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Geneva, May 16, 2022

Swiss national SARS-CoV-2 genomic and variants surveillance program: report of the month of March

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1. Summary

In March, COVID-19 cases numbers began to rise again in Switzerland, largely driven by the BA.2 Omicron variant, possibly combined with the lifting of some of the prevention measures in the community. In parallel, circulation of the BA.1 variant strongly decreased.

In the midst of this increase in case numbers, approximately 0.9% of the total number of cases identified in Switzerland in March were sequenced by the Surveillance program, yielding nearly 8,000 sequences.

Delta is now extremely rare in Switzerland, with only 4 sequences detected in March, some known to be follow-up samples from severely immunosuppressed chronically infected patients treated with specific SARS-COV-2 antiviral therapy. Unsurprisingly, the BA.1 and BA.2 Omicron sub-lineages were the most frequent variants detected, with BA.2 being by far the most common.

Two new Omicron subvariants, BA.4 and BA.5, have been detected in South Africa. BA.4 and BA.5 are identical in their Spike protein, which closely resembles the Spike of BA.2, with a few additional mutations that are likely to further decrease vaccine efficacy as well as protection against infection conferred by prior infection by previous variants. BA.4 and BA.5 are currently driving a new wave of infections in South Africa. In March, no BA.4 and/or BA.5 samples were detected in Switzerland. Early data for April indicates one BA.4 sequence in Switzerland.

2. Description of the Swiss national SARS-CoV-2 genomic and variants surveillance program.

The overall goal of the program is to provide epidemiological trends and to highlight meaningful observations.

Because greater transmissibility and/or immune escape potential of the different VOCs and VOIs can result in new surges in COVID-19 numbers despite the vaccination campaign, this program aims to closely monitor each variant displaying mutations known to be linked with either increased transmissibility or immune escape potential.

Currently, 13 diagnostic laboratories are participating in the program, including university hospital centres in Switzerland (Geneva, Lausanne, Bern, Basel, Zurich, St-Gall, Ticino), in addition to private laboratories (Viollier; Medisupport including Dianalabs, Polyanalytic, Dianalabs Valais, Proxilab and Bioanalytica; Labor Team W, Risch), cantonal-based laboratories (Hôpital du Valais – Institut Central), Spital Region Oberaargau (Bern, Solothurn, Aargau, Luzern), and 3 high-throughput sequencing platforms (Health 2030 Genome Centre in Geneva, Functional Genomics Centre Zurich run by ETH Zürich and University of Zürich, Genomics Facility Basel run by ETH Zürich and University of Basel).

Processed sequencing data are shared openly within 14 days from positive PCR result through the GISAID platform (https://www.gisaid.org) and eventually through the Swiss Pathogen Surveillance Platform (SPSP). The centralized analysis of this National Surveillance will be performed by the groups of Pr. Neher, Pr. Stadler and Dr. Althaus, where variants of concern are counted, analyzed and all sequences scanned for new variants with potential changes in antibody-Spike interactions (https://nextstrain.org/groups/swiss, https://covariants.org/per-country, https://cov-spectrum.ethz.ch). This work is done in close collaboration with the Swiss National COVID-19 Science Task Force and the Swiss Institute of Bioinformatics (SIB).

In order to complement the genomic surveillance based on patient samples, sequencing of SARS-CoV