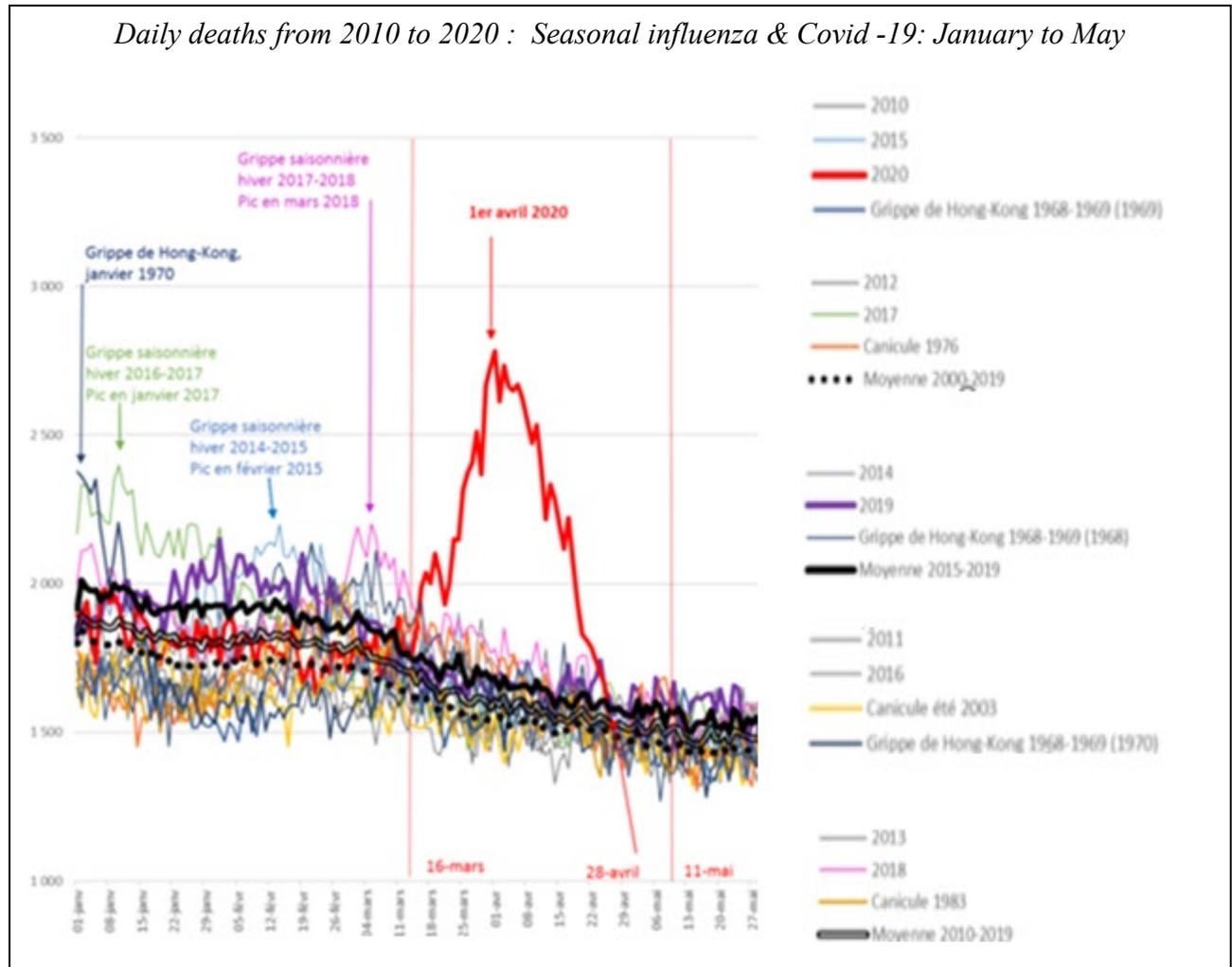


# Annex France Covid-19 analysis

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## Seasonality of influenza and Covid-19 first months profile



In mainland France, the 2018-19 season started early-January, peaked early February and lasted 8 weeks, ending at the end of February. The epidemic was characterized by the co-circulation of A(H3N2) and A(H1N1)pdm09 viruses, with almost no detection of type B viruses. Its impact was moderate in the community, but high numbers of hospitalizations (>10 700) and severe cases admitted to IUC (>1800) were recorded for influenza-like illness. During the epidemic, excess mortality was observed, with about 8 100 deaths attributed to influenza.

