 20 in 2021 as reported to the Robert Koch Institute [5].



10 Tables

Table S1. Aggregated data set used for analyses. The units of observation are formed by all 160 combinations of calendar week in 2021 (1 to 20), sex (female, male), and age group (15-34, 35-59, 60-79, 80+ years) [6].

Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
1	f	15-34	445412	1	0.00	0	0.00	765	2946	0.26	0	151	0.00
1	f	35-59	709015	2	0.00	0	0.00	1022	2946	0.35	3	151	0.02
1	f	60-79	475567	0	0.00	0	0.00	424	2946	0.14	30	151	0.20
1	f	80+	173095	1	0.00	0	0.00	579	2946	0.20	118	151	0.78
1	m	15-34	482066	0	0.00	0	0.00	728	2373	0.31	0	134	0.00
1	m	35-59	709197	1	0.00	0	0.00	843	2373	0.36	3	134	0.02
1	m	60-79	438976	0	0.00	0	0.00	401	2373	0.17	49	134	0.37
1	m	80+	108937	0	0.00	0	0.00	252	2373	0.11	82	134	0.61
2	f	15-34	445412	36	0.01	0	0.00	598	2403	0.25	1	133	0.01
2	f	35-59	709015	156	0.02	0	0.00	796	2403	0.33	3	133	0.02
2	f	60-79	475567	86	0.02	0	0.00	358	2403	0.15	14	133	0.11
2	f	80+	173095	233	0.13	0	0.00	530	2403	0.22	115	133	0.86
2	m	15-34	482066	32	0.01	0	0.00	617	2078	0.30	0	122	0.00
2	m	35-59	709197	47	0.01	0	0.00	718	2078	0.35	6	122	0.05
2	m	60-79	438976	52	0.01	0	0.00	389	2078	0.19	36	122	0.30
2	m	80+	108937	62	0.06	0	0.00	221	2078	0.11	80	122	0.66
3	f	15-34	445412	299	0.07	1	0.00	528	2326	0.23	1	120	0.01
3	f	35-59	709015	925	0.13	2	0.00	807	2326	0.35	1	120	0.01
3	f	60-79	475567	521	0.11	0	0.00	380	2326	0.16	23	120	0.19
3	f	80+	173095	1254	0.72	1	0.00	493	2326	0.21	95	120	0.79
3	m	15-34	482066	165	0.03	0	0.00	507	1867	0.27	0	87	0.00
3	m	35-59	709197	305	0.04	1	0.00	705	1867	0.38	3	87	0.03
3	m	60-79	438976	322	0.07	0	0.00	329	1867	0.18	26	87	0.30
3	m	80+	108937	377	0.35	0	0.00	203	1867	0.11	58	87	0.67
4	f	15-34	445412	1757	0.39	36	0.01	413	1719	0.24	0	62	0.00
4	f	35-59	709015	3969	0.56	156	0.02	613	1719	0.36	2	62	0.03
4	f	60-79	475567	1417	0.30	86	0.02	272	1719	0.16	13	62	0.21
4	f	80+	173095	4390	2.54	233	0.13	302	1719	0.18	47	62	0.76

