

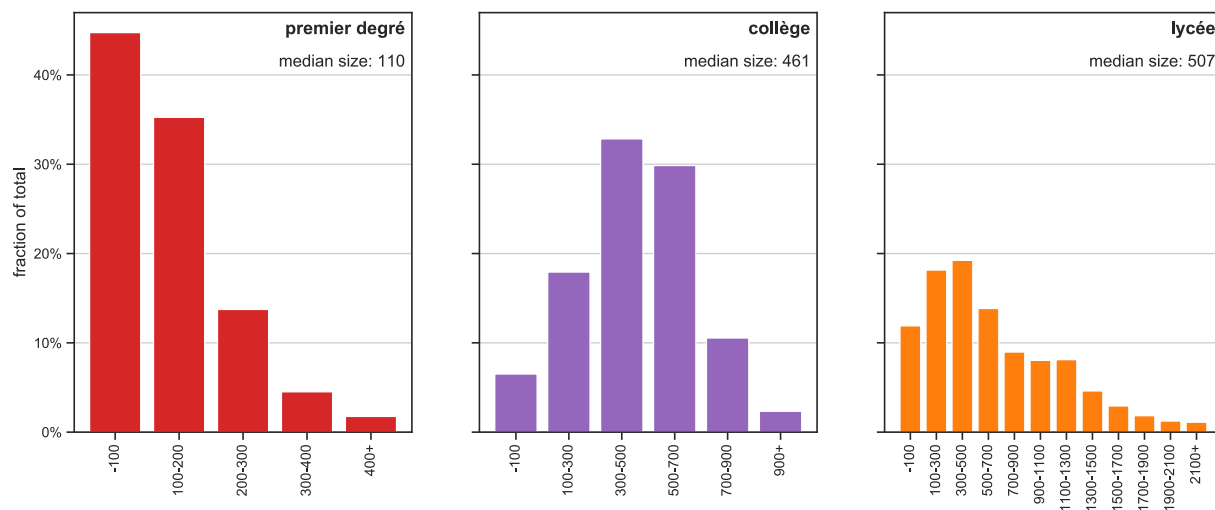
## RISK OF COVID-19 INTRODUCTIONS IN SCHOOLS IN FRANCE WEEK 37 (Sept 7-13, 2020)

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This short report presents the estimation of the risk of COVID-19 introductions into schools in France. We estimated the expected number of COVID-19 cases introduced into a school of a given size  $n$  based on the incidence in the student age classes reported by virological surveillance [1] and accounting for possible underreporting. Methodology follows Ref. [2] with adaptations to the epidemic situation and availability of data in France. In addition, using data on number of schools and school sizes by department, we estimated the number of schools by department expected to have at least one COVID-19 introduction in the week under study and compared this estimate with the detected introductions.

**School size.** We used data from the Ministry of Education on the number of schools and their size (number of students) by department and school level – primary schools (*premier degré : écoles maternelles, écoles élémentaires*), middle schools (*collèges*) and high schools (*lycées*) in metropolitan France [3], [4]. Data were from academic year 2019-2020. Figure 1 shows the distribution of school sizes for the different school levels. Based on these data, we estimated the expected introductions for sizes  $n=50, 200, 400, 900$  as examples of the range of sizes of French schools.



**Figure 1.** Distribution of school sizes (number of students per school) for *premier degré* (left), *collèges* (middle), and *lycées* (right).