The corona virus toll is considered for the period starting March 1<sup>st</sup>, thus after the end of the 2018-19 influenza epidemic. However, for SARS-cov2 a delay of 22 days is observed between

infections and deaths, if we consider the same for influenza, it might have been some interference in 2020 between the seasonal influenza<sup>1</sup> and SARS-cov2. The deaths of the first two weeks of March might include deaths linked to H1N1 or H3N2. The deaths cases registered in the 20 first days of March are related to contaminations during the second half of february. One may observe on the time profile for France as a whole that the excess of deaths is larger for these weeks than the official count.

**Official figures published on the INED web-site by June 4<sup>th</sup> 2020**

INED	France entière		
	Total cumulated incidence	cumulate incidence in hospital	Cumulateed incidence in EHPAD & EMS
21/03/2020		562	
22/03/2020		674	
23/03/2020		860	
24/03/2020		1100	
25/03/2020		1388	
26/03/2020		1695	
27/03/2020		1994	
28/03/2020		2314	
29/03/2020		2606	
30/03/2020		3024	
31/03/2020		3523	
01/04/2020		4032	
02/04/2020		4503	
03/04/2020		5091	
04/04/2020		5532	
05/04/2020		5889	
06/04/2020		6494	
07/04/2020	10328	7091	3237
08/04/2020	10869	7632	3237
09/04/2020	12210	8044	4166
10/04/2020	13197	8598	4599
11/04/2020	13832	8943	4889
12/04/2020	14393	9253	5140
13/04/2020	14967	9588	5379
14/04/2020	15729	10129	5600
15/04/2020	17167	10643	6524

<sup>1</sup> For 2018-19 the excess of death due to dseasonnal influenza is estimated at 8100. But the influenza epidémic is located between December and March

16/04/2020	17920	11060	6860
17/04/2020	18681	11478	7203
18/04/2020	19323	11842	7481
19/04/2020	19718	12069	7649
20/04/2020	20265	12513	7752
21/04/2020	20796	12900	7896
22/04/2020	21340	13236	8104
23/04/2020	21856	13547	8309
24/04/2020	22245	13852	8393
25/04/2020	22614	14050	8564
26/04/2020	22856	14202	8654
27/04/2020	23293	14497	8796
28/04/2020	23660	14810	8850
29/04/2020	24087	15053	9034
30/04/2020	24376	15244	9132
01/05/2020	24594	15369	9225
02/05/2020	24760	15487	9273
03/05/2020	24895	15583	9312
04/05/2020	25201	15826	9375
05/05/2020	25531	16060	9471
06/05/2020	25809	16237	9572
07/05/2020	25987	16386	9601
08/05/2020	26230	16497	9733
09/05/2020	26310	16573	9737
10/05/2020	26380	16642	9738
11/05/2020	26643	16820	9823
12/05/2020	26991	17003	9988
13/05/2020	27074	17101	9973
14/05/2020	27425	17224	10201
15/05/2020	27529	17342	10187
16/05/2020	27625	17412	10213
17/05/2020	28108	17466	10642
18/05/2020	28239	17589	10650
19/05/2020	28022	17714	10308*
20/05/2020	28132	17812	10320
21/05/2020	28215	17870	10345
22/05/2020	**	17944	**
23/05/2020	**	17987	**
24/05/2020	**	18022	**
25/05/2020	**	18112	**
26/05/2020	28530	18195	10335
27/05/2020	***	18260	***
28/05/2020	***	18326	***

29/05/2020	***	18387	***
30/05/2020	***	18444	***
31/05/2020	***	18475	***
01/06/2020	***	18506	***
02/06/2020	28940	18590	10350

### Death and residence places

The ARS Ile de France using data not publicly released has made computations of the percentag of people dying outside their departement of residence. But if we consider the percentages of people who died not in their departement of residence as provided by INSEE it is likely that it does not affect seriously the results of anaysis. Among the highest percentages figure both poor and rich vdépartements as Seine St Denis and Hauts de Seine.