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Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
4	m	15-34	482066	987	0.20	32	0.01	454	1495	0.30	0	52	0.00
4	m	35-59	709197	1834	0.26	47	0.01	533	1495	0.36	3	52	0.06
4	m	60-79	438976	928	0.21	52	0.01	267	1495	0.18	19	52	0.37
4	m	80+	108937	2771	2.54	62	0.06	128	1495	0.09	30	52	0.58
5	f	15-34	445412	3995	0.90	299	0.07	317	1311	0.24	0	29	0.00
5	f	35-59	709015	9187	1.30	925	0.13	472	1311	0.36	0	29	0.00
5	f	60-79	475567	3468	0.73	521	0.11	205	1311	0.16	4	29	0.14
5	f	80+	173095	17089	9.87	1254	0.72	220	1311	0.17	25	29	0.86
5	m	15-34	482066	2239	0.46	165	0.03	374	1223	0.31	0	37	0.00
5	m	35-59	709197	4049	0.57	305	0.04	447	1223	0.37	0	37	0.00
5	m	60-79	438976	2206	0.50	322	0.07	204	1223	0.17	13	37	0.35
5	m	80+	108937	11840	10.87	377	0.35	79	1223	0.06	24	37	0.65
6	f	15-34	445412	6879	1.54	1757	0.39	278	1026	0.27	0	24	0.00
6	f	35-59	709015	16765	2.36	3969	0.56	390	1026	0.38	0	24	0.00
6	f	60-79	475567	6290	1.32	1417	0.30	163	1026	0.16	8	24	0.33
6	f	80+	173095	32917	19.02	4390	2.54	101	1026	0.10	16	24	0.67
6	m	15-34	482066	3769	0.78	987	0.20	352	1065	0.33	0	24	0.00
6	m	35-59	709197	6830	0.96	1834	0.26	369	1065	0.35	1	24	0.04
6	m	60-79	438976	3886	0.89	928	0.21	178	1065	0.17	7	24	0.29
6	m	80+	108937	22297	20.47	2771	2.54	70	1065	0.07	16	24	0.67
7	f	15-34	445412	8636	1.94	3995	0.90	336	1089	0.31	0	16	0.00
7	f	35-59	709015	22172	3.13	9187	1.30	379	1089	0.35	0	16	0.00
7	f	60-79	475567	8851	1.86	3468	0.73	161	1089	0.15	4	16	0.25
7	f	80+	173095	42493	24.55	17089	9.87	77	1089	0.07	12	16	0.75
7	m	15-34	482066	4648	0.96	2239	0.46	332	1108	0.30	0	14	0.00
7	m	35-59	709197	8705	1.23	4049	0.57	448	1108	0.40	1	14	0.07
7	m	60-79	438976	5460	1.24	2206	0.50	156	1108	0.14	7	14	0.50
7	m	80+	108937	27677	25.41	11840	10.87	30	1108	0.03	6	14	0.43
8	f	15-34	445412	9443	2.12	6879	1.54	297	1049	0.28	0	20	0.00
8	f	35-59	709015	24599	3.47	16765	2.36	403	1049	0.38	0	20	0.00
8	f	60-79	475567	10130	2.13	6290	1.32	149	1049	0.14	5	20	0.25
8	f	80+	173095	45679	26.39	32917	19.02	57	1049	0.05	15	20	0.75

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Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
8	m	15-34	482066	5058	1.05	3769	0.78	332	1017	0.33	0	14	0.00
8	m	35-59	709197	9452	1.33	6830	0.96	367	1017	0.36	2	14	0.14
8	m	60-79	438976	6261	1.43	3886	0.89	137	1017	0.13	7	14	0.50
8	m	80+	108937	28933	26.56	22297	20.47	36	1017	0.04	5	14	0.36
9	f	15-34	445412	9729	2.18	8636	1.94	279	984	0.28	0	12	0.00
9	f	35-59	709015	25329	3.57	22172	3.13	393	984	0.40	1	12	0.08
9	f	60-79	475567	10488	2.21	8851	1.86	130	984	0.13	5	12	0.42
9	f	80+	173095	46493	26.86	42493	24.55	49	984	0.05	6	12	0.50
9	m	15-34	482066	5199	1.08	4648	0.96	340	1139	0.30	0	18	0.00
9	m	35-59	709197	9714	1.37	8705	1.23	455	1139	0.40	2	18	0.11
9	m	60-79	438976	6489	1.48	5460	1.24	142	1139	0.12	6	18	0.33
9	m	80+	108937	29244	26.84	27677	25.41	34	1139	0.03	10	18	0.56
10	f	15-34	445412	9980	2.24	9443	2.12	405	1376	0.29	0	28	0.00
10	f	35-59	709015	25721	3.63	24599	3.47	498	1376	0.36	3	28	0.11
10	f	60-79	475567	10593	2.23	10130	2.13	190	1376	0.14	10	28	0.36
10	f	80+	173095	46861	27.07	45679	26.39	87	1376	0.06	15	28	0.54
10	m	15-34	482066	5311	1.10	5058	1.05	420	1454	0.29	0	22	0.00
10	m	35-59	709197	9910	1.40	9452	1.33	555	1454	0.38	4	22	0.18
10	m	60-79	438976	6579	1.50	6261	1.43	202	1454	0.14	7	22	0.32
10	m	80+	108937	29480	27.06	28933	26.56	40	1454	0.03	11	22	0.50
11	f	15-34	445412	10331	2.32	9729	2.18	524	1863	0.28	0	17	0.00
11	f	35-59	709015	26850	3.79	25329	3.57	688	1863	0.37	2	17	0.12
11	f	60-79	475567	10941	2.30	10488	2.21	248	1863	0.13	5	17	0.29
11	f	80+	173095	52449	30.30	46493	26.86	87	1863	0.05	10	17	0.59
11	m	15-34	482066	5439	1.13	5199	1.08	551	1820	0.30	0	29	0.00
11	m	35-59	709197	10234	1.44	9714	1.37	684	1820	0.38	4	29	0.14
11	m	60-79	438976	6811	1.55	6489	1.48	217	1820	0.12	11	29	0.38
11	m	80+	108937	33699	30.93	29244	26.84	57	1820	0.03	14	29	0.48
12	f	15-34	445412	10503	2.36	9980	2.24	669	2354	0.28	1	23	0.04
12	f	35-59	709015	27472	3.87	25721	3.63	888	2354	0.38	0	23	0.00
12	f	60-79	475567	11400	2.40	10593	2.23	296	2354	0.13	6	23	0.26
12	f	80+	173095	57724	33.35	46861	27.07	100	2354	0.04	16	23	0.70

