SUPPLEMENTARY MATERIAL

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Fighting a pandemic: sociodemographic disparities and coronavirus disease-2019 vaccination gaps. A population study

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SUPPLEMENTARY TABLES

Table S1: Characteristics of pre-vaccination COVID-19 cases excluded from the study population compared to the general population

	Pre-vaccination cases		General population	
Characteristic	**N**	**(%)**	**N**	**(%)**
Men	140 427	(49.7)	3 318 418	(48.9)
Age, years				
15-19	40 833	(14.4)	742 528	(11.0)
20-24	40 479	(14.3)	674 039	(9.9)
25-34	55 422	(19.6)	1 263 569	(18.6)
35-44	44 476	(15.7)	1 198 852	(17.7)
45-54	40 561	(14.3)	984 829	(14.5)
55-59	15 911	(5.6)	412 122	(6.1)
60-64	13 581	(4.8)	390 600	(5.8)
65-74	18 462	(6.5)	674 953	(10.0)
≥75	13 134	(4.6)	437 892	(6.5)
Population group				
Arabs	65 511	(23.2)	1 237 095	(18.2)
Orthodox Jews	7 737	(2.7)	199 064	(2.9)
Ultra-orthodox Jews	71 851	(25.4)	538 017	(7.9)
Other*	137 760	(48.7)	4 805 208	(70.9)
SES rank				
1-3	90 133	(32.1)	1 304 534	(20.0)
4-5	97 769	(34.8)	1 953 809	(30.0)
6-7	69 861	(24.8)	2 181 175	(33.5)
8-10	23 449	(8.3)	1 075 421	(16.5)
Periphery				
Very peripheral	20375	(7.2)	650 746	(9.6)
Peripheral	84247	(29.8)	1 990 177	(29.4)
Central	62343	(22.0)	1 382 096	(20.4)
Very central	115880	(41.0)	2 751 380	(40.6)

SES denotes socioeconomic status.. * Other population group mostly comprising non-orthodox Jews

Table S2: Distribution of age groups by socio-demographic characteristics among 6 478 999 individuals age 15 and older

			Interquartile range	
		Median	**25%**	**75%**
Population group [a]	Arabs	30-34	20-24	45-49
	Orthodox	35-39	20-24	50-54
	Ultra-Orthodox	30-34	20-24	45-49
	Other	40-44	25-29	60-64
SES class	1-3	30-34	20-24	45-49
	4-5	40-44	25-29	55-59
	6-7	40-44	25-29	60-64
	8-10	40-44	30-34	60-64
Persons/household area mean	0-2.0	35-39	30-34	55-59
	2.1-6.0	40-44	25-29	55-59
	6.1-10.0	25-29	20-24	40-44
Locality population	<2000	40-44	25-29	55-59
	2000-99 900	35-39	25-29	55-59
	100 000-499 900	40-44	25-29	60-64
	≥500 000	35-39	20-24	50-54
Population density population/km^2	<746	40-44	25-29	55-59
	746-3064	35-39	25-29	50-54
	3064-11 137	40-44	25-29	55-59
	> 11 137	40-44	25-29	55-59
Periphery	Very central	40-44	25-29	55-59
	Central	40-44	25-29	55-59
	Peripheral	35-39	25-29	55-59
	Very peripheral	35-39	20-24	50-54

SES denotes socioeconomic status. $P< 0.0001$ for all. [a] Other population group mostly comprising non-orthodox Jews

Table S3: Unadjusted cumulative vaccination incidence*

Characteristic		Cumulative incidence (%)
Sex	Men	73.9
	Women	73.6
Age	15-19	43.7
	20-24	66.7
	25-34	64.5
	35-44	69.5
	45-54	81.4
	55-59	83.8
	60-64	89.3
	65-74	95.0
	≥75	95.8
Population group	Arabs	64.8
	Orthodox Jews	78.1
	Ultra-orthodox Jews	54.2
	Other	78.0
SES class	1-3	61.0
	4-5	74.2
	6-7	82.4
	8-10	86.7
Locality population	<2,000	81.3
	2000-99 900	73.3
	100 000-499 900	75.4
	≥500 ,000	54.1
Population density population/km^2	<746	79.9
	746-3064	76.7
	3064-11 137	76.6
	> 11 137	75.6
Periphery	Very central	73.5
	Central	75.6
	Peripheral	74.3
	Very peripheral	69.2

