Covid-19 report: Update on the current epidemic status in Luxembourg

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Background information

This report has been elaborated by the Research Luxembourg Covid-19 Task Force to inform the Luxembourg Government about the current epidemic status in Luxembourg as an update to the last report from 17 March. It gives a short overview on the most important epidemic indicators and contains projections for the current epidemic status **based on data available up to 23 March**.

Main conclusions

- **During the current week, the epidemic dynamics exhibits an exponential dynamics.** Thus, the 7-day average of daily cases for the current week has increased to 1192 cases/day today compared to 956 cases/day for the week before, which corresponds to a 25% increase compared to a 26% increase last week.

- **R_{eff} of today has remained rather constant with 1.28** compared to 1.17 on Thursday of last week (Figure 1). The **7-day average value of R_{eff} has remained constant** at 1.12 for this week compared to 1.13 for the previous week.

- The current epidemic dynamics **exhibits a manifestation of an exponential regime** with an increasing slope obtained by linear fitting since 20 February of the cumulative cases of 826 cases/day compared to 774 cases/day for last week's estimate (Figure 2 and 3).

- The 7-day average for the **normal care hospitalization demands has increased** compared to last week (36.8 cases on average for this week compared to 32.4 cases for last week). The average **ICU occupancy has remained constant at** 3.4 cases on average for this week compared to 3.4 cases for last week.

- The continuously increasing case numbers of the current epidemic rebound driven by the BA.2 subtype of the Omicron variant trigger an **anticipated peak in the corresponding midterm projections of daily cases of around 1,500 cases** on average in beginning of April (Figure 4 and 5). The projections come with some uncertainties based on the approximately 40%-60% increased transmissibility of the BA.2 subtype of the Omicron variant and the recent relaxation in measures.

- The corresponding projections for the hospitalization demands reflect the apparently milder disease progression for the Omicron variant. With the assumption of a 60% reduction for normal care hospitalization, an 80% reduction of ICU hospitalization for the Omicron variant in comparison to the Delta variant and the current trend of an epidemic rebound, the **projections indicate a peak in normal care cases** of potentially around 80 beds in April (Figure 6). With the adapted assumption for disease severity and the recent increase in the epidemic dynamics, the current **projection for ICU demands indicates a potential peak between 7 and 20 beds** on average in April (Figure 7). Note that hospitalization and specifically ICU demands strongly depend on the age structure of the cases and the vaccination status as well as antiviral treatments. Hence, it is important that vulnerable people are fully vaccinated and remain cautious in their social interactions to prevent severe cases and an increase in hospital demands.

- The average **positivity rate has again increased to around 37%** compared to 32% for last week (Figure 8).

- The total number of estimated **active cases has also increased to 16,348** cases compared to 12,973 cases for the previous week which corresponds to a 26% increase (Figure 9).

The epidemic dynamics of the current week exhibits a manifestation of the exponential regime driven by the increased transmissibility of the BA.2 subtype of the Omicron variant compared to the BA.1 subtype and reduced measures. Based on the continuously increasing case numbers, the standard projections which do not consider the increased transmissibility explicitly have now caught up with the projection of two strain model and indicate a potential peak of around 1,500 cases/day at the beginning of April. Note that the spring vacation period may facilitate an intermediate relaxation in April, but the effect can only roughly be estimated. The situation in the hospitals may indicate that the current BA.2-subtype based infections may lead to less severe cases which is probably caused by better treatment strategies by antiviral compounds and the higher incidences of fully vaccinated and boostered persons, which have subsequently a lower risk for severe symptoms. A corresponding analysis is ongoing. In any case, sustained efforts in social distancing, in following hygiene strategies as well as in vaccination uptake, including booster shots, remain in particular for elderly and vulnerable persons essential to prevent severe situations in the hospitals.

Graphical analysis of epidemic indicators

Below, the epidemic indicators are visualized and analyzed in more detail including the midterm projections for daily cases and hospitalization.