*Percentages of people whose death took place in another ddépartements than their residence département*

Vald'Oise	12.7	Seine ét marne	15.0	Hauts de Seine	17.1
Essonne	14.3	Val de Marne	14.5	Paris	12.5
Yvelines	17.3	Seine St Denis	22.1		

Source : Insee 2020 and ARS.

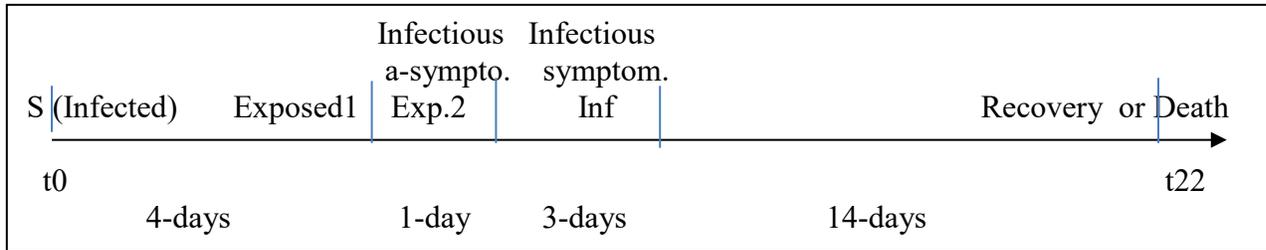
While the percentage of people in the Paris region for which département of death does not coincide with départerment of résidence, the distributions of the deaths given in the anonymized files and in the nominative files are very high as can be seen on the table below.

dep numb er	Deaths registered in nominative files				Deaths registered in non- nominative files			
	2017 dc	2018 dc	2019 dc	2020 dc	2017 ano	2018 ano	2019 ano	2020 ano
1	343	377	347	468	343	458	407	528
2	395	520	454	672	640	550	483	705
3	375	432	401	410	375	435	390	409
4	122	186	145	177	122	203	189	182
5	125	136	120	112	125	129	112	104
6	969	997	973	1038	969	968	910	1035
7	296	313	309	398	296	353	352	428
8	214	225	221	249	214	249	242	283
9	132	153	139	134	132	164	162	134
10	271	287	264	326	271	302	271	357
11	324	401	326	400	324	430	351	415
12	285	297	255	302	285	310	275	323
13	1530	1687	1622	1547	1530	1571	1530	1819
14	606	750	655	649	606	674	595	602
15	168	201	180	151	168	206	183	153
16	348	374	379	368	348	384	385	386
17	593	665	625	666	593	693	656	704
18	254	308	298	356	254	346	326	378
19	258	315	262	272	258	304	262	263
20	245	257	255	289	0	275	262	285
21	438	517	449	618	438	447	397	537
22	529	643	588	611	529	699	626	646
23	139	150	140	151	139	173	164	168
24	405	431	416	384	405	496	498	474
25	358	447	368	530	358	465	402	595
26	386	442	434	463	386	437	468	492
27	364	385	358	449	364	501	488	541
28	347	336	313	450	347	370	354	459
29	883	951	843	859	883	936	831	847
30	528	641	598	603	528	677	632	683
31	903	959	865	948	903	830	773	846
32	177	196	197	194	177	228	221	226
33	1164	1262	1280	1246	1164	1135	1136	1109
34	881	983	968	1065	881	927	888	995
35	766	878	737	806	766	820	675	713
36	256	244	230	332	256	251	245	335
37	478	547	528	544	478	514	500	506
38	715	757	792	872	715	807	819	898
39	161	214	222	252	161	260	249	266
40	315	399	308	358	315	445	358	398
41	286	319	337	349	286	362	364	390
42	638	681	678	831	638	626	650	786
43	167	194	181	186	167	239	214	203

