Weak or No Correlation Between Recent COVID-19 Data and Vaccination Rates in France

Mohamed Bouanane (mhamadib@gmail.com)
Independent https://orcid.org/0000-0003-2786-2682

Research Article

Keywords: COVID-19, SARS-CoV-2, Immunity, Correlation, Vaccine Coverage, Vaccine Efficacy, Linear Regression

Posted Date: November 2nd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-1028704/v1

Weak or No Correlation Between Recent COVID-19 Data and Vaccination Rates in France

Mohamed BOUANANE[1]

Abstract

Since August 9, the "health pass" became mandatory in France and applies to many economic sectors and social activities such as commercial catering, trade fairs and exhibitions, healthcare services and medical-social centres, public long-distance transport, and some stores and shopping malls. In addition, since September 30, 2021, the "health pass" has been made compulsory for minors aged 12 and two months to 17 years old. The aim is to better control the spread of the Sars-Cov-2 virus by forcing the entire population to be vaccinated in order to reduce the effects of the epidemic.

Since vaccination is currently the only pursued strategy to fight against COVID-19 in the world, we were interested in verifying the explanation often put forward to justify the improvement (due to high vaccination rate) or the recrudescence (due to low vaccination percentage) of the health situation linked to COVID-19. At the same time, several developed countries have launched the injection of a third dose of vaccines following a substantial increase in COVID-19 cases.

In this regard, we have studied the correlation between the levels of vaccination coverage (percentage of the vaccinated population) and the various epidemiological variables of COVID-19 in the 101 French departments (territories) during the month of September 2021.

The findings of the study indicate no significant relationship between vaccination rates and COVID-19 data.

Keywords: COVID-19, SARS-CoV-2, Immunity, Correlation, Vaccine Coverage, Vaccine Efficacy, Linear Regression

[1] Management Consulting Director, Toulouse – France. No funding was received for this study. The author has no competing interest.

Methodology

The epidemiological data[2] used in this study are published by Santé France and made available as of October 4th and 5th 2021. We have calculated the hospitalisation (tx_hosp), ICU admissions (tx_rea) and daily mortality ratios (tx_dchosp or tx_dc[3]) per 100 thousand people for each territory. COVID-19 incidence ratios (tx_incid), positivity percentages (tx_pos) and reproduction ratio (R_0) are provided by Santé France.

The correlation or statistical relationship between these variables and the levels of vaccination (D1 for Dose 1 & D2 for Dose 2) is investigated through an affine relation estimated by linear regression. The Pearson's correlation coefficient "R" is then calculated as the covariance of two variables divided by the product of their standard deviations. Its sign indicates whether higher values of one variable correspond "on average" to higher or lower values for the other variable. It is +1 in the case of a perfect increasing linear association, -1 in the case of a perfect decreasing linear association. For all other cases, a value between -1 and +1, indicating the degree of linear relationship between the variables. The closer the coefficient is to -1 or +1, the higher the correlation between the variables. As it approaches zero, there is weak or no relationship. The Coefficient of Determination "R^2" represents the ratio of the variation of the Y variable that is being explained by the X variable.

The table below summarises the different correlation levels for a linear regression of the population P (sample S) defined as follows:

$$Y_P = \beta_0 + \beta_1 * x + \epsilon \qquad (1)$$

$$E(Y_S) = b_0 + b_1 * x \qquad (2)$$

Table 1: Correlation Level Based on Correlation Coefficient and Coefficient of Determination

Correlation Level	Coefficient | R |	R2 <=
No	<= 0,40	16,00%
Weak	> 0,40 & <= 0,65	42,25%
Moderate	> 0,65 & <= 0,75	56,25%
Strong	> 0,75 & <= 0,90	81,00%
Very Strong	> 0,90	100%

We define the Null Hypothesis H_0 as there is no correlation: No to Weak correlation exists between COVID-19 epidemiological dependent variables (Y-axis) and the vaccination rates (independent variables, X-axis) in France during September 2021 ($R > 0$ OR $R^2 <= 0.423$).

$$H_0: \beta_1 = 0$$

We test the Alternative Hypothesis H_a defined as: There is a moderate or strong or very strong decreasing correlation between COVID-19 epidemiological dependent variables (Y-axis) and the vaccination rates (independent variables, X-axis) in France during September 2021 ($R < 0$ AND $R^2 > 0.423$).

$$H_a: \beta_1 \neq 0$$

[2] table-indicateurs-open-data-france-2021-10-03-19h05, vacsi-fra-2021-10-04-19h09, table-indicateurs-open-data-dep-2021-10-03-19h05, vacsi-dep-2021-10-04-19h09

[3] Tx_dc is the total mortality ratio per 100k people. Tx-dchosp is the hospitalised mortality ratio excluding social-health centres.

The outcome of the test is either the rejection of the Null Hypothesis or the failure to reject H_0 at 5% level of significance.

General Results

For the whole country, Figure 1 shows a very strong decreasing relationship (R = -0.9980, $R^2 > 0.99$) between the incidence ratio (tx_incid) and the percentages of vaccination during the month of September. The incidence ratio (infection cases per 100 thousand people) decreases while the vaccination rate increases. However, the daily mortality ratio (tx_dc) plot shows weak association (R = -0.4799 vs. D2 – p-value < 0.001; R = -0.4902 vs. D1 – p-value < 0.001) with the vaccination rates (Figure 2).

France has a percentage of the population fully vaccinated between 66% and 72.4% (72.7% to 75% for first dose) in September 2021. This vaccination rate represents an average of values with strong disparities across the 101 territories, varying between 20.5% and 88.9% for the second dose (25.1% to 92% for the first dose). In fact, this wide disparity in vaccination percentages makes the analysis of the correlation biased.

Indeed, across 101 territories and during September 2021, there is a weak decreasing relationship between the vaccination percentages and the COVID-19 variables ($R^2 < 0.38$ vs. D1 – p-value = 0.000; $R^2 < 0.39$ vs. D2 – p-value = 0.000) as shown in Figures 3, 4, 7 & 8. Such that territories with a high percentage of fully vaccinated people (> 60%) experience a high COVID-19 daily incidence ratio (> 430 per 100k people). The R^2=0.384 (0.353) means that two doses (one dose) vaccination explain only 38.4% (35.28%) of the variation of the daily incidence ratio.

However, for the daily mortality rate, there is an insignificant association (R = -0.4038 vs. D1 – p-value = 0.000; R = -0.4039 vs. D2 – p-value = 0.000) with the percentage of the vaccinated population, throughout September 2021, which accounts for only R^2=16.3% for each dose (Figure 4), i.e., the variation – decrease of the daily mortality ratio can only be explained by 16% of the progression of vaccination rate.

The same analysis – weak relationship – applies to the ratios of hospitalised patients (tx_hosp) and ICU admissions (tx_rea) per 100 thousand people, shown in Figures 7 & 8, where the effect of vaccination is less than 38% and less than 32% in their decrease respectively.

For September 30, data show slightly moderate decreasing association between the vaccination percentages and the hospitalized patients ($0.44 < R^2 < 0.47$ – p-value = 0.000) according to Figure 9. Although there is weak association regarding the incidence, the daily mortality, and the ICU admissions as per Figures 5, 6 & 10 ($0.20 < R^2 < 0.36$ – p-value = 0.000).