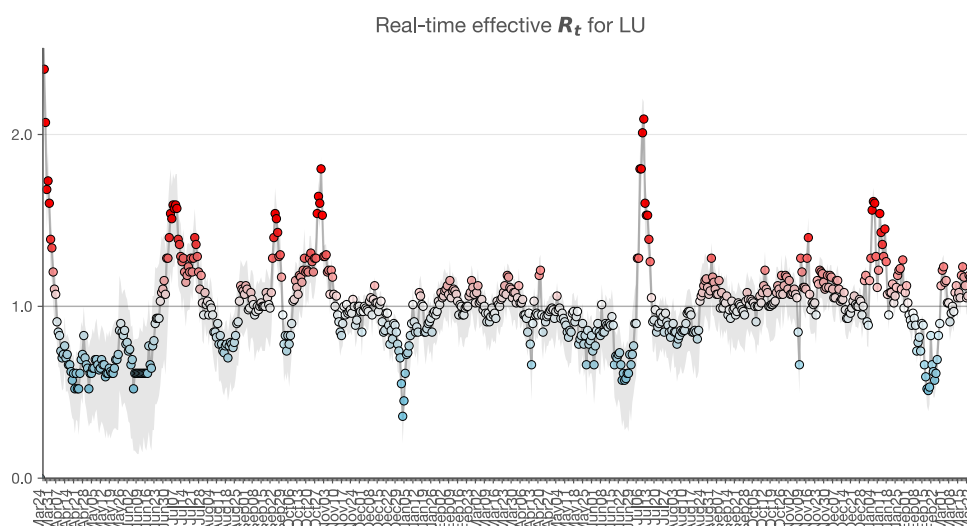
Real-time effective R_t for LU

Figure 1. For the current week, the effective reproduction R_{eff} has increased to 1.28 today compared to 1.17 on Thursday of last week. The 7-day average of the current week has remained rather constant at 1.12 compared to 1.13 of last week.
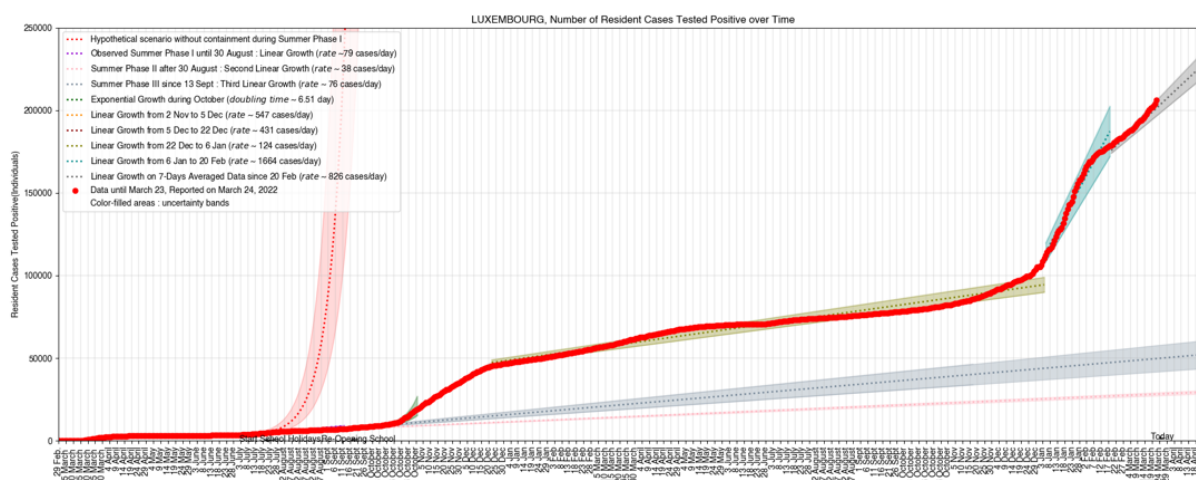