* Cumulative incidence at the end of follow-up accounting for the competing COVID-19 infections.
SES-socioeconomic class

Table S4: Multivariable adjusted cause-specific vaccination hazard ratio among 6 478 999 individuals age 15 and older

Characteristic (reference value)		**HR**	**(95% CI)**
Men (Women)		1.06	(1.045-1.075)
Age (20-24)	15-19	0.52	(0.501-0.537)
	25-34	0.93	(0.909-0.955)
	35-44	1.08	(1.048-1.107)
	45-54	1.51	(1.472-1.549)
	55-59	1.71	(1.668-1.755)
	60-64	2.18	(2.120-2.240)
	65-74	3.10	(3.005-3.190)
	≥75	3.22	(3.119-3.322)
Population group (Other)	Arabs	0.96	(0.936-0.983)
	Orthodox Jews	0.95	(0.899-0.997)
	Ultra-orthodox Jews	0.70	(0.681-0.725)
SES class (1-3)	4-5	1.24	(1.215-1.275)
	6-7	1.67	(1.628-1.718)
	8-10	2.05	(1.981-2.116)
Locality population (<2,000)	2000-99 900	0.84	(0.821-0.867)
	100 000-499 900	0.80	(0.771-0.822)
	≥500 ,000	0.75	(0.723-0.787)
Population density population/km^2 (<746)	746-3064	1.02	(0.989-1.043)
	3064-11 137	1.00	(0.972-1.039)
	> 11 137	0.95	(0.918-0.988)
Periphery (Central)	Very central	1.03	(1.012-1.058)
	Peripheral	1.07	(1.049-1.095)
	Very peripheral	1.00	(0.968-1.025)
Past SARS-CoV-2 Infection rates [a] % (<0.011)	0.011-0.383	1.50	(1.448-1.549)
	> 0.383	1.71	(1.658-1.768)

CI denotes confidence interval, HR-hazard ratio, SES-socioeconomic class. P<0.0001 for all. [a] Past SARS=CoV-2 infection rate tertiles.

SUPPLEMENTARY FIGURES

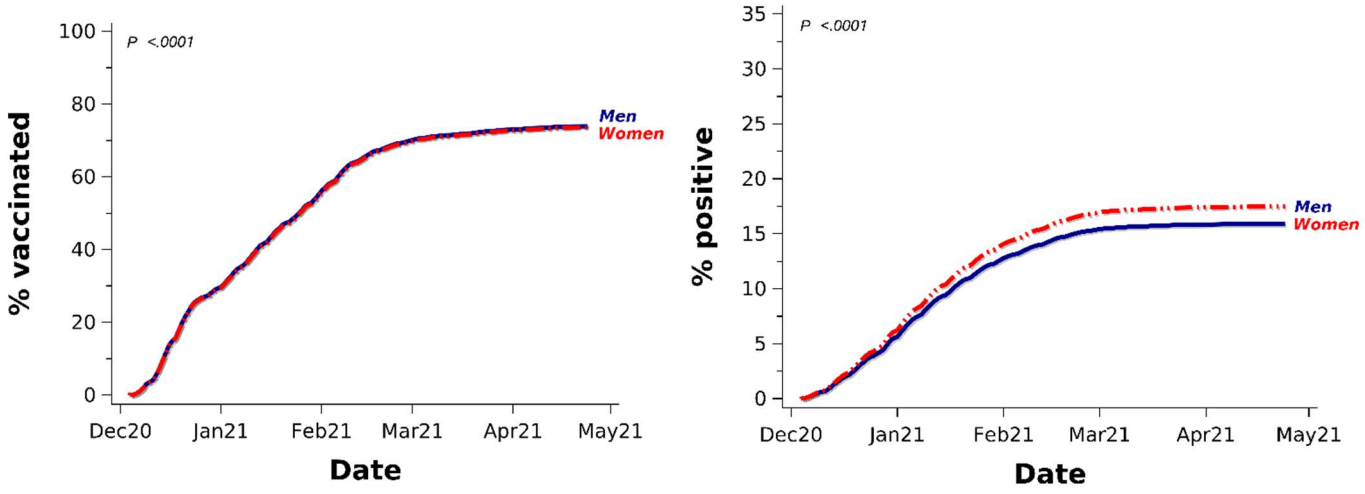

Figure S1: Cumulative vaccination incidence (left panel) and competing SARS-CoV-2 infection rates (right panel) by sex, among 6 478 999 Israeli residents, age 15 or above