More Findings

Comparing the most with the least vaccinated territories (62 in total), we observe opposite results. For September 30, the incidence, hospitalisation, and ICU ratios tended to increase with the vaccination percentages (Figures 11a,12a & 13a). Although, such association is insignificant ($0.01 < R^2 < 0.14$ vs. D2; $0.04 < R^2 < 0.23$ vs. D1), it shows that a relationship between the variables of the COVID-19 epidemy and the vaccination rates is unlikely to exist (p-value > 0.05).

The same applies for the daily mortality ratio (R^2 = 0.094 vs. D2 – p-value = 0.094; R^2 = 0.075 vs. D1 – p-value = 0.135) even though there is a decreasing but no significant relationship with the vaccine coverage in the 31 most vaccinated territories (Figure 14a).

The obtained results of mortality, hospitalization, and incidence ratios, shown in the below tables for the most vaccinated territories (September 30), demonstrate that they (Y dependent variable) are unrelated to the vaccination rates (X independent variable). **Such absence of impact means the null hypothesis H_0 (No correlation) cannot be rejected for those territories. For instance, p-value = 0.094 means that it is quite likely if β_1 equals zero to get a slope b_1 = -1.613 for the daily mortality ratio, since the 95% Confidence Interval [-3.52; 0.29] includes zero.**

Table 2: Analysis of Variance of Mortality, Hospitalization, and Incidence Ratios vs. One Dose Vaccine Mean Rate

Most Vaccinated vs. D1	*R^2*	*Intercept*	*Slope*	*Standard Error*	*t Statistic*	*p-value*	*Slope Lower - Upper CI 95%*	
tx_dchosp	0,075	1,160	-1,356	0,882	-1,538	0,135	-3,159	0,448
tx_hosp	0,074	-26,883	41,845	27,561	1,518	0,140	-14,525	98,214
tx_incid	0,048	-81,932	142,256	117,441	1,211	0,236	-97,937	382,449

Table 3: Analysis of Variance of Mortality, Hospitalization, and Incidence Ratios vs. Two Doses Vaccine Mean Rate

Most Vaccinated vs. D2	*R^2*	*Intercept*	*Slope*	*Standard Error*	*t Statistic*	*p-value*	*Slope Lower - Upper CI 95%*	
tx_dchosp	0,094	1,333	-1,613	0,932	-1,730	0,094	-3,520	0,294
tx_hosp	0,019	-10,677	22,778	30,289	0,752	0,458	-39,170	84,725
tx_incid	0,010	-20,474	69,457	127,910	0,543	0,591	-192,149	331,063

On the other hand, the least vaccinated territories have experienced a decreasing regression of the variables of the COVID-19 epidemic in relation to the vaccination rates. Even though such relationship is weak or moderate ($0.35 < R^2 < 0.51$ vs. D2 – p-value < 5E-04; $0.40 < R^2 < 0.59$ vs. D1 – p-value < 2E-04), it is statistically highly significant (Figures 11b, 12b, 13b & 14b).

Conclusion and Proposal

The weak or slightly moderate decreasing relationship found between the epidemiological variables of COVID-19 and the vaccination rates (D1 & D2) in France during September 2021, is due to territories with very low rate of vaccinated population (7 territories still had less than 60% of population fully vaccinated by September 30).

The above findings indicate no correlation between tested COVID-19 data and vaccine coverage for the 31 territories whose population is the most vaccinated (more than 76% fully vaccinated). The more the vaccination rate increases, the more the association with the epidemiological variables of COVID-19 weakens (p-value = 0.591 for tx_incid; p-value = 0.458 for tx_hosp; p-value = 0.094 for tx_dchosp vs. D2) as shown in the above Tables.

Recently, Subramanian and Kumar have found no discernible relationship between new COVID-19 cases and percentage of population fully vaccinated in 68 countries as of September 3, 2021. There also appears to be no significant signalling of COVID-19 cases decreasing with higher percentages of population fully vaccinated in 2947 counties in the US [1].

It has been widely reported that vaccines against COVID-19 had greatly contributed to reducing the number of severe disease and therefore hospitalizations and mortality [2, 3] but have failed in preventing the spread of the SARS-CoV-2 variants. However, the lack of correlation between the epidemiological variables of COVID-19 and vaccine coverage in France is certainly attributed to the combination of several factors, such as the gradual decline of vaccine efficacy [4, 5, 6, 7]; lower vaccine's effectiveness against highly infectious spread of new SARS-CoV-2 variants, as well as the improvement of medical care for COVID-19 patients, and probably a fairly significant development of natural immunity.

In addition, the decrease of the population's vigilance (especially, those vaccinated) with regard to barrier and hygiene measures, could explain – at least partially – the growth of SARS-CoV-2 infections. A study has found in the

United States that adherence to mask wearing and acceptance of vaccines are correlated, which makes the vaccine efficacy estimation from real-world data biased by a significant amount [8]. Therefore, the lack of correlation with vaccine coverage suggests that herd immunity threshold would not be reached without respecting barrier gestures.

Assuming the Null Hypothesis (No correlation) cannot not be rejected as explained above, and using the regression line trend equations, we have estimated the mean of the epidemiological variables based on different vaccination rates (for vaccine coverage > 50% with D2 and > 60% with D1), such as shown in Figures 15, 16, 17 & 18.

The exercise consists in determining the main variables ratios, as per equation (2), such that the linear regression line follows a slightly decreasing trend (R < 0, whenever it is possible) with a coefficient of determination (R^2) very close to zero. For instance, the obtained values (as shown in Figures 17 & 18 and below Tables) for R_0 and the daily mortality ratio are on average within intervals [0.74; 0.77] and [0.076; 0.10] respectively, for a vaccination percentage within interval [0.65; 0.71] on average. Such scenario would lead to approximately 22000 hospitalized deaths on average per year.

Table 4: Estimation of Mean Dependent Variable vs. Two Doses Vaccination Mean Rate

Y Variable	***R^2***	***D2 Mean Rate***	***Variable Mean***	***Mean Lower -***	***Upper CI 95%***
tx_dchosp	0,0004	0,6546	0,0900	0,0787	0,1014
tx_hosp	0,0134	0,6546	13,4389	12,9907	13,8870
tx_incid	0,0335	0,6546	101,4796	97,9347	105,0245
R_0	0,0105	0,6546	0,7566	0,7459	0,7673

Table 5: Estimation of Mean Dependent Variable vs. One Dose Vaccination Mean Rate

Y Variable	***R^2***	***D1 Mean Rate***	***Variable Mean***	***Mean Lower -***	***Upper CI 95%***
tx_dchosp	0,0016	0,7089	0,0857	0,0757	0,0957
tx_hosp	0,0444	0,7089	12,4849	12,1175	12,8523
tx_incid	0,0523	0,7089	90,5526	87,5945	93,5107
R_0	0,0004	0,7089	0,7538	0,7431	0,7646

If the unique pursued strategy is that of vaccination, a reasonable objective would be around 60% to 70% coverage, in a homogeneous manner and across all territories. Thus, an optimal vaccination plan would be as follows:

1. Vaccinate high-risk population (vulnerable people, people with comorbidities, elderly…) and avoid delivering booster doses to the entire population [9].
2. Vaccinate people in contact with the public at work unless they have recently recovered from COVID-19 infection or still have sufficient antibodies.
3. Recommend a single jab of vaccine for people under 50s who do not fit into the above categories.
4. Reinforce respect for barrier gestures (mainly wearing mask, washing hands, and social distancing) wherever it is recommended by the health authorities.