*Figure 2. Official COVID-19 case numbers up to 23 March (red dots) were approximated with an adapted model for short-term forecasts for the different phases of the epidemics (color coded). **The dynamics during the current week indicates the manifestation of the exponential regime as indicated by the further increased slope of the linear fit of 826 cases/day compared to 774 cases/day for the fit from last week.***
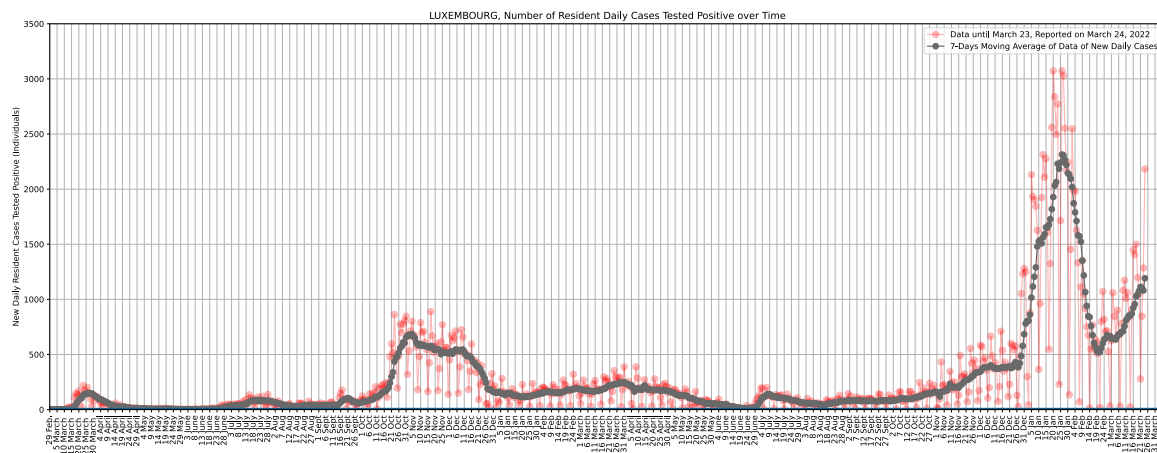
Figure 3. *The daily COVID-19 cases numbers up to 23 March (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve and that an exponential behavior would correspond to a straight line. **For the current week, the 7-day average of daily cases (grey) has increased to 1192 cases/day compared to 956 cases/day for the week before** where the linear increase for the last 3 weeks indicates the shift towards an exponential dynamics.*

To assess the future epidemiological development in Luxembourg, we parameterized an extended epidemiological SIR model with data from Luxembourg by a Kalman filter. The model considers the current state of vaccination in the population, the vaccine efficacy against transmission for the Delta variant inferred from Luxembourg data as 44% and 68% for the first and the second dose, respectively, and the efficacy against severe outcome as 74% and 85%, respectively. For the Omicron variant, the transmissibility is increased by roughly 200%. However, the hospitalization risk is reduced by 60% for normal care and 80% for ICU compared to the Delta variant. Based on these assumptions and the current age-distribution of infected persons of the last two weeks, the model integrates the dynamics of daily cases, hospitalizations and ICU occupancy and projects the future development of the epidemics. Note that the model does not consider future changes in social behavior or vaccine efficacies nor the increased transmissibility of the BA.2 subtype explicitly and that the projections are accompanied by uncertainties as shown by the confidence intervals, which currently correspond to a 13% decrease or increase in social interactions for the optimistic and pessimistic scenarios (Figures 4, 6 and 7). To respect the current rebound driven by the BA.2 subtype, we additionally applied a two-strain model which explicitly considers the increased transmissibility of BA.2 and further indicates an anticipated rebound with a similar peak of more than 1,500 cases/day on average in April (Figure 5). Note that none of the projections considers the potential relaxing effect of the spring vacation period since the effect cannot be estimated solidly.