Percent (%) of vaccinated refer to cumulative incidence /100 accounting for the competing COVID-19 infection risk. % positive refers to cumulative SARS-CoV-2 infection rate/100 based on Kaplan-Meir infection-free survival.

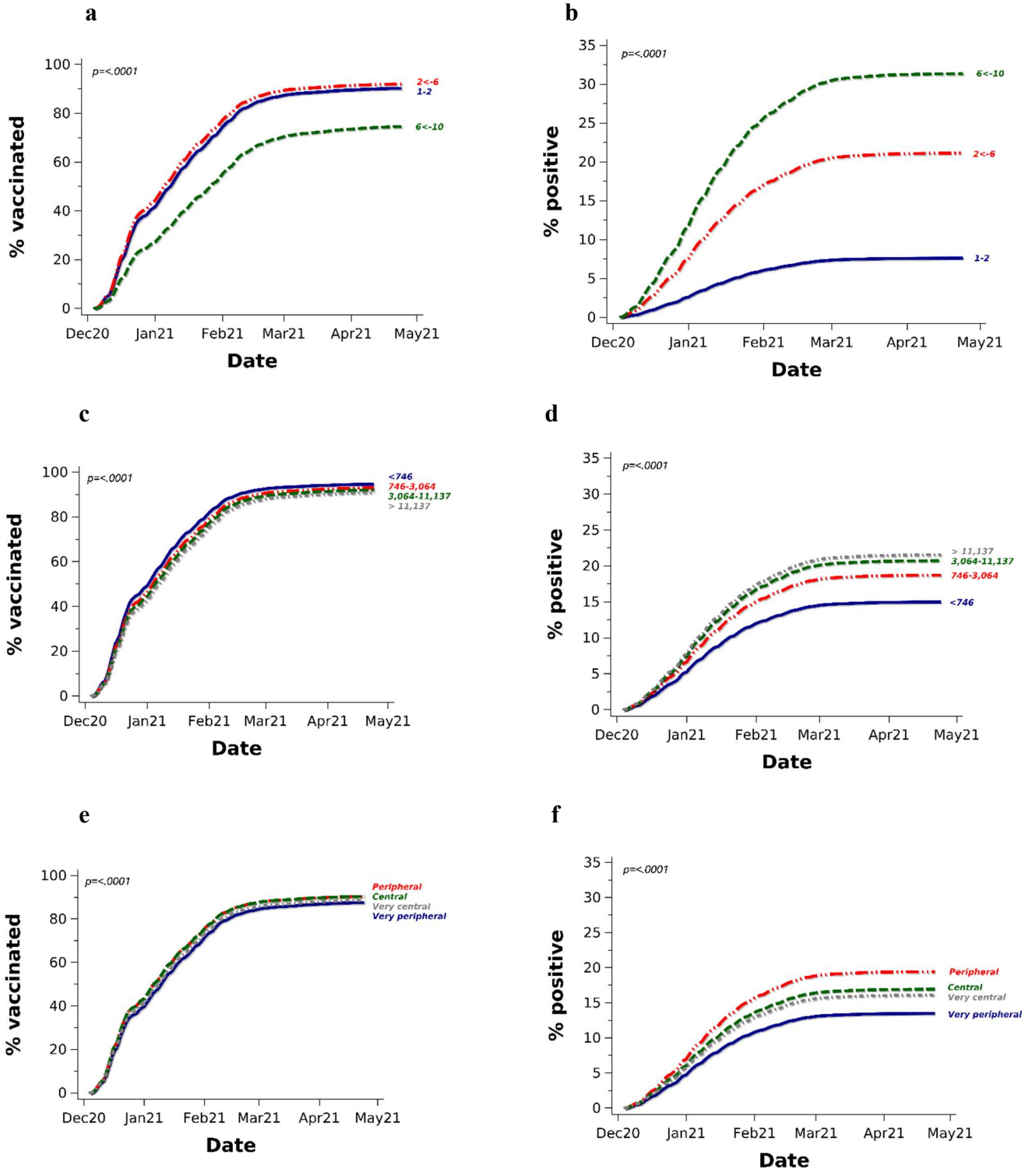

Figure S2: Age adjusted cumulative vaccination incidence and age adjusted competing SARS-CoV-2 infection rates by: mean number of household members (a,b); area population/km^2 (c,d); and periphery (e,f).