dep numb er	Deaths registered in				Deaths registered in non-			
	2017 dc	2018 dc	2019 dc	2020 dc	2017 ano	2018 ano	2019 ano	2020 ano
44	927	1069	1065	1135	927	1014	1019	1091
45	486	550	545	579	486	543	534	578
46	145	190	169	186	145	227	184	204
47	331	347	319	340	331	378	329	365
48	83	89	77	74	83	95	93	76
49	624	698	647	732	624	675	614	691
50	433	556	435	510	433	606	452	526
51	475	535	476	679	475	495	437	613
52	164	177	151	226	164	196	170	246
53	229	274	247	260	229	297	271	284
54	562	693	589	775	562	635	519	766
55	148	168	193	204	148	189	204	218
56	673	818	699	768	673	802	726	767
57	806	954	822	1366	806	960	842	1367
58	240	270	217	277	240	278	237	296
59	1793	2194	1942	2250	1793	2112	1873	2218
60	487	557	497	799	487	623	561	947
61	224	284	277	291	224	316	311	309
62	1113	1318	1218	1393	1113	1391	1268	1435
63	576	626	534	550	576	603	519	551
64	605	665	607	614	605	632	588	574
65	207	230	257	259	207	226	239	264
66	469	526	521	522	469	518	520	528
67	779	882	858	1285	779	877	844	1263
68	533	625	598	1241	533	606	584	1293
69	1203	1294	1259	1673	1203	1143	1112	1535
70	175	202	192	274	175	248	244	318
71	482	563	540	611	482	606	562	626
72	510	574	472	550	510	569	476	543
73	265	353	324	394	265	343	310	365
74	468	507	520	635	468	464	490	610
75	1439	1525	1534	2530	1439	1130	1157	2166
76	1008	1202	1053	1214	1008	1142	973	1151
77	645	739	649	1165	645	815	751	1267
78	649	714	707	1156	649	791	774	1319
79	290	348	269	357	290	377	298	385
80	506	581	517	631	506	542	496	608
81	328	395	374	352	328	430	398	381
82	236	221	228	216	236	229	232	228
83	833	898	916	975	833	964	986	1077
84	528	451	531	482	528	426	475	484
85	548	618	564	610	548	676	591	642
86	380	474	408	419	380	421	359	383
87	381	412	385	363	381	359	341	325
88	367	400	302	554	367	425	335	611
89	314	361	345	370	314	371	357	400
90	178	225	205	278	178	130	107	179
91	631	647	556	1083	631	708	632	1172
92	833	837	795	1674	833	783	733	1565
93	595	677	638	1430	595	779	740	1760
94	718	817	786	1514	718	731	690	1422
95	608	612	639	1194	608	639	650	1284
<b>Correlations nominatives non nominatives</b>					<b>0,994</b>	<b>0,986</b>	<b>0,986</b>	<b>0,986</b>

### Delay infection to death

To estimate more accurately the epidemic burden, models have been devised by epidemiologists. The classical compartmental models initiated in the late 1920s by Kermack & McKendrick called



SIR or SEIR are among the mostly used because they follow the progression of the disease from the infection to death through stages or compartments corresponding to specific state starting with a fully susceptible population, a fraction is exposed, a fraction of exposed to the virus, there is an incubation period during most of which the person infected is not shedding the virus, followed by an infectious stage which could be mild or severe, leading to hospitalization, sometime admission in an ICU (intensive care unit), then recovery or death. Relying on Salje & al. 2020 (preprint Pasteur -02548181), we may draw the following time chart. Salje & al. 2020 have computed case fatality rates (CFR) by age classes for twelve regions of France (metropolitan areas excluding over-sea and Corsica) before the effective lockdown date (March 19<sup>th</sup>) from which we could infer infectious cases and epidemic dynamic up to March 19<sup>th</sup>.