The midterm **projections of the 7-day average of daily new cases** (Figure 4) estimate the current level of social interactions and consider the vaccination status. The projections reflect the recent epidemic rebound and the corresponding projections for **the 7-day average of daily cases** indicates a continuing increase with a peak of around 1500 cases/day on average in April (Figure 4 left) compared to a peak of 1,200 cases/day in last week's projections (Figure 4 right). As stated in last week's report, this increase in the peak height was expected since this model does not consider the increased transmissibility and the current projection agrees with the anticipated peak from the two-strain model and the pessimistic scenario from last week's projections. The destabilized regime is further indicated by the pessimistic scenario corresponding to 13% change in social interaction, which indicates a potential peak of around 2,000 cases/day. Note that the increased transmissibility of the BA.2 subtype of the Omicron variant and relaxed measures are not explicitly considered in these projections. Furthermore, the epidemic dynamics will also depend on the future development of social life where the spring vacation period might lead to an intermediate relaxation in the epidemic dynamics for the first weeks in April but also bears the danger of potential import cases.
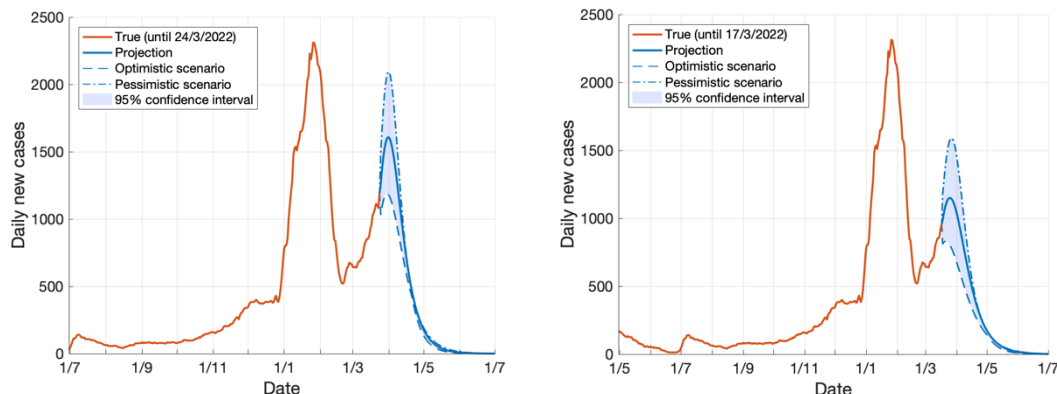
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Figure 4. Comparison of midterm projections for the 7-day average of daily cases from this week (left) and last week (right) based on an extended epidemiological SIR model parameterized to the situation in Luxembourg data by a Kalman filter. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 13% decrease and increase in social interactions for this week's and for last week's projections. The comparison indicates the effect of the current increase in infection numbers by a significant rebound with a peak of around 1,500 cases beginning of April similar to the pessimistic scenario of the projection of last week (right). Note that the increased transmissibility of the BA.2 subtype may push the dynamics even further towards the more pessimistic scenario.

To estimate the effect of the increased transmissibility of the BA.2 subtype and relaxed measures, we applied a two-strain model (as done during the period of the Alpha and Delta variant appearance), which considers a 60% increased transmissibility (Fig. 5 right) in analogy to the pessimistic projections form last week (Fig. 5 right). This comparison indicates that the current rebound is driven by the increased transmissibility of the BA.2 subtype and potentially further facilitated by the reduced measures.
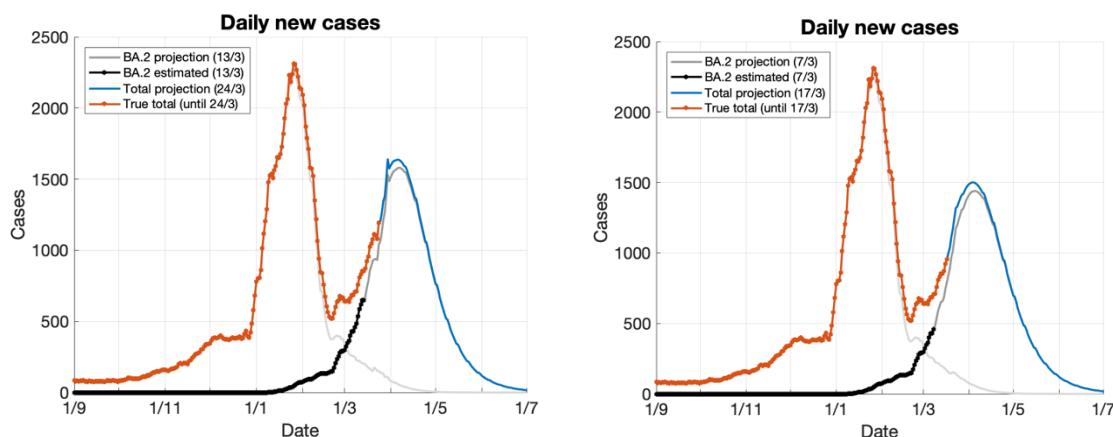