Percent (%) of vaccinated refer to cumulative incidence /100 accounting for the competing COVID-19 infection risk. % positive refers to cumulative SARS-CoV-2 infection rate/100 based on Kaplan-Meir infection-free survival. Results are presented for the 60-64 age slice for comparability.

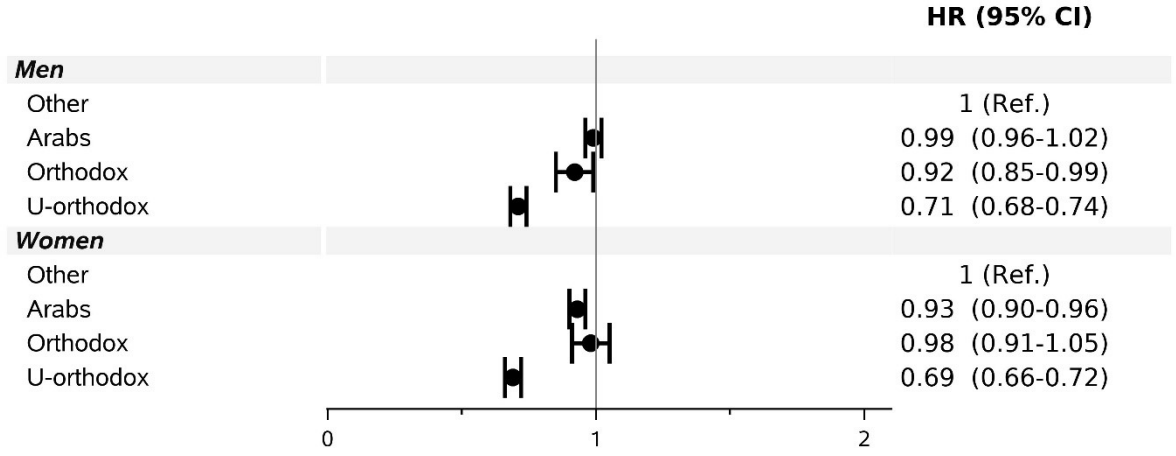

Figure S3: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under sex and population group interaction