Such plan will help achieve a reasonable herd immunity (mix of vaccine and natural immunity), with acceptable levels of severe disease and deaths, while reducing the number of severe side effects of the vaccines.

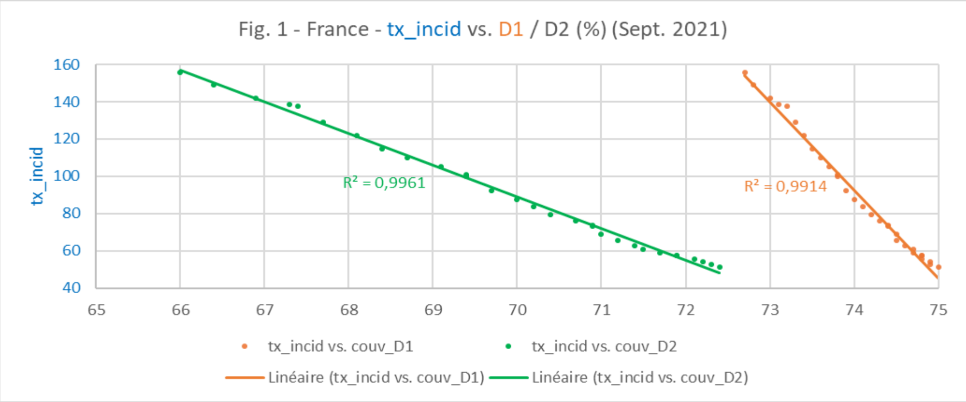


Fig. 1 - France - tx_incid vs. D1 / D2 (%) (Sept. 2021)
tx_incid
R² = 0,9961
R² = 0,9914
tx_incid vs. couv_D1
tx_incid vs. couv_D2
Linéaire (tx_incid vs. couv_D1)
Linéaire (tx_incid vs. couv_D2)

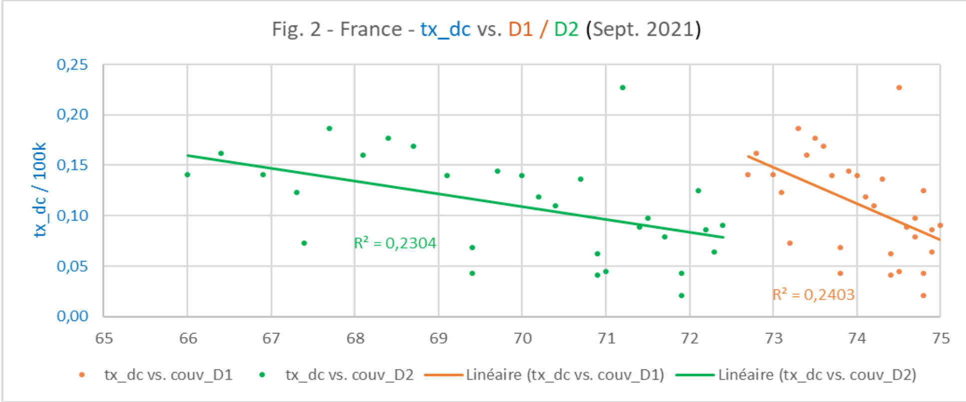


Fig. 2 - France - tx_dc vs. D1 / D2 (Sept. 2021)
tx_dc / 100k
R² = 0,2304
R² = 0,2403
tx_dc vs. couv_D1
tx_dc vs. couv_D2
Linéaire (tx_dc vs. couv_D1)
Linéaire (tx_dc vs. couv_D2)

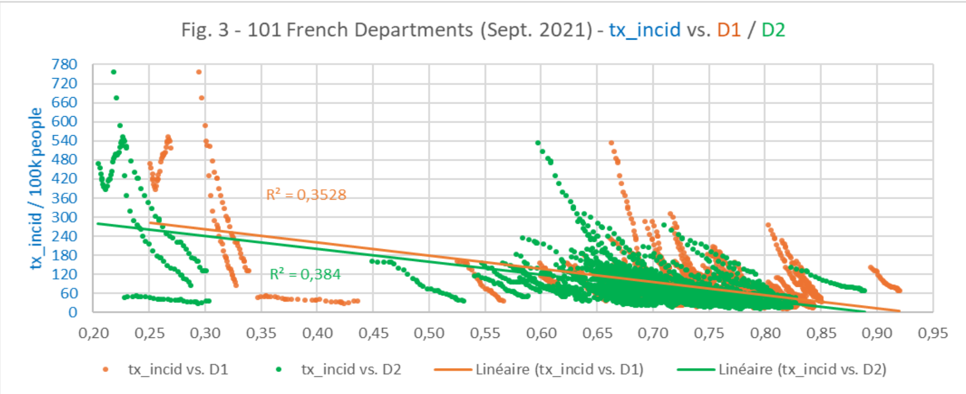


Fig. 3 - 101 French Departments (Sept. 2021) - tx_incid vs. D1 / D2
tx_incid / 100k people
R² = 0,3528
R² = 0,384
tx_incid vs. D1
tx_incid vs. D2
Linéaire (tx_incid vs. D1)
Linéaire (tx_incid vs. D2)

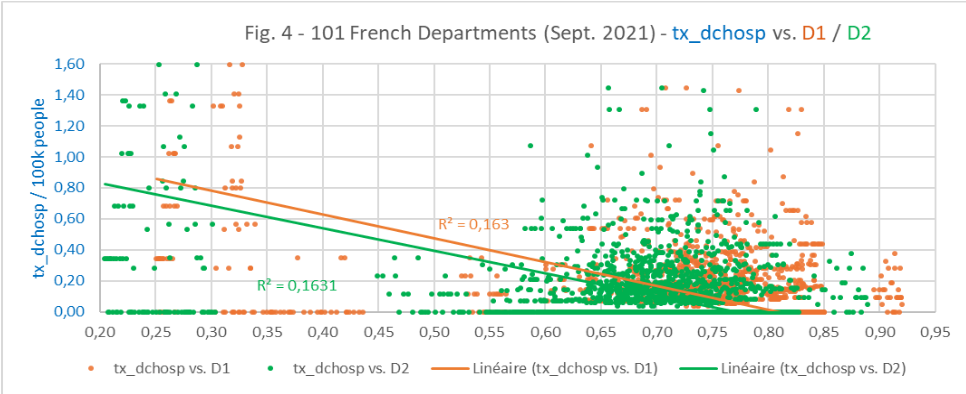


Fig. 4 - 101 French Departments (Sept. 2021) - tx_dchosp vs. D1 / D2
tx_dchosp / 100k people
R² = 0,163
R² = 0,1631
tx_dchosp vs. D1
tx_dchosp vs. D2
Linéaire (tx_dchosp vs. D1)
Linéaire (tx_dchosp vs. D2)