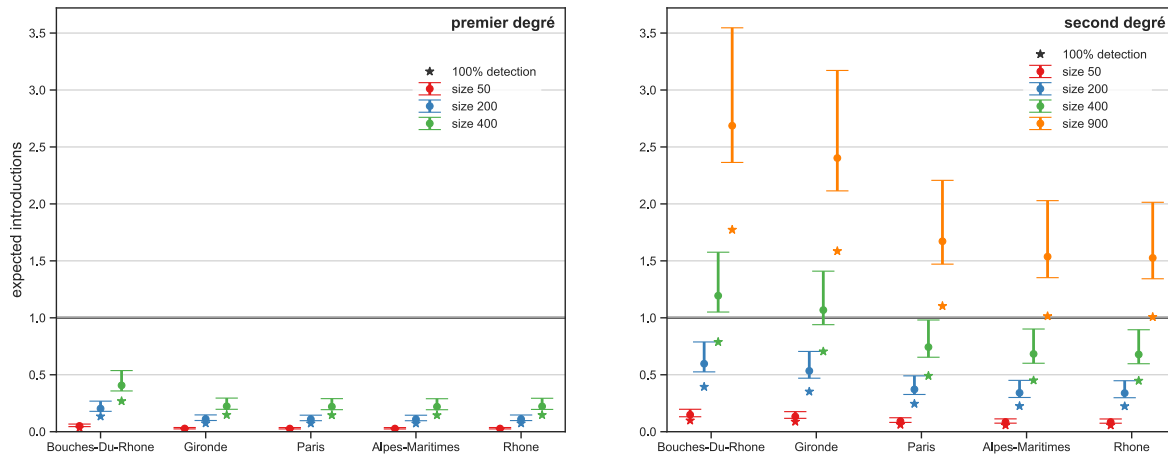
**Incidence.** We used the weekly incidence by department and age class provided in the GEODES platform by Santé publique France [1]. The classes of 0-9 years old and of 10-19 years old were considered for estimates of introductions in primary schools, and in middle/high schools, respectively.

**Underdetection.** The rate of detection of cases ranged between 10% and 80% at the end of June, depending on the region [5]. Estimates are not available yet for the current period, but preliminary results indicated that detection in Île-de-France improved over July and August. Therefore, we assumed a detection rate ranging between 50% (1 out of 2 cases detected) and 75% (3 out of 4), using 66% as a reference value. Detection rate was considered to be uniform across regions and across ages. We also considered the situation corresponding to 100% detection (i.e. all cases are detected), to provide a lower bound in the risks.

**Expected introductions.** The expected number of COVID-19 introductions in a given week is based on the estimated prevalence in the student age class, computed from the reported incidence in the preceding week and considering 7 days of infectious period [2]. Given the number of schools of a given size and educational level in each department, we estimated the number of schools by department with at least one COVID-19 introduction in the week of September 7, 2020.

## Results

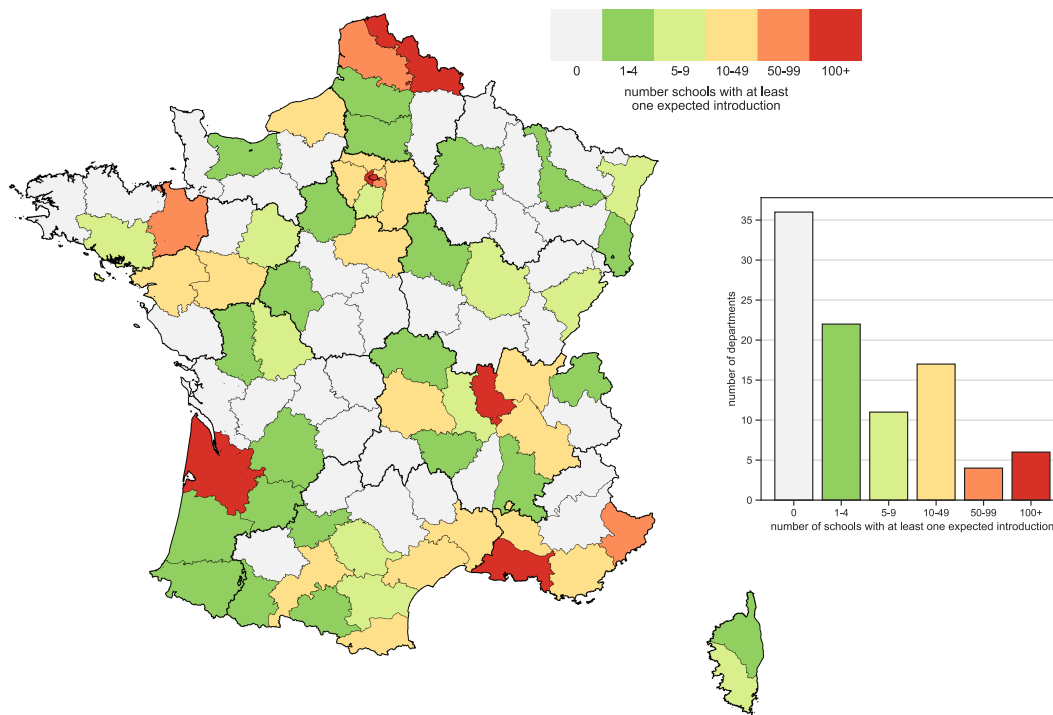
Figure 2 presents the expected number of COVID-19 introductions among students arriving at primary schools, *collèges* and *lycées* in the week of Sept 7 in the 5 departments in metropolitan France reporting the largest overall incidence in the preceding week. The risk of introduction in a primary school is rather low (expected introductions <0.5 in the top five departments with highest incidence) due to the smaller school size and lower incidence levels in this age class. Similar results are obtained for small-size middle and high schools (size~50). The expected number of COVID-19 introductions in middle or high schools of average size (~400) ranges between 0.5 and 1.5 in the most affected departments. Very large schools (size ~900) should expect between 1 and 4 introduction per school at current epidemic activity levels throughout a week. Even with a detection rate higher than the range considered, these very large schools would still expect introductions: predicted introductions range between 1 and 2 assuming 100% detection.