Ref. denotes reference. *P* for interaction =0.005

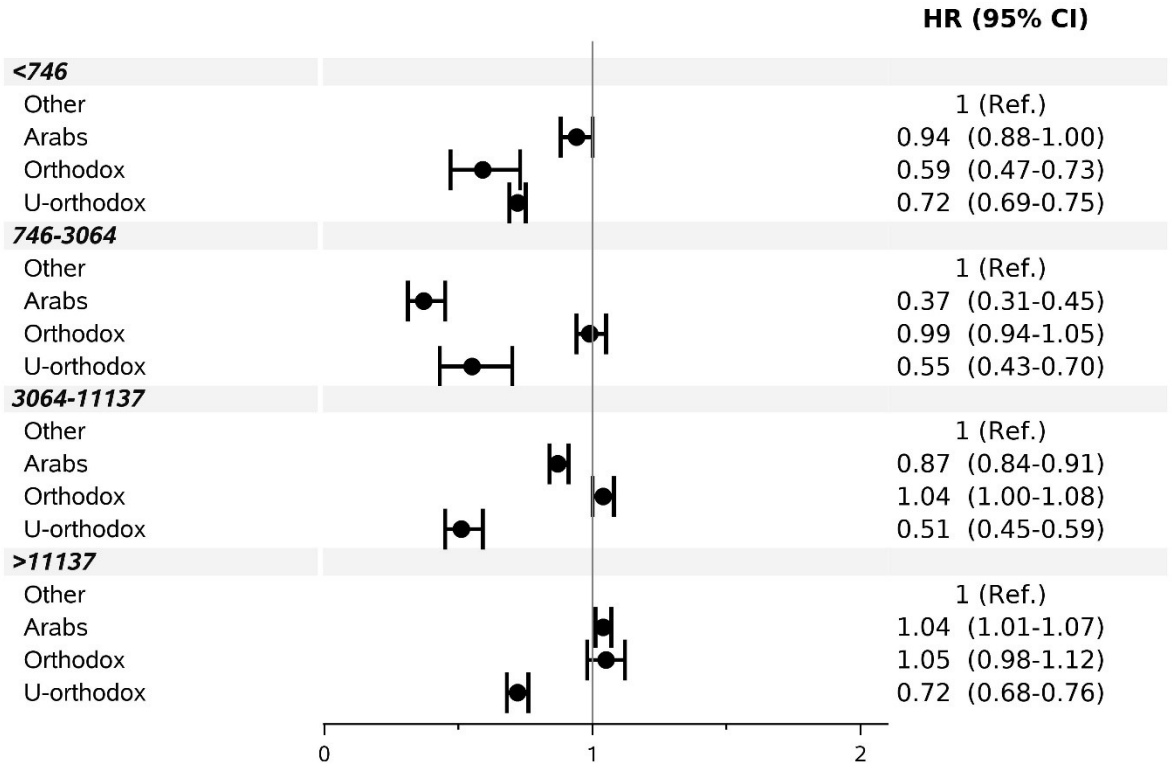

Figure S4: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under area population density (population/km^2) and population group interaction

Ref. denotes reference. *P* for interaction <0.0001

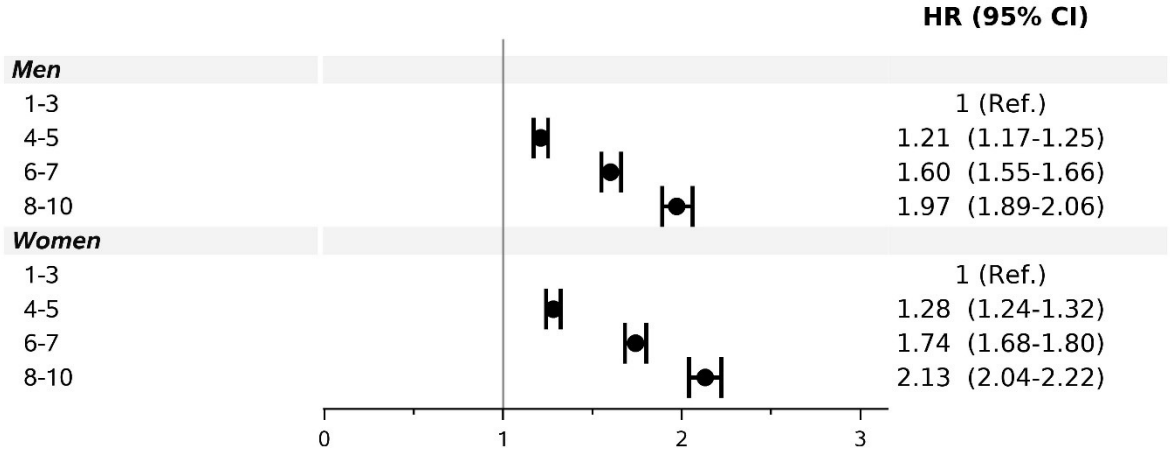

Figure S5: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under sex and socioeconomic status group interaction