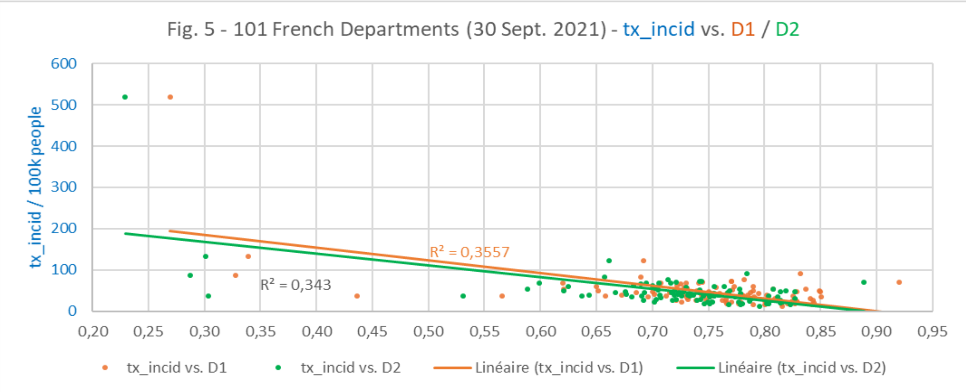


Fig. 5 - 101 French Departments (30 Sept. 2021) - tx_incid vs. D1 / D2
tx_incid / 100k people
R² = 0,3557
R² = 0,343
tx_incid vs. D1
tx_incid vs. D2
Linéaire (tx_incid vs. D1)
Linéaire (tx_incid vs. D2)

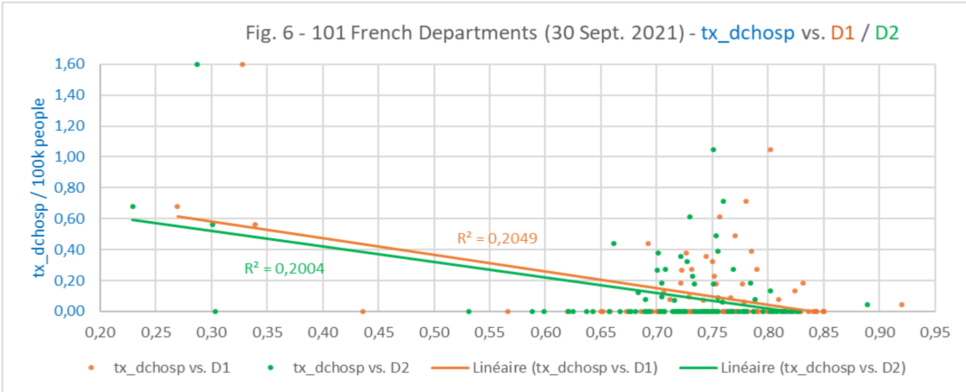


Fig. 6 - 101 French Departments (30 Sept. 2021) - tx_dchosp vs. D1 / D2
tx_dchosp / 100k people
R² = 0,2049
R² = 0,2004
tx_dchosp vs. D1
tx_dchosp vs. D2
Linéaire (tx_dchosp vs. D1)
Linéaire (tx_dchosp vs. D2)

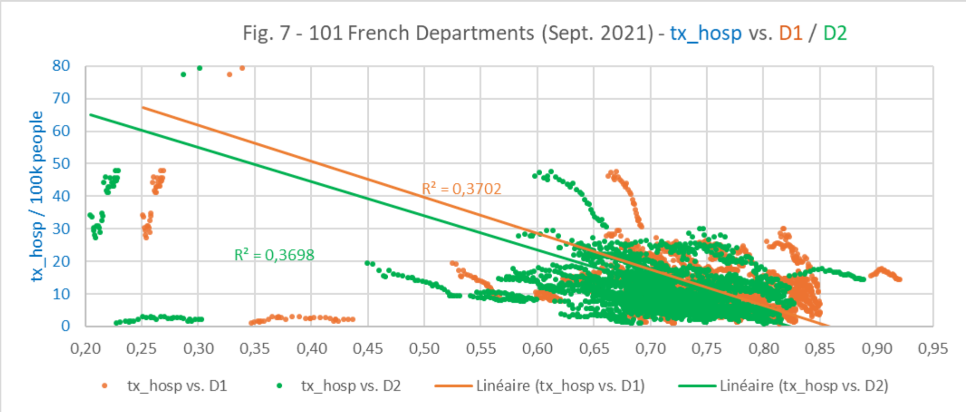


Fig. 7 - 101 French Departments (Sept. 2021) - tx_hosp vs. D1 / D2
tx_hosp / 100k people
80
70
60
50
40
30
20
10
0
0,20 0,25 0,30 0,35 0,40 0,45 0,50 0,55 0,60 0,65 0,70 0,75 0,80 0,85 0,90 0,95
R² = 0,3702
R² = 0,3698
tx_hosp vs. D1
tx_hosp vs. D2
Linéaire (tx_hosp vs. D1)
Linéaire (tx_hosp vs. D2)

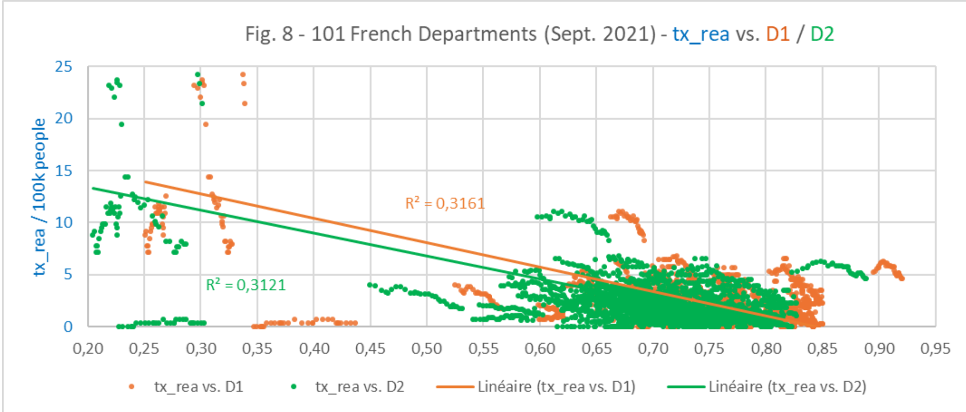


Fig. 8 - 101 French Departments (Sept. 2021) - tx_rea vs. D1 / D2
tx_rea / 100k people
25
20
15
10
5
0
0,20 0,25 0,30 0,35 0,40 0,45 0,50 0,55 0,60 0,65 0,70 0,75 0,80 0,85 0,90 0,95
R² = 0,3161
R² = 0,3121
tx_rea vs. D1
tx_rea vs. D2
Linéaire (tx_rea vs. D1)
Linéaire (tx_rea vs. D2)