$$D_{i,t}^a = CFR^a \times I_{i,t-22}^a.$$

### Death ratios by département and ethnicity

Men: deaths ratio March-April 2020/ March-April 2017-19

département of death	France	Afrique centrale et australe	Afrique sahélo-saharienne	Maghreb	DOM & Haïti	Europe	Asie du Sud et Sud-est
Aisne	1,46	2,00		2,65	3,00	1,17	1,50
Moselle	1,53	5,00	0,00	2,25	4,00	1,77	1,50
Oise	1,48	2,10	0,60	3,00	3,00	2,17	1,00
Bas-Rhin	1,50	10,50	4,50	1,72	0,30	1,87	2,14
Haut-Rhin	2,08	1,80	12,00	2,62	4,50	2,04	4,50
Paris	1,50	2,86	3,40	2,46	2,18	1,51	2,10
Seine-et-Marne	1,63	7,17	4,09	1,80	1,30	1,55	2,43
Yvelines	1,63	3,32	3,64	2,16	2,00	1,17	4,36
Essonne	1,61	4,13	8,00	2,60	3,63	1,63	2,29
Hauts-de-Seine	1,92	4,89	3,29	2,56	2,93	1,56	3,86
Seine-Saint-Denis	2,02	5,49	3,45	2,48	4,86	1,72	2,43
Val-de-Marne	1,77	4,09	2,92	3,00	2,68	1,40	2,47
Val-d'Oise	1,55	9,55	4,13	3,34	3,30	1,77	3,19

Source : author's computation. The 13 départements are those where 2020 deaths are larger than two standard deviations, and in which the number of deaths for the whole period is at least 200.

### Women: deaths ratio March-April 2020/ March-April 2017-19

département of death	France	Afrique centrale et australe	Afrique sahélienne	Maghreb	DOM & Haïti	Europe	Asie du Sud et Sud-est
Aisne	1,44	1,00	0,00	1,13	0,60	1,17	1,00
Moselle	1,46	3,00	3,00	1,80	0,00	1,53	1,50
Oise	1,49	2,50	0,00	1,87	1,50	1,39	1,71
Bas-Rhin	1,62	1,20		2,90	1,50	1,52	0,75
Haut-Rhin	2,16	1,80		3,00	0,00	1,83	
Paris	1,59	3,36	3,95	1,74	2,13	1,67	2,27
Seine-et-Marne	1,56	2,55	3,00	1,93	1,56	1,87	1,50
Yvelines	1,58	1,91	1,85	1,86	1,65	1,60	2,45
Essonne	1,65	4,50	4,50	2,16	2,42	2,18	1,57
Hauts-de-Seine	1,95	2,25	0,86	2,13	3,08	2,27	1,96
Seine-Saint-Denis	1,92	3,00	2,06	2,46	2,56	2,10	3,96
Val-de-Marne	1,66	2,93	7,00	1,88	1,77	1,83	2,57
Val-d'Oise	1,73	4,76	1,64	2,14	3,72	1,81	3,45

Source : author's computation. The 13 départements are those where 2020 deaths are larger than two standard deviations, and in which the number of deaths for the whole period is at least 200

*Percentages of people whose death took place in another ddépartements than their residence département*

Vald'Oise	12.7	Seine ét marne	15.0	Hauts de Seine	17.1
Essonne	14.3	Val de Marne	14.5	Paris	12.5
Yvelines	17.3	Seine St Denis	22.1		

Source Insee 2020 and ARS.

### **Computation of the standard deviation of the mean to illustrate the deviation from the base line in 2020.**

For each department is computed the amount of variability (the square root of the variance of the phenomenon "nb of deaths in a département" noted  $x_i$  and  $n$  the sample size.<sup>2</sup>