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Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
12	m	15-34	482066	5513	1.14	5311	1.10	720	2418	0.30	0	28	0.00
12	m	35-59	709197	10446	1.47	9910	1.40	924	2418	0.38	6	28	0.21
12	m	60-79	438976	7291	1.66	6579	1.50	301	2418	0.12	7	28	0.25
12	m	80+	108937	37519	34.44	29480	27.06	59	2418	0.02	15	28	0.54
13	f	15-34	445412	10642	2.39	10331	2.32	670	2150	0.31	0	31	0.00
13	f	35-59	709015	27938	3.94	26850	3.79	803	2150	0.37	1	31	0.03
13	f	60-79	475567	11771	2.48	10941	2.30	263	2150	0.12	6	31	0.19
13	f	80+	173095	68853	39.78	52449	30.30	84	2150	0.04	24	31	0.77
13	m	15-34	482066	5599	1.16	5439	1.13	725	2319	0.31	0	27	0.00
13	m	35-59	709197	10606	1.50	10234	1.44	902	2319	0.39	3	27	0.11
13	m	60-79	438976	7563	1.72	6811	1.55	314	2319	0.14	9	27	0.33
13	m	80+	108937	45770	42.02	33699	30.93	62	2319	0.03	15	27	0.56
14	f	15-34	445412	10964	2.46	10503	2.36	785	2502	0.31	0	22	0.00
14	f	35-59	709015	28804	4.06	27472	3.87	908	2502	0.36	3	22	0.14
14	f	60-79	475567	12573	2.64	11400	2.40	343	2502	0.14	6	22	0.27
14	f	80+	173095	80729	46.64	57724	33.35	81	2502	0.03	13	22	0.59
14	m	15-34	482066	5753	1.19	5513	1.14	857	2619	0.33	2	38	0.05
14	m	35-59	709197	10926	1.54	10446	1.47	930	2619	0.36	6	38	0.16
14	m	60-79	438976	8138	1.85	7291	1.66	360	2619	0.14	14	38	0.37
14	m	80+	108937	53994	49.56	37519	34.44	53	2619	0.02	16	38	0.42
15	f	15-34	445412	12808	2.88	10642	2.39	927	3073	0.30	1	29	0.03
15	f	35-59	709015	33941	4.79	27938	3.94	1123	3073	0.37	4	29	0.14
15	f	60-79	475567	17866	3.76	11771	2.48	355	3073	0.12	10	29	0.34
15	f	80+	173095	93354	53.93	68853	39.78	106	3073	0.03	14	29	0.48
15	m	15-34	482066	6808	1.41	5599	1.16	985	3085	0.32	0	36	0.00
15	m	35-59	709197	13774	1.94	10606	1.50	1118	3085	0.36	5	36	0.14
15	m	60-79	438976	12586	2.87	7563	1.72	361	3085	0.12	17	36	0.47
15	m	80+	108937	62691	57.55	45770	42.02	74	3085	0.02	14	36	0.39
16	f	15-34	445412	15525	3.49	10964	2.46	865	2806	0.31	0	22	0.00
16	f	35-59	709015	41687	5.88	28804	4.06	1020	2806	0.36	0	22	0.00
16	f	60-79	475567	21538	4.53	12573	2.64	301	2806	0.11	4	22	0.18
16	f	80+	173095	104925	60.62	80729	46.64	86	2806	0.03	18	22	0.82