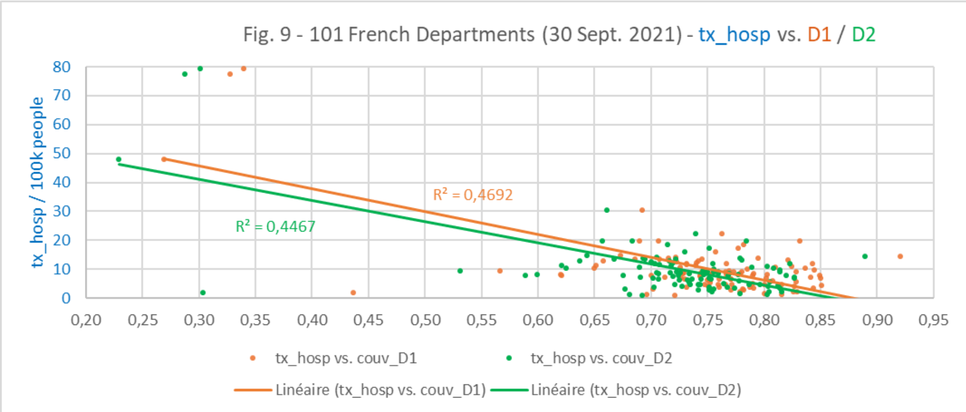


Fig. 9 - 101 French Departments (30 Sept. 2021) - tx_hosp vs. D1 / D2
tx_hosp / 100k people
80
70
60
50
40
30
20
10
0
0,20 0,25 0,30 0,35 0,40 0,45 0,50 0,55 0,60 0,65 0,70 0,75 0,80 0,85 0,90 0,95
R² = 0,4692
R² = 0,4467
tx_hosp vs. couv_D1
tx_hosp vs. couv_D2
Linéaire (tx_hosp vs. couv_D1)
Linéaire (tx_hosp vs. couv_D2)

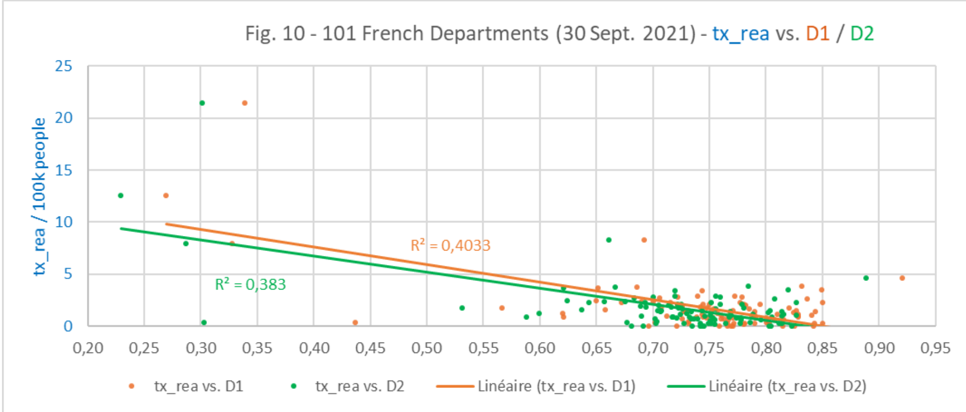


Fig. 10 - 101 French Departments (30 Sept. 2021) - tx_rea vs. D1 / D2
tx_rea / 100k people
25
20
15
10
5
0
0,20 0,25 0,30 0,35 0,40 0,45 0,50 0,55 0,60 0,65 0,70 0,75 0,80 0,85 0,90 0,95
R² = 0,4033
R² = 0,383
tx_rea vs. D1
tx_rea vs. D2
Linéaire (tx_rea vs. D1)
Linéaire (tx_rea vs. D2)

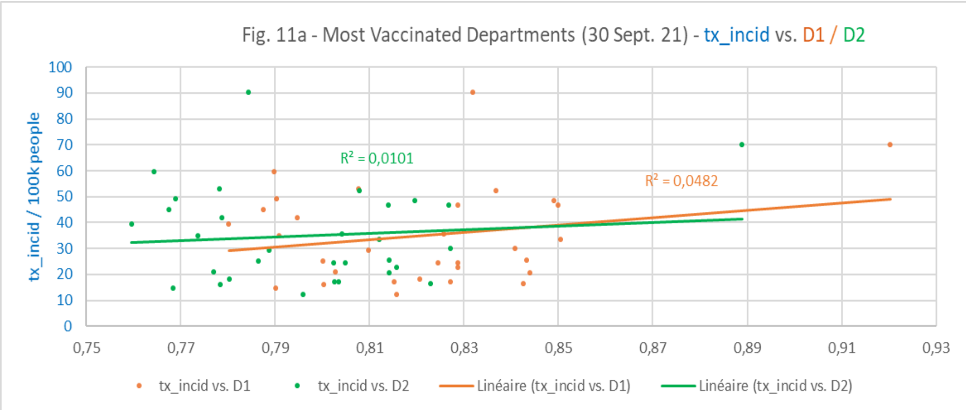


Fig. 11a - Most Vaccinated Departments (30 Sept. 21) - tx_incid vs. D1 / D2
tx_incid / 100k people
100
90
80
70
60
50
40
30
20
10
0
0,75 0,77 0,79 0,81 0,83 0,85 0,87 0,89 0,91 0,93
R² = 0,0101
R² = 0,0482
tx_incid vs. D1
tx_incid vs. D2
Linéaire (tx_incid vs. D1)
Linéaire (tx_incid vs. D2)

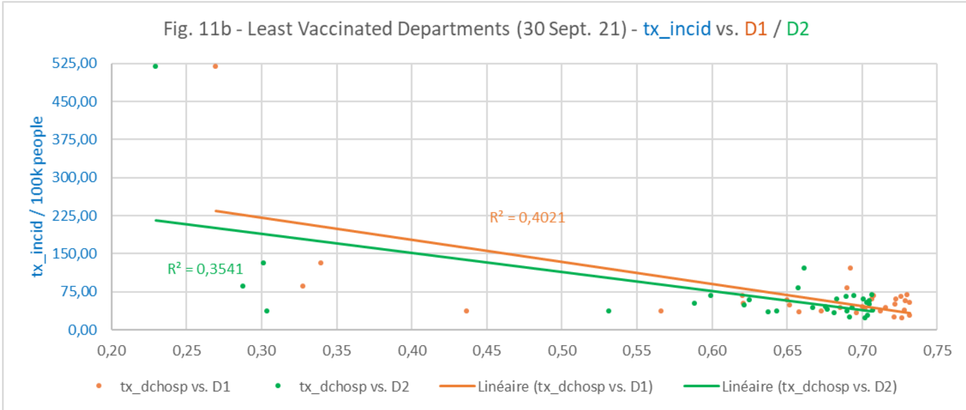


Fig. 11b - Least Vaccinated Departments (30 Sept. 21) - tx_incid vs. D1 / D2
tx_incid / 100k people
525,00
450,00
375,00
300,00
225,00
150,00
75,00
0,00
0,20 0,25 0,30 0,35 0,40 0,45 0,50 0,55 0,60 0,65 0,70 0,75
R² = 0,4021
R² = 0,3541
tx_dchosp vs. D1
tx_dchosp vs. D2
Linéaire (tx_dchosp vs. D1)
Linéaire (tx_dchosp vs. D2)