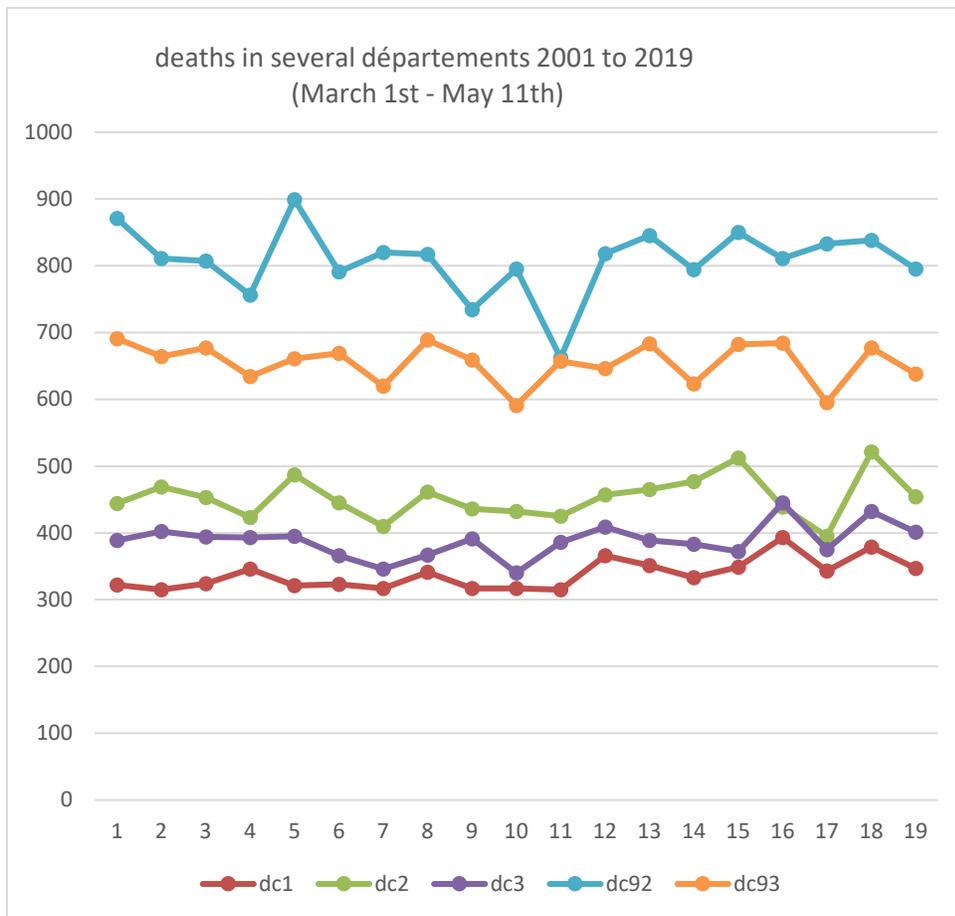
$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

I consider the number of deaths for years 2001 to 2019 as a sample. Each year is a measure of the same phenomenon across a sample of 19 years. As an illustration on the graph below the variations across the years 2001-2019 of death in several départements.

<sup>2</sup>The standard error of the mean would have been :

$$\text{standard error } (\sigma_{\bar{x}}) = \frac{\sigma}{\sqrt{n}}$$





Dep: Ain, Aisne, Allier , Hauts de Seine, et Seine St Denis.

## Ethnicity : Demography place of birth and deaths

<b>Men: Deaths in March - April 2020 vs mean deaths March- April 2017-19</b>							
département of death	France	Afrique centrale et australe	Afrique sahélienne	Maghreb	DOM & Haïti	Europe	Asie du Sud et Sud-est
Aisne	198	1	2	9	2	3	0
Moselle	395	4	-1	32	3	59	0
Oise	226	4	-1	24	5	23	0
Bas-Rhin	376	6	2	15	-2	34	3
Haut-Rhin	544	1	4	30	5	48	2
Paris	516	65	60	233	33	58	22
Seine-et-Marne	346	47	11	25	2	29	10
Yvelines	358	15	12	47	7	7	12
Essonne	308	25	14	48	21	29	7
Hauts-de-Seine	579	35	16	114	27	29	13
Seine-Saint-Denis	414	61	43	117	54	46	22
Val-de-Marne	430	45	24	111	31	28	22
Val-d'Oise	260	63	17	97	31	36	23
France métropolitaine	<b>8688</b>	<b>409</b>	<b>210</b>	<b>1257</b>	<b>247</b>	<b>707</b>	<b>159</b>
<b>Women: Deaths in March - April 2020 vs mean deaths March- April 2017-19</b>							
département of death	France	Afrique centrale et australe	Afrique sahélienne	Maghreb	DOM & Haïti	Europe	Asie du Sud et Sud-est
Aisne	194	0	0	1	-1	3	0
Moselle	353	1	1	12	0	61	1
Oise	241	3	-1	9	1	9	2
Bas-Rhin	471	0	3	20	1	23	3
Haut-Rhin	595	1	1	18	0	41	4
Paris	614	46	19	99	31	68	5
Seine-et-Marne	340	10	3	18	5	39	6
Yvelines	360	3	4	25	4	27	7
Essonne	378	16	2	32	12	47	8
Hauts-de-Seine	685	12	0	65	28	71	9
Seine-Saint-Denis	437	23	6	84	25	66	10
Val-de-Marne	421	26	12	49	17	50	11
Val-d'Oise	376	21	2	42	26	34	12
France métropolitaine	<b>9325</b>	<b>203</b>	<b>56</b>	<b>733</b>	<b>151</b>	<b>1050</b>	<b>115</b>
Source author's computation.							