Ref. denotes reference. *P* for interaction=0.002

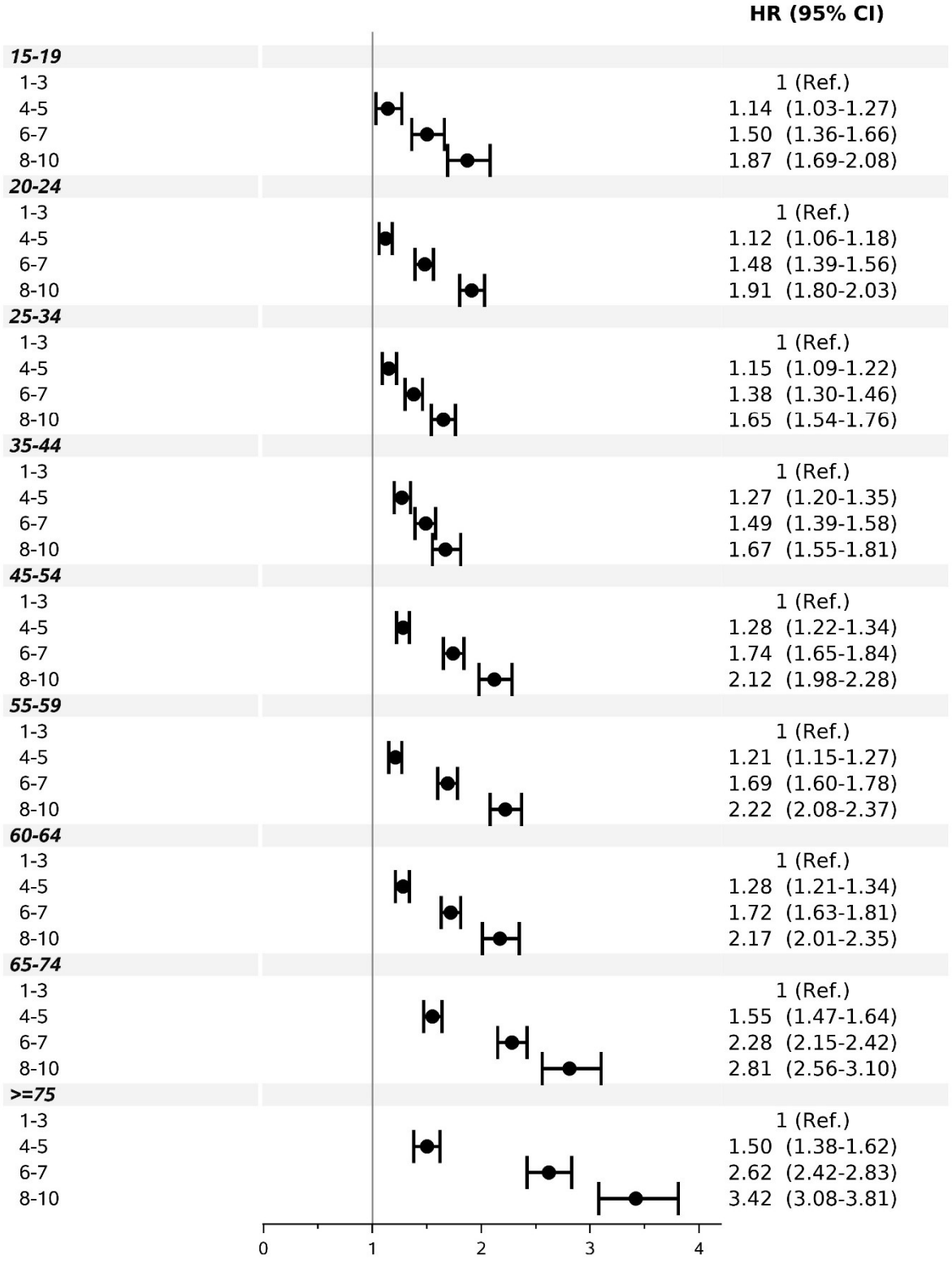

Figure S6: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under age and socioeconomic rank interaction