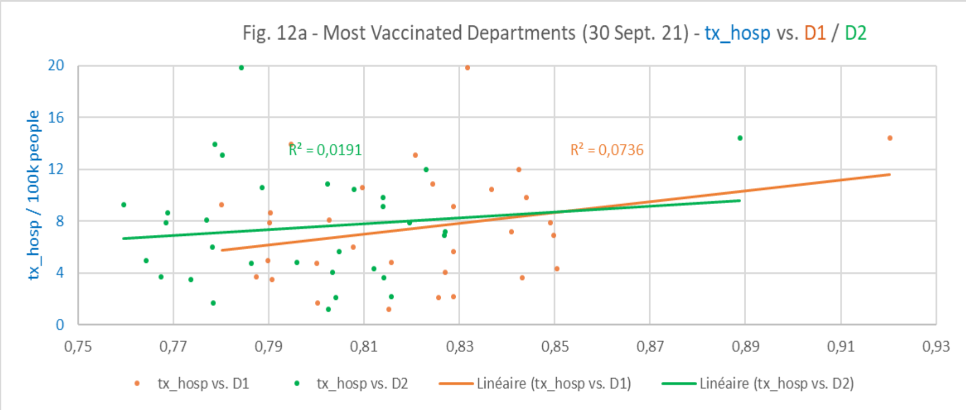


Fig. 12a - Most Vaccinated Departments (30 Sept. 21) - tx_hosp vs. D1 / D2
tx_hosp / 100k people
R² = 0,0191
R² = 0,0736
tx_hosp vs. D1
tx_hosp vs. D2
Linéaire (tx_hosp vs. D1)
Linéaire (tx_hosp vs. D2)

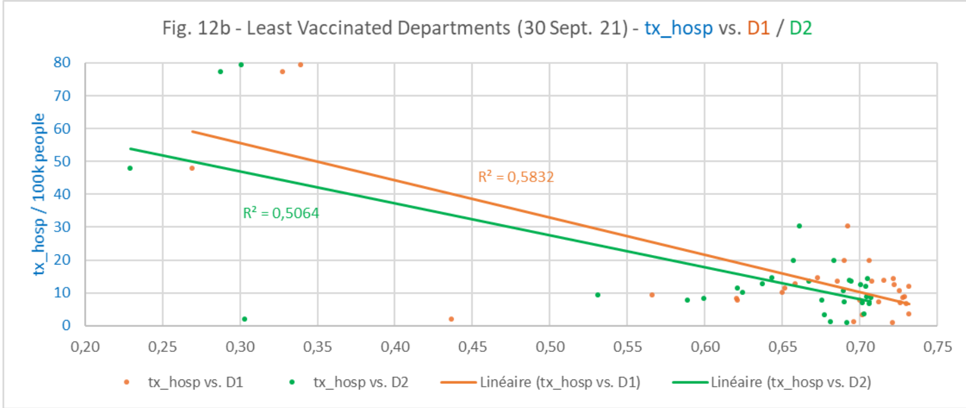


Fig. 12b - Least Vaccinated Departments (30 Sept. 21) - tx_hosp vs. D1 / D2
tx_hosp / 100k people
R² = 0,5832
R² = 0,5064
tx_hosp vs. D1
tx_hosp vs. D2
Linéaire (tx_hosp vs. D1)
Linéaire (tx_hosp vs. D2)

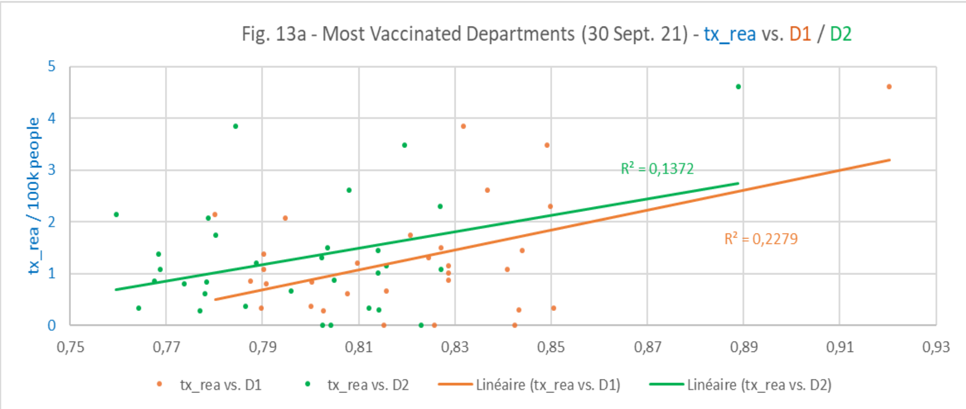
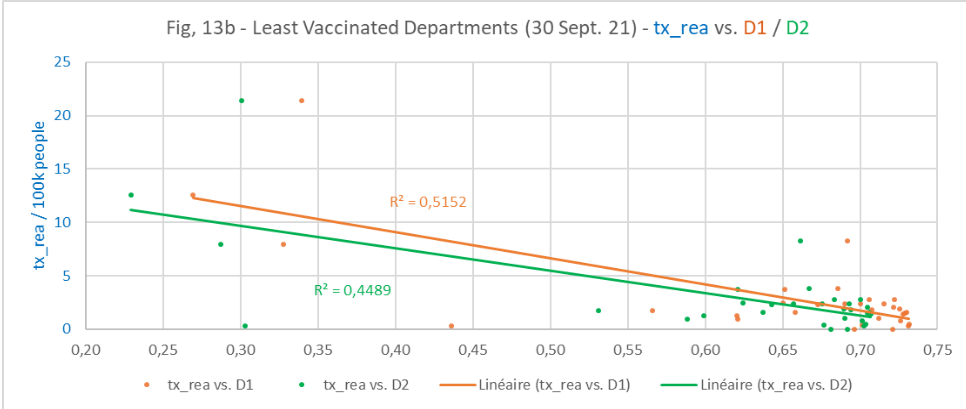


Fig. 13a - Most Vaccinated Departments (30 Sept. 21) - tx_rea vs. D1 / D2
tx_rea / 100k people
R² = 0,1372
R² = 0,2279
tx_rea vs. D1
tx_rea vs. D2
Linéaire (tx_rea vs. D1)
Linéaire (tx_rea vs. D2)


Fig, 13b - Least Vaccinated Departments (30 Sept. 21) - tx_rea vs. D1 / D2
tx_rea / 100k people
R² = 0,5152
R² = 0,4489
tx_rea vs. D1
tx_rea vs. D2
Linéaire (tx_rea vs. D1)
Linéaire (tx_rea vs. D2)

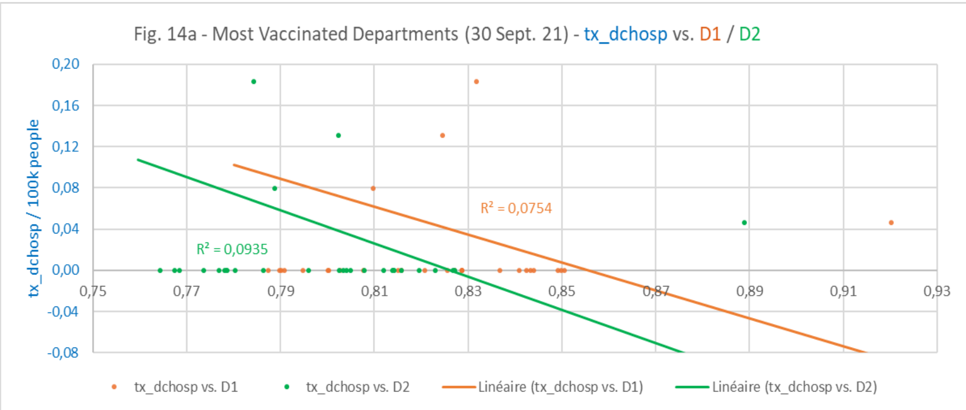


Fig. 14a - Most Vaccinated Departments (30 Sept. 21) - tx_dchosp vs. D1 / D2
tx_dchosp / 100k people
R² = 0,0754
R² = 0,0935
tx_dchosp vs. D1
tx_dchosp vs. D2
Linéaire (tx_dchosp vs. D1)
Linéaire (tx_dchosp vs. D2)