*Départements of Ile de France*

	Population Ile de France 2015	% of people according birth place living in in Ile de France	% of people by birth place who died between 2010-2019	Excess of deaths according to place of birth during Covid 19	Ratio geographical origin to France metro birth
	11898049				
France metro	9115182	76,6	77,5		
Europe_ 27 south-east (Portugal excluded)		1,5	3,5		
Portugal		2,1	1,9		
Europe_27 north-east		1,9	2,2		
*Europe_27		5,5			
Algeria		3,4	3,6		
Morocco		2,3	1,9		
Tunisia		1,2	1,8		
*Maghreb		6,9	7,3		
Central & Sub-equatorial Africa			1,3		
Sahel			0,6		
*Black Africa		4,3	2,0		
Dom-Tom		1,7	1,4		
Asia_(China excluded)			0,7		
Other regions of the world		4,3	3,3		

In an average département, people born in Africa who died represent 0.5% of the deceased population, i.e. for an average department about 6,500, thus  $6,500 \times 0.005$  means 32 people by year and around 5 people on the two months period considered.

*Size and population of main residences according to type of housing (individual vs collectif)*

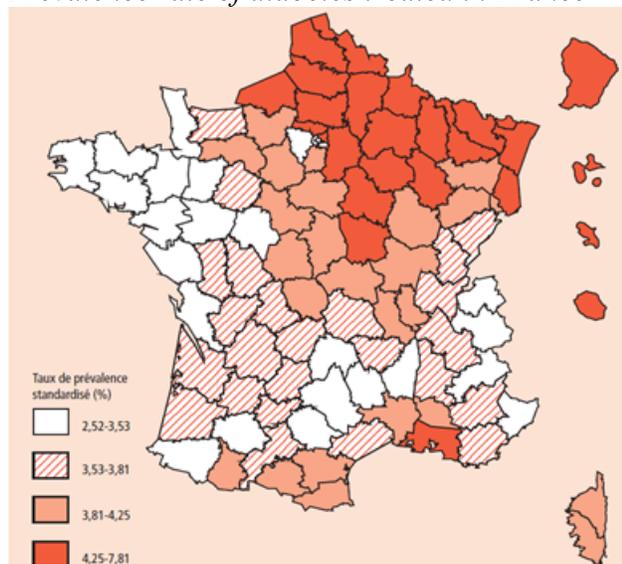
Indicateurs de taille et d'occupation des résidences principales, selon le type d'habitat			
	France métropolitaine	Zus	UUE Zus*
<b>Surface moyenne en mètres carrés par logement</b>	<b>90,9</b>	<b>69,5</b>	<b>80,6</b>
Individuel	112,3	93,4	110,8
Collectif	63,0	65,8	61,9
<b>Nombre moyen de pièces par logement</b>	<b>4,0</b>	<b>3,4</b>	<b>3,6</b>
Individuel	4,9	4,5	4,9
Collectif	2,9	3,2	2,8
<b>Nombre moyen de personnes par logement</b>	<b>2,3</b>	<b>2,4</b>	<b>2,1</b>
Individuel	2,5	2,7	2,6
Collectif	1,9	2,4	1,9

E Zus: Autres quartiers des unités urbaines environnantes.  
 rce: Enquête nationale Logement 2013, Insee.  
 mp: France métropolitaine, résidences principales.