Figure 5. Estimates of the potential effect of the more contagious virus subtype BA.2. Based on the epidemic dynamics of observed cases (red line for 7-day average), the projections show the overall dynamics (blue) and the potential contribution of the variants of concern (black). Left: Considering the reported prevalence of the subtype BA.2, a 60% increased transmissibility and current social interactions, the projection exhibits a potential rebound with a peak of more than 1,500 cases/day in April. Right: Corresponding projections from last week with an overall increase of 60% for the current BA.2 regime which indicated already a similar peak of around 1,500 cases/day on average in April. This consistency supports the hypothesis that the current rebound is driven by the BA.2 subtype. [Note that the model does not consider a potential effect of the spring break which may lead to an intermediate relaxation due to reduced social interactions.]

The model **projection for normal care** assumes a 60% decrease in the hospitalization risk for the Omicron variant compared to the Delta variant which seems to hold also for the Ba.2 subtype. Based on the current epidemic rebound in cases (Figures 4 and 5), the observed increase in normal care demands and age distribution of cases, the projections exhibit an anticipated peak of around 80 beds in April compared to 60 beds in last week's projection (Figure 6). The current situation in the hospitals indicates a further reduced hospitalization risk for the current situation that is probably caused by more infections of vaccinated and boostered people who have a reduced risk to develop severe

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symptoms. In addition, the improved treatment strategies by antiviral compounds may further decrease the anticipated hospital demands. Note that hospitalizations strongly depend on the age distribution of cases since older people are more likely to develop severe symptoms and that booster shots are essential to push down the curve. Hence, changes in the age distribution and the administration of booster shots can significantly modify the projections.
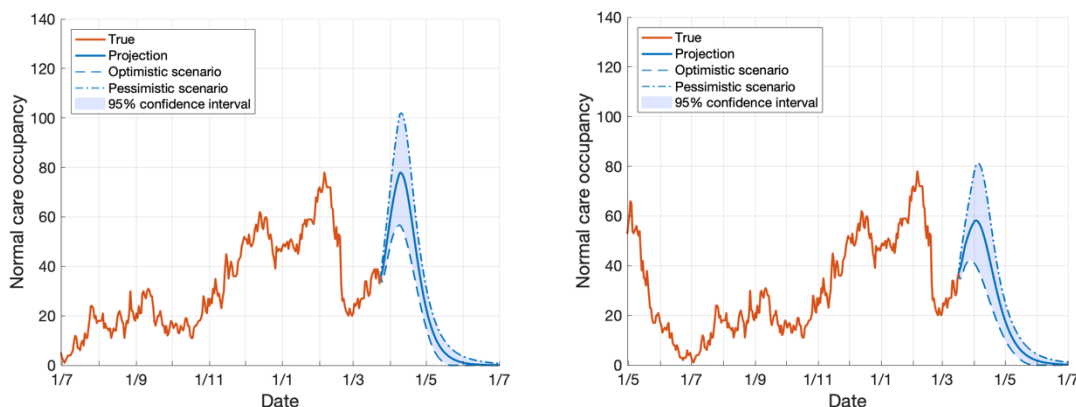

*Figure 6. Comparison of midterm projections for the 7-day average of normal care demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 13% decrease and increase in social interactions. **The comparison indicates a significant peak of around 80 beds in April before a relaxation (left) compared to a peak of 60 beds in the projections of last week (right)**. The improved treatments by antiviral compounds and the current high incidences of vaccinated and boostered people with their reduced risk for severe symptoms will probably decrease the actual hospital demands compared to these projections but this effect is currently still under investigation. [Note again that the model does not consider a potential effect of the spring break which may lead to an intermediate relaxation due to reduced social interactions.]*