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Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
16	m	15-34	482066	8165	1.69	5753	1.19	933	3115	0.30	0	31	0.00
16	m	35-59	709197	16888	2.38	10926	1.54	1147	3115	0.37	6	31	0.19
16	m	60-79	438976	15553	3.54	8138	1.85	370	3115	0.12	16	31	0.52
16	m	80+	108937	70408	64.63	53994	49.56	55	3115	0.02	9	31	0.29
17	f	15-34	445412	20232	4.54	12808	2.88	716	2299	0.31	0	18	0.00
17	f	35-59	709015	54730	7.72	33941	4.79	849	2299	0.37	3	18	0.17
17	f	60-79	475567	29890	6.29	17866	3.76	270	2299	0.12	5	18	0.28
17	f	80+	173095	118209	68.29	93354	53.93	59	2299	0.03	10	18	0.56
17	m	15-34	482066	10536	2.19	6808	1.41	809	2489	0.33	0	23	0.00
17	m	35-59	709197	23029	3.25	13774	1.94	903	2489	0.36	4	23	0.17
17	m	60-79	438976	22086	5.03	12586	2.87	308	2489	0.12	13	23	0.57
17	m	80+	108937	79178	72.68	62691	57.55	41	2489	0.02	6	23	0.26
18	f	15-34	445412	28538	6.41	15525	3.49	531	1818	0.29	0	18	0.00
18	f	35-59	709015	76998	10.86	41687	5.88	661	1818	0.36	2	18	0.11
18	f	60-79	475567	46764	9.83	21538	4.53	211	1818	0.12	8	18	0.44
18	f	80+	173095	127425	73.62	104925	60.62	50	1818	0.03	8	18	0.44
18	m	15-34	482066	14185	2.94	8165	1.69	649	1959	0.33	1	19	0.05
18	m	35-59	709197	32358	4.56	16888	2.38	702	1959	0.36	2	19	0.11
18	m	60-79	438976	35993	8.20	15553	3.54	214	1959	0.11	13	19	0.68
18	m	80+	108937	85438	78.43	70408	64.63	37	1959	0.02	3	19	0.16
19	f	15-34	445412	35578	7.99	20232	4.54	426	1358	0.31	0	5	0.00
19	f	35-59	709015	97268	13.72	54730	7.72	486	1358	0.36	1	5	0.20
19	f	60-79	475567	56194	11.82	29890	6.29	125	1358	0.09	3	5	0.60
19	f	80+	173095	129398	74.76	118209	68.29	29	1358	0.02	1	5	0.20
19	m	15-34	482066	17323	3.59	10536	2.19	451	1411	0.32	0	8	0.00
19	m	35-59	709197	40253	5.68	23029	3.25	504	1411	0.36	0	8	0.00
19	m	60-79	438976	43315	9.87	22086	5.03	145	1411	0.10	2	8	0.25
19	m	80+	108937	86723	79.61	79178	72.68	16	1411	0.01	6	8	0.75
20	f	15-34	445412	40794	9.16	28538	6.41	285	924	0.31	0	5	0.00
20	f	35-59	709015	109656	15.47	76998	10.86	293	924	0.32	0	5	0.00
20	f	60-79	475567	76124	16.01	46764	9.83	89	924	0.10	4	5	0.80
20	f	80+	173095	130003	75.11	127425	73.62	15	924	0.02	1	5	0.20

(continued)

Week	Sex	Age	Population	Vaccinated	Vaccinated Percent	Vaccinated Lag 14	Vaccinated Lag 14 Percent	SARS-CoV-2 Incidence	SARS-CoV-2 Incidence all	SARS-CoV-2 Incidence share	COVID-19 Fatality	COVID-19 Fatality all	COVID-19 Fatality share
20	m	15-34	482066	20859	4.33	14185	2.94	313	961	0.33	0	6	0.00
20	m	35-59	709197	48893	6.89	32358	4.56	349	961	0.36	2	6	0.33
20	m	60-79	438976	60940	13.88	35993	8.20	94	961	0.10	4	6	0.67
20	m	80+	108937	87051	79.91	85438	78.43	8	961	0.01	0	6	0.00

Table S2. Non-pharmaceutical interventions in Rhineland-Palatinate, Germany, from calendar week 1 to 20 in 2021 [1]. X: Intervention enacted.