Ref. denotes reference. *P* for interaction <0.0001

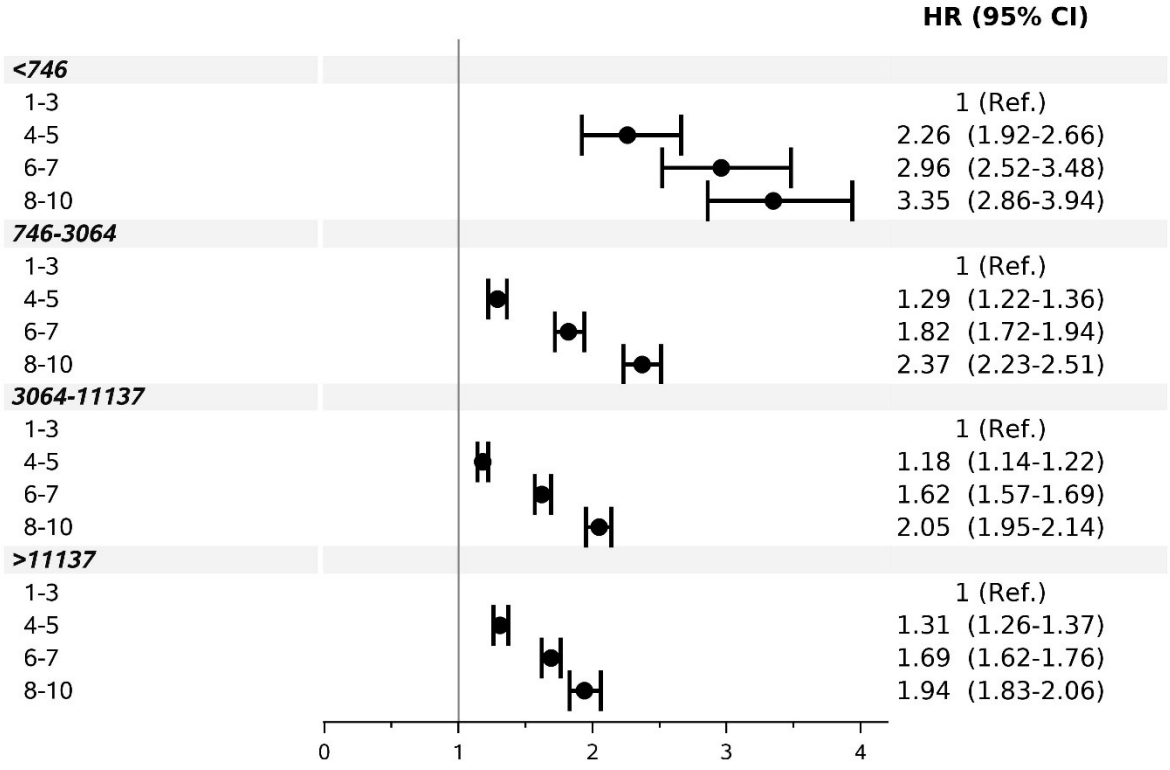

Figure S7: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under area population density (population/km^2) and socioeconomic status group interaction