## Health conditions

The variables used classify by age-groups and sex, are provided by the same source provided : DREES. The rate of recourses (/1000) to short term hospital sojourns (séjour court MCO Médecine Chirurgie obstétrique). The BEH published by the same DREES has also given a départemental map of the general prevalence rate of treated diabetes, which cover more widely the importance of this pathology.

*Prevalence rate of diabetes treated in France*



Source: BEH n° 43 / 12 novembre 2008

To these illnesses, the Health direction adds recours for obesity in the same frame. The prevalence of obesity as reflected in the per 100,000 recourse rates increases with age until about 45-50 years of age and then declines. Thus, the départements that are most affected by obesity are, all other things being equal, those in which the population in intermediate age-strata between youth and seniority are relatively large. We have selected (ist below) those in which the 25-54 age-group exceeds 50% of the population. We find in this list many of the départements with the highest number of deaths due to SARS-cov2 (official statistics).

In the regressions presented in the text, we have used besides the obesity rates for youth under 14 years, the diabetes prevalences and the ratio between standard rates and brut rates. The significance of this last variable indicates the contribution of diabetes among relatively young persons to this early mortality – observed typically in départements of Ile de France.

*Diabetes prevalence and deaths excesses 2020 vs 2017-19:  
Twenty départements sorted by ratio of standardized rates/brut rates*

	Diabetes standardised /brut rates	deaths 2020/ deaths 2017-19
Marne	1,04	1,37
Ille-et-Vilaine	1,05	1,02
Haute-Savoie	1,05	1,27
Pas-de-Calais	1,05	1,15
Bas-Rhin	1,05	1,53
Moselle	1,07	1,59
Territoire de Belfort	1,07	1,37
Hauts-de-Seine	1,07	2,04
Loire-Atlantique	1,08	1,11
Paris	1,08	1,69
Mayenne	1,08	1,04
Ain	1,09	1,32
Nord	1,11	1,14
Haute-Garonne	1,11	1,04
Oise	1,12	1,56
Val-d'Oise	1,14	1,93
Essonne	1,14	1,77
Yvelines	1,18	1,68
Seine-et-Marne	1,19	1,72
Seine-Saint-Denis	1,19	2,25

## Regressions supplement

### Men's death excess 2020 vs 2017-19 (R20\_1789)

Source	SS	df	MS	Number of obs	=	180
Model	16.1161622	5	3.22323244	F(5, 174)	=	162.20
Residual	3.45777327	174	.01987226	Prob > F	=	0.0000
				R-squared	=	0.8233
				Adj R-squared	=	0.8183
Total	19.5739354	179	.109351595	Root MSE	=	.14097

r20_1789	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
txpauvre_2016	-.0237099	.0038964	-6.09	0.000	-.0314002 -.0160195
pctne_afrn	.1171011	.0134146	8.73	0.000	.0906248 .1435775
ppopmen4papp	.0162944	.0023806	6.84	0.000	.011596 .0209929
diabetb_8	1.956756	.1689318	11.58	0.000	1.623337 2.290175
obesh14	.1475477	.0229404	6.43	0.000	.1022704 .192825
_cons	.3344639	.0669695	4.99	0.000	.2022867 .466641

**Women's death excess 2020 vs 2017-19 (R20\_1789)**

Source	SS	df	MS	Number of obs	=	180
Model	13.8224072	6	2.30373453	F(6, 173)	=	130.93
Residual	3.0438814	173	.01759469	Prob > F	=	0.0000
				R-squared	=	0.8195
				Adj R-squared	=	0.8133
Total	16.8662886	179	.094225076	Root MSE	=	.13264

r20_1789	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
pctne_afrn	.0817905	.0126605	6.46	0.000	.0568017 .1067794
txpauvre_2016	-.0203401	.0037654	-5.40	0.000	-.0277723 -.012908
ppopmen4papp	.0192935	.0022376	8.62	0.000	.0148769 .0237101
diabetb_8	2.000529	.1713654	11.67	0.000	1.662292 2.338765
obesf34	-.0412692	.0107535	-3.84	0.000	-.0624942 -.0200443
obesf14	.0961808	.0127166	7.56	0.000	.0710812 .1212805
_cons	.4308507	.0629984	6.84	0.000	.3065063 .5551951