	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
Secondary schools - No restrictions																			X	X
Secondary schools - Restricted opening with hygiene regulations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Secondary schools - Different days/weeks per class/group										X	X	X	X	X	X	X	X	X	X	X
Secondary schools - Only certain age groups									X	X	X	X	X	X	X	X	X	X	X	X
Secondary schools - Only emergency mode for kids from certain parent groups	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Elementary school - Fully open with hygiene regulations	X	X	X	X	X	X	X	X												
Elementary school - Restricted opening with hygiene regulations									X	X	X	X	X	X	X	X	X	X	X	X
Elementary school - Different days/weeks per class/group										X	X	X	X	X	X	X	X	X	X	X
Elementary school - Only emergency mode for kids from certain parent groups										X	X	X	X	X	X	X	X	X	X	X
Masks required in secondary school classrooms	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Masks required in elementary school classrooms										X	X	X	X	X	X	X	X	X	X	X
Masks required outside in elementary schools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

(continued)

	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
Culture and education institutions - Museums open with conditions																			X	X
Culture and education institutions - Fully closed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Masks required on public transport	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Masks required in shops	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Masks required in public spaces	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Indoor public events - Fully forbidden	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Outdoor public events - Fully forbidden	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Contact and gathering restrictions in private spaces - Recommendation to avoid social contact	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Contact and gathering restrictions in private spaces - Max 5 people, except same household / close family																		X	X	
Contact and gathering restrictions in private spaces - Only people from 2 households, except close family									X	X										
Contact and gathering restrictions in public spaces – Recommendation to avoid social contact		X	X	X	X	X	X	X										X	X	X
Gastronomy - Restricted opening with hygiene regulations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gastronomy - Only outside dining																		X	X	X
Gastronomy - Only delivery and pick-up	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Small and large shops - Restricted opening with hygiene regulations	X	X	X	X	X	X	X	X												
Small and large shops - Only critical provisions		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Small and large shops - Critical provisions including bookstores and flower shops	X																			
Services and Trades - Fully open with hygiene regulations																			X	X
Services and Trades - Restricted opening with hygiene regulations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

(continued)

	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
Services and Trades - Only services with avoidable customer contact and health/care services	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Services and Trades - Only by appointment									X											
Services and Trades - Entry resrtictions related to testing										X										
Social distancing - Introduction of social distancing rules	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Testing - Required for system-relevant professions									X	X	X	X	X	X	X	X	X	X	X	X

Table S3. COVID-19 vaccination prioritization policy in Rhineland-Palatinate, Germany, from calendar week 1 to 20 in 2021. X: Eligible for vaccination.

Priority	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
Priority group I - Age group 80+, nursing home residents, health care workers with very high risk of exposure	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Priority group II - Persons in certain occupational groups, with underlying medical conditions, in need of care, with contact to vulnerable persons, health care workers with high risk of exposure								X	X	X	X	X	X	X	X	X	X	X	X	X
Age group 70-79										X	X	X	X	X	X	X	X	X	X	X
Age group 60-69														X	X	X	X	X	X	X
Priority group III - Secondary school teachers, grocery store workers, workers in critical infrastructure																X	X	X	X	X

Table S4. Absolute frequency (percentage) of vaccines used for the first shot from calendar week 1 to 20 in 2021 in Rhineland-Palatinate, Germany. NA: Not Available.

Age group	NA	BNT15b2	mRNA1273	Vaxzevria	Janssen
15-34	36 (0.0)	76633 (57.6)	21116 (15.9)	35172 (26.4)	175 (0.1)
35-59	66 (0.0)	194602 (59.7)	47116 (14.5)	84032 (25.8)	129 (0.0)
60-79	89 (0.0)	179766 (52.4)	28766 (8.4)	134234 (39.1)	22 (0.0)
80+	17 (0.0)	214456 (95.6)	7192 (3.2)	2775 (1.2)	1 (0.0)

Table S5. Absolute frequency (percentage) of vaccines used for the second shot from calendar week 1 to 20 in 2021 in Rhineland-Palatinate, Germany.

Age group	BNT15b2	mRNA1273	Vaxzevria
15-34	46057 (57.6)	6499 (15.9)	5856 (26.4)
35-59	117301 (59.7)	16164 (14.5)	19455 (25.8)
60-79	116933 (52.4)	11140 (8.4)	7632 (39.1)
80+	210023 (95.6)	6539 (3.2)	31 (1.2)

Table S6. Adjusted odds ratios (OR), 95% confidence intervals (CI) and p-values (p) from the multivariable logistic regression model for the sex-specific proportion of all-cause mortality formed by each age group.

Variable	OR	CI	p
Sex male	1.003	[0.876, 1.147]	0.97
Age 15-34	0.004	[0.003, 0.006]	0.00
Age 35-59	0.052	[0.041, 0.066]	0.00
Age 60-79	0.292	[0.226, 0.378]	0.00
Proportion vaccinated	0.996	[0.991, 1.001]	0.16

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