Ref. denotes reference. *P*<0.0001

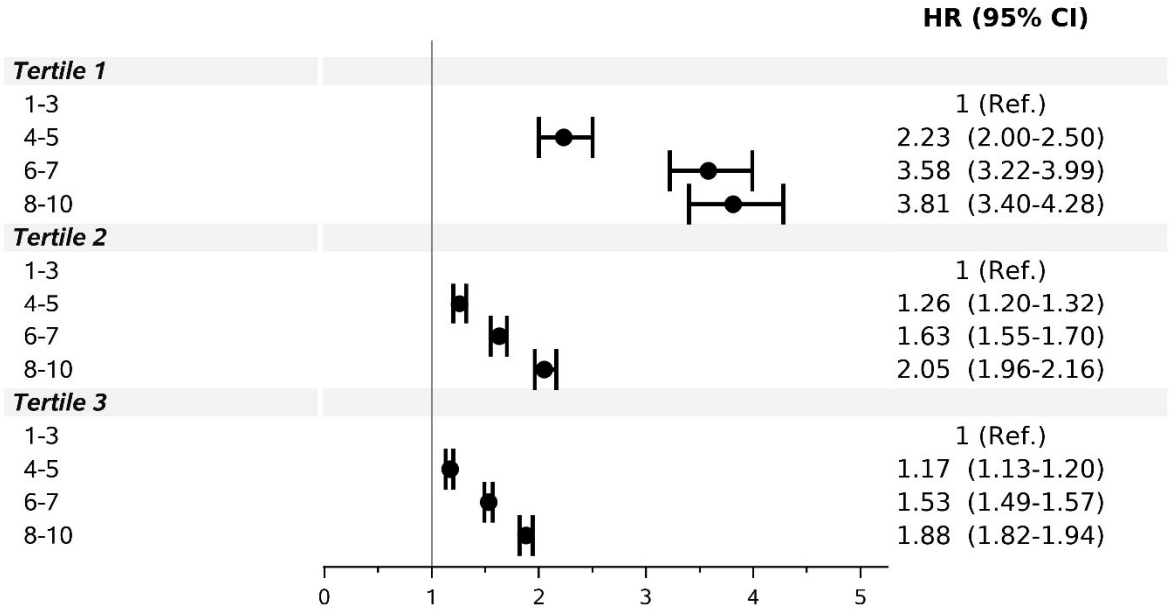

Figure S8: Multivariable adjusted hazard ratio (HR) and 95% confidence interval (CI) under pre-vaccine infection rate tertile and socioeconomic rank interaction

Ref. denotes reference. *P* for interaction <0.0001

METHOD DETAILS

Classification of population group

A number of data sources were used for the identification of the predominant population group in each geo-spatial units (referred to as "area" hereafter).

1. The share of each population group in each area categorized by POINTS as: none (<10%), low (10-20%), intermediate (20-15%), high (50-70%) or very high (>70%).
2. The percent of Arab and Jewish population in the area, reported by the Israeli Bureau of Statistics (ICBS)
3. The percent of Arab and Jewish population in localities, reported by ICBS
4. The percent of ultra-orthodox Jews in localities with ultra-orthodox population reported by Regev et al [1]

Based on these sourced, we identified the predominant population in each area. Following classification the median percent of Arabs in area labeled as "Arab" was 98% (interquartile range:79.5-99.6%), 75% of the areas identified as "Ultra-Orthodox Jewish" had very high (>70%) ultra-orthodox population and 81% of the areas identified as "orthodox Jewish" had very high orthodox population rate.

[1] Regev E.Gordon G. The ultra-orthodox housing Market, and geographical distribution of the ultra-orthodox population in Israel. The Israel Democracy Institute. 2020 The Israel Democracy Institution policy paper 150. In Hebrew

Data augmentation

To reduce the dimension of the big data and reduce computation time data was rearranged and augmented as follows:

- Data were stratified by area, sex, and age-group
- Within each stratum, we created a record for each time point (date) in which vaccination occurred and summarized the number of individual vaccinated on the day and the number of new COVID-19 cases detected up to that day since last date with vaccinations.

- The summary data was then augmented to create a separate record for each event type (1=vaccination, 2=competing infection) with the number of individuals with the event type as weight. Another record was added for censoring at the end of follow-up (event type=0) with the number of individual still at risk (area population in stratum minus the number of individual who were vaccinated, detected as COVID-19 case or died up to censoring) as weight.

The results of a model based on the resulting weighted data is identical to those obtained from a model based on individual level data.

Test of the PH assumption

The proportional hazard assumption was tested based on weighted Schoenfeld residuals in cause-specific models. The correlations and tests of the hypothesis of zero correlation with time rank are listed below:

Characteristic (reference category)		**Correlation**	***P***
Men (Women)		-0.0263	<.0001
Age (20-24)	15-19	-0.0169	<.0001
	25-34	-0.00464	<.0001
	35-44	-0.0577	<.0001
	45-54	-0.1005	<.0001
	55-59	-0.1276	<.0001
	60-64	-0.1949	<.0001
	65-74	-0.2467	<.0001
	≥75	-0.2235	<.0001
Population group (other)	Arabs	0.0576	<.0001
	Orthodox	-0.0117	<.0001
	Ultra orthodox	-0.0346	<.0001
SES class (1-3)	4-5	-0.0253	<.0001
	6-7	-0.0562	<.0001
	8-10	-0.0725	<.0001
Locality population (<2,000)	2000-99 900	-0.00585	<.0001
	100 000-499 900	-0.00214	<.0001
	≥500 000	-0.0131	<.0001
Population density population/km^2 (<746)	746-3064	-0.00417	<.0001
	3064-11 137	0.000094	0.8375
	> 11 137	0.00200	<.0001
Periphery (Central)	Very central	-0.0191	<.0001
	Peripheral	0.0100	<.0001
	Very peripheral	-0.0316	<.0001
Past SARS-CoV-2 Infection rates [a] % (<0.011)	0.011-0.383	0.0912	<.0001
	> 0.383	0.1230	<.0001