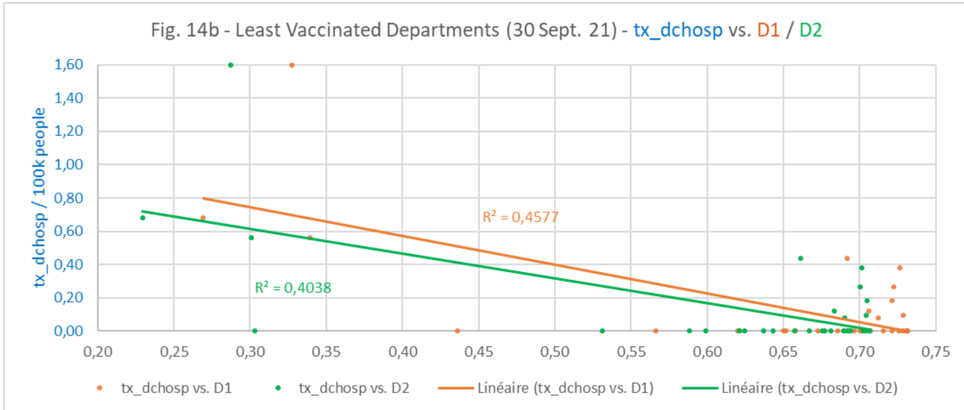


Fig. 14b - Least Vaccinated Departments (30 Sept. 21) - tx_dchosp vs. D1 / D2
tx_dchosp / 100k people
R² = 0,4577
R² = 0,4038
tx_dchosp vs. D1
tx_dchosp vs. D2
Linéaire (tx_dchosp vs. D1)
Linéaire (tx_dchosp vs. D2)

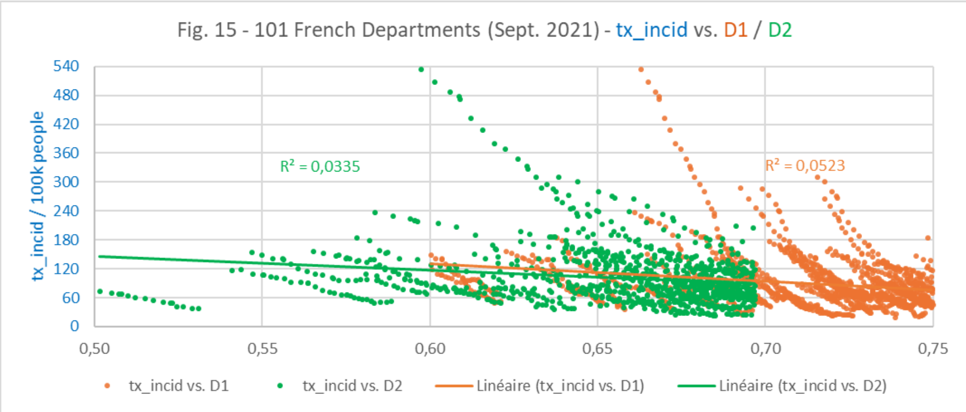


Fig. 15 - 101 French Departments (Sept. 2021) - tx_incid vs. D1 / D2
tx_incid / 100k people
540
480
420
360
300
240
180
120
60
0
0,50
0,55
0,60
0,65
0,70
0,75
R² = 0,0335
R² = 0,0523
tx_incid vs. D1
tx_incid vs. D2
Linéaire (tx_incid vs. D1)
Linéaire (tx_incid vs. D2)

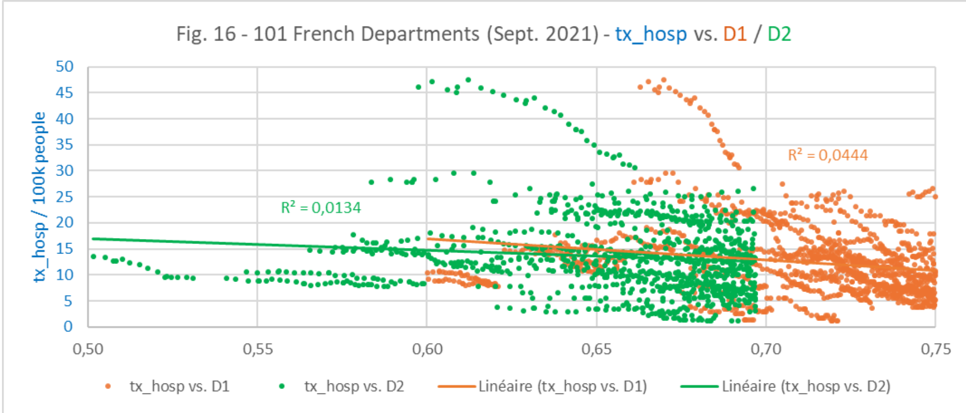


Fig. 16 - 101 French Departments (Sept. 2021) - tx_hosp vs. D1 / D2
tx_hosp / 100k people
50
45
40
35
30
25
20
15
10
5
0
0,50
0,55
0,60
0,65
0,70
0,75
R² = 0,0134
R² = 0,0444
tx_hosp vs. D1
tx_hosp vs. D2
Linéaire (tx_hosp vs. D1)
Linéaire (tx_hosp vs. D2)

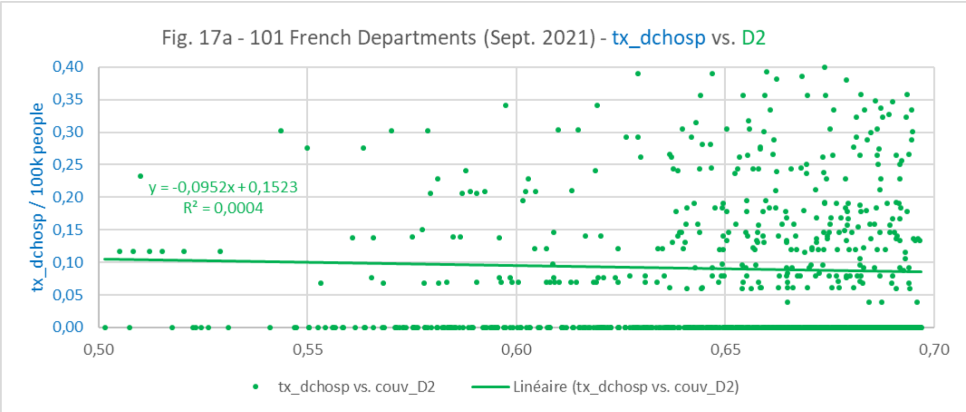


Fig. 17a - 101 French Departments (Sept. 2021) - tx_dchosp vs. D2
tx_dchosp / 100k people
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
0,50
0,55
0,60
0,65
0,70
y = -0,0952x + 0,1523
R² = 0,0004
tx_dchosp vs. couv_D2
Linéaire (tx_dchosp vs. couv_D2)