The corresponding **projections for ICU demands** also reflect the 80% reduced hospitalization risk for the Omicron variant and the current epidemic rebound. Together with the current age distribution of cases, the projections with the adapted hospitalization risk indicate a temporary increase in the ICU bed demands with a peak of around 15 beds in April (Fig. 6 left) compared to a peak of 10 beds in the projection of last week (Fig. 6 right). The more pessimistic scenario with a 13% increase in social interactions indicates a peak of 20 beds in April. Note that hospitalization and specifically ICU demands strongly depend on the age structure and vaccination status of cases. Hence, it is particularly important that vulnerable people are vaccinated and remain cautious in their social interactions to prevent severe cases. Furthermore, the projections consider the same reduction of the hospitalization risk for the subtype BA.2 as for the original Omicron variant.
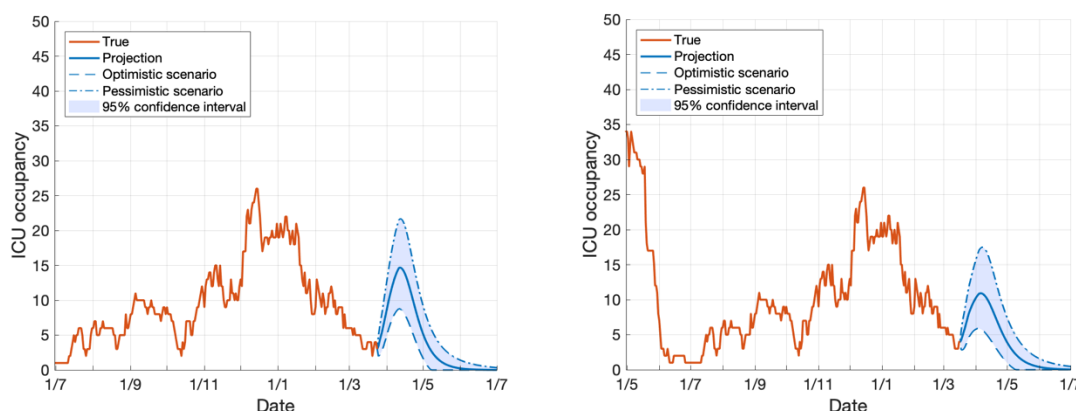

*Figure 7. Comparison of midterm projections for the 7-day average of ICU demands from this week (left) and last week (right). The blue solid line represents the most likely scenario and the optimistic (dashed line) and pessimistic scenarios (dotted-dashed line) correspond to a 13% decrease and increase in social interactions. **The projections exhibit a potential peak in ICU demands of 15 beds in April (left) compared to 10 beds in the projection of last week's projections (right)**.*
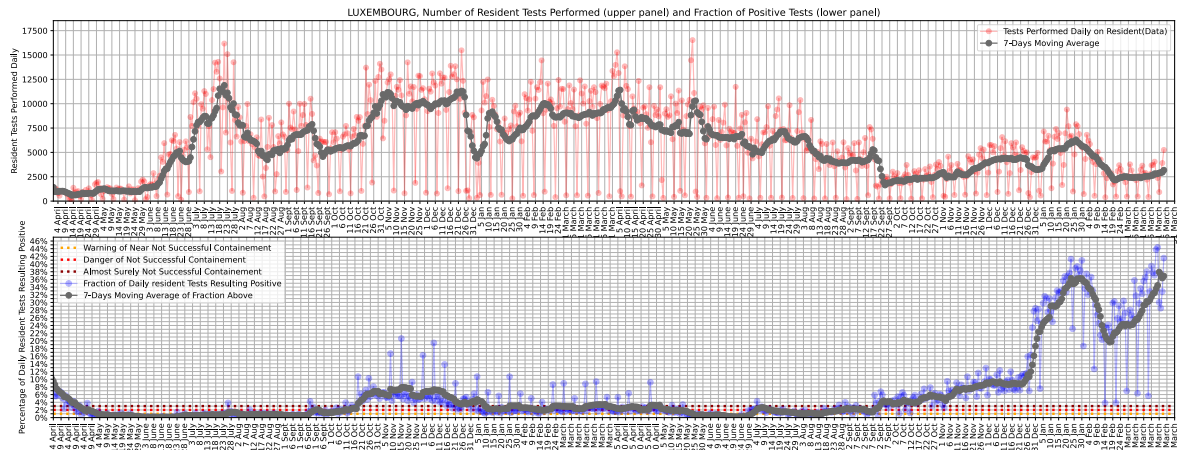
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Figure 8. *Number of daily tests performed (top) and overall normalized positive tests (bottom).* **During the current week, the 7-day average of positivity rate (grey) increased to around 37%** *compared to 32% last week.*
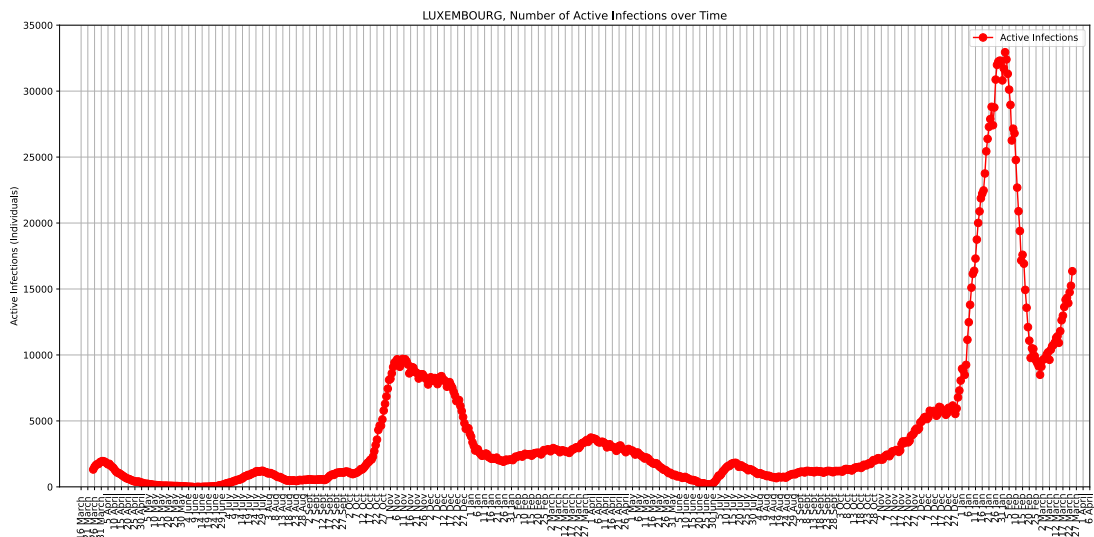