**Figure 2.** Expected number of COVID-19 infected students arriving at primary schools (*écoles maternelles, élémentaires*; left), or middle and high schools (*collèges and lycées*; right) in the week of Sept 7, 2020 in the 5 departments with largest overall incidence in metropolitan France in the preceding week. Estimates are computed for different values of school sizes. The interval in the estimates refers to the assumed range of detection rate (50% to 75%, limits of the interval, with 66% as the reference value, corresponding to the point). Stars correspond to 100% detection of cases, and represent the lower bound.

Figure 3 shows the number of schools in each department with at least one expected COVID-19 introduction among students in the week of Sept 7. The estimated risk is very heterogeneous across space. 60 departments (62.5%) are expected to have at least one school affected by COVID-19 throughout the week. Among them, 10 departments are likely to have >50 schools concerned: Nord (# of schools: 315), Bouches-du-Rhône (256), Gironde (167), Rhône (132), Paris (123), Hauts-de-Seine (101), Pas-de-Calais (76), Alpes-Maritimes (76), Val-de-Marne (68), Ile-et-Vilaine (53).

Most vulnerable departments are clearly recognizable in the map. However, the estimate of the number of affected schools comprises not only the incidence level but also the educational offer of the department in terms of number of schools and their size. This means that the number of schools at risk in a department is not simply proportional to the local epidemic activity. For example, Côte-d'Or has higher incidence than Seine-et-Marne, considering all age classes, or the students age classes only (60 vs. 46 cases per 100,000 in 10-19 years old, respectively). But it has a lower expected number of schools affected by COVID-19 (9 vs. 10). This happens because Côte-d'Or has half the number of schools of Seine-et-Marne (635 vs. 1,345), and they are half as large (median size 79 vs. 147, respectively).