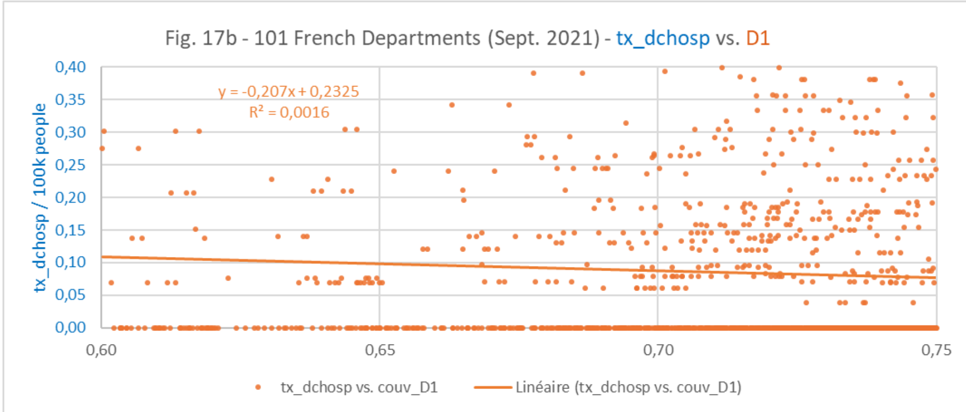


Fig. 17b - 101 French Departments (Sept. 2021) - tx_dchosp vs. D1
tx_dchosp / 100k people
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
0,60
0,65
0,70
0,75
y = -0,207x + 0,2325
R² = 0,0016
tx_dchosp vs. couv_D1
Linéaire (tx_dchosp vs. couv_D1)

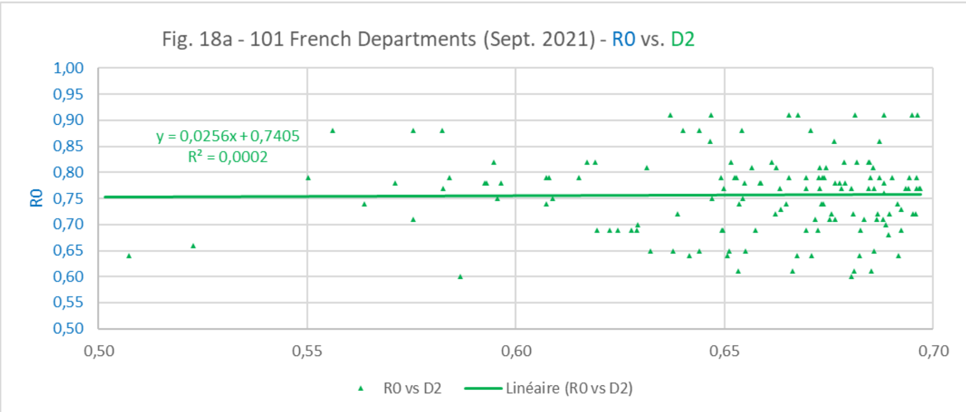


Fig. 18a - 101 French Departments (Sept. 2021) - R0 vs. D2
R0
1,00
0,95
0,90
0,85
0,80
0,75
0,70
0,65
0,60
0,55
0,50
0,50
0,55
0,60
0,65
0,70
y = 0,0256x + 0,7405
R² = 0,0002
R0 vs D2
Linéaire (R0 vs D2)

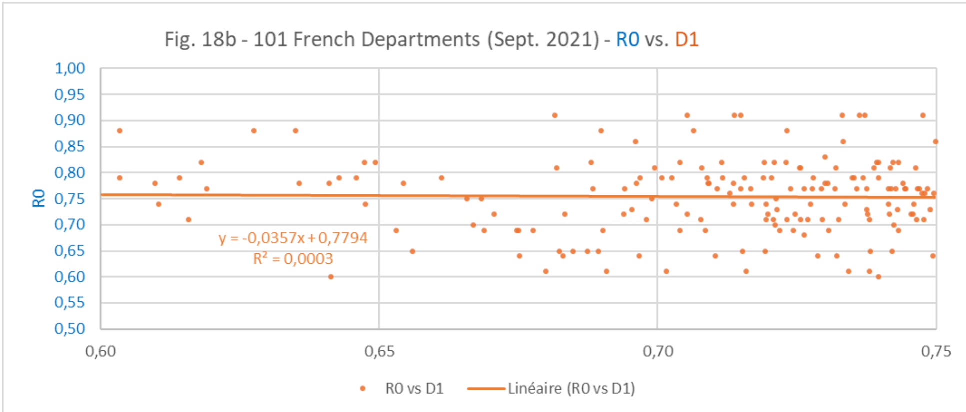


Fig. 18b - 101 French Departments (Sept. 2021) - R0 vs. D1
R0
1,00
0,95
0,90
0,85
0,80
0,75
0,70
0,65
0,60
0,55
0,50
0,60
0,65
0,70
0,75
y = -0,0357x + 0,7794
R² = 0,0003
R0 vs D1
Linéaire (R0 vs D1)

References

[1] Subramanian, S.V., Kumar, A. Increases in COVID-19 are unrelated to levels of vaccination across 68 countries and 2947 counties in the United States. Eur J Epidemiol (2021). https://doi.org/10.1007/s10654-021-00808-7

[2] Simona Iftimie, Ana F. López-Azcona, Maria José Lozano-Olmo, Anna Hernández-Aguilera, et al. Differential features of the fifth wave of COVID-19 associated with vaccination and the delta variant in a reference hospital in Catalonia, Spain. MedRxiv. October 2021. https://doi.org/10.1101/2021.10.14.21264933

[3] Junko Kurita, Tamie Sugawara, Yasushi Ohkusa. Vaccine effectiveness for the COVID-19 in Japan. MedRxiv. October 2021. https://doi.org/10.1101/2021.06.20.21259209

[4] Thomas Sj, Moreira Ed, Kitchin N, Absalon J, Gurtman A, Lockhart S, Perez Jl, et al. Six-month safety and efficacy of the Bnt162b2 mRNA Covid-19 vaccine. Medrxiv. September 2021. https://doi.org/ 10. 1101/ 2021. 07. 28. 21261 159

[5] Paul M Mckeigue, David Mcallister, Sharon J Hutchinson, Chris Robertson, et al. Efficacy of vaccination against severe COVID-19 in relation to delta variant and time since second dose: The REACT-SCOT Case-Control Study. Medrxiv. October 2021. Https://doi.org/10.1101/2021.09.12.21263448

[6] Sara Y Tartof, Je M Slezak, Heidi Fischer, et al. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: A Retrospective Cohort Study. The Lancet. October 2021. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)02183-8/fulltext

[7] Vaccines and Related Biological Products Advisory Committee. Evaluation of a Booster Dose (Prizer Inc., BNT162b2 Third Dose). Briefing Document, September 17, 2021. https://www.fda.gov/media/152161/download

[8] Andrew Matytsin. The Mask-wearing bias in the estimates of vaccine efficacy. MedRxiv. October 2021. https://doi.org/10.1101/2021.10.19.21265093

[9] Refer to [5]