Figure 9. *During the current week,* **the number of estimated active cases has increased by 20% to 16,348 cases** *compared to 12,973 cases last week.*
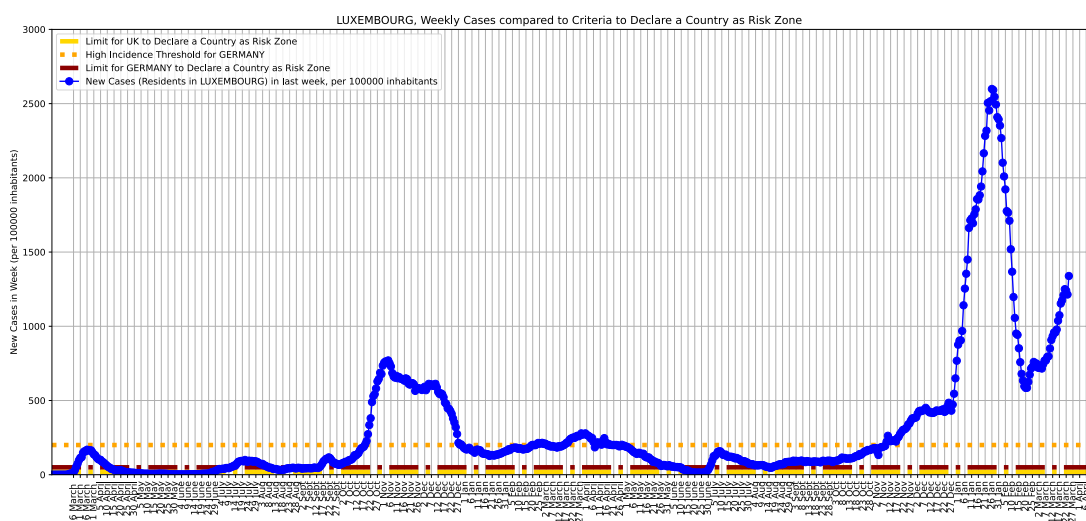

Figure 10. *Number of weekly cases per 100,000 inhabitants that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and per 100,000 inhabitants (dark red line).* **During the current week, the number of weekly cases per 100,000 inhabitants increased to around 1,400 cases for this week compared to 1,100 cases for last week.**