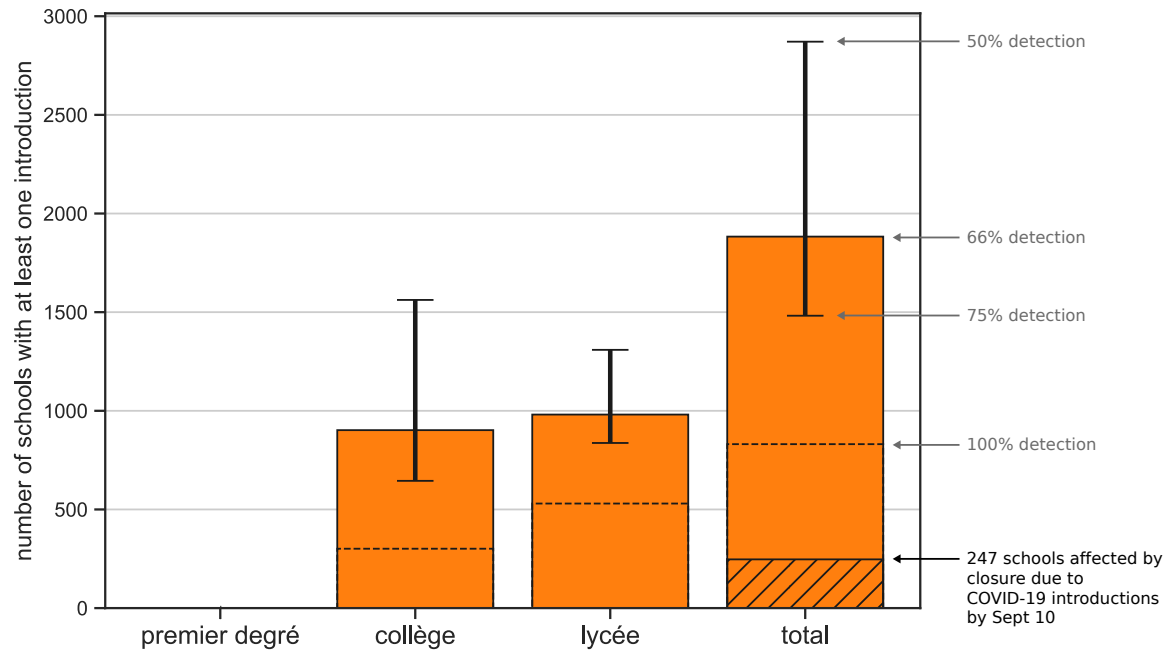


**Figure 3.** Left: Map of the number of schools by department expected to have at least one COVID-19 introduction in the week of Sept 7, 2020 in metropolitan France. Right: Number of departments in each category of risk. Estimates are based on the reference value of the detection rate (66%).

Figure 4 presents the total number of schools in metropolitan France expected to have at least one COVID-19 introduction among students in the week of Sept 7, by school level. The risk is estimated to be low for primary schools. Almost 2,000 schools in metropolitan France, nearly equally distributed among middle and high schools, are expected to have at least one infected student in the week, based on a detection rate of 66%. This estimate would be larger if detection was less efficient (a total of ~3,000 schools if one case out of two is detected by the test and tracing system).

Even assuming a perfect detection (i.e. 100% detection of all cases), the estimated number of schools with introductions would still be more than 3 times the number of schools reporting cases and affected by partial or full closure over these first few days after school reopening (247 affected schools, data up to Sept 10 [6]). For plausible detection rates, our findings indicate that the number of schools affected by COVID-19 introductions may be between 6 and 11 times the number detected so far. Part of these introductions may have gone undetected because of asymptomatic infections or cases with subclinical symptoms.

On the other hand, suspicions for COVID-19 infections in the primary schools may be higher than estimated introductions due to the higher frequency of respiratory episodes in younger children.



**Figure 4.** Number of schools (from left: *écoles maternelles et élémentaires*, *collèges*, *lycées*, total number) expected to have at least one COVID-19 introduction in the week of Sept 7, 2020 in metropolitan France. The height of the bin refers to the reference value of the assumed detection rate (66%); the interval shows the estimates obtained with the assumed range (from 50% to 75% detection of cases); the dashed line indicates the estimates corresponding to the assumption of 100% detection (lower bound). The bin with the diagonal pattern indicates the number of schools (247) affected by partial or full closure due to detected COVID-19 introductions (data up to Sept 10 [6]). Data include only schools reported by a verifiable source. Data do not take into account schools where detection of positive cases occurred but did not lead to closure.

Our study shows a rather heterogeneous situation for the risk of introduction of COVID-19 cases at school across the country. **Results prompt caution against a larger risk of introduction than currently observed.** Risk will evolve over time as epidemic activity changes. **Given the rapidly increasing circulation of the virus on the territory, and in particular in certain regions, introductions are expected to increase in the next weeks.** The analysis can be routinely updated. Detailed data on number of schools affected by confirmed COVID-19 infection by school level are required to quantitatively assess reporting biases and guide planning.

### Limitations

- The underlying assumption is that the probability that a student is infected and brings the infection to school is well measured by the incidence in the student age class reported by active virological surveillance (after accounting for underdetection). As such, this report presents average estimates and does not account for outbreaks or clusters specific to certain locations close to particular schools.

- In absence of estimates for current underdetection, we assumed a range of values. In addition, these values are assumed to be uniform across regions and age classes. We used 100% detection for comparison and to provide a lower bound of the estimates.
- Incidence estimates by age classes are not corrected for onset-to-test or infection-to-test delays [5]. As such, they likely represent an underestimate of the actual incidence in the week.
- Transmission at school is not considered, the risk is computed as an introduction from the community. As such, preventive measures taken at school (e.g. cohorting, use of masks, hand hygiene) are not considered in this study. Introductions are considered among students only, because of lack of data on the number of teachers and personnel at schools.
- This analysis is not meant to estimate the risk of reopening schools on the community [7].
- Quantitative assessment of biases in reporting cases by school level is hindered by lack of detailed data on affected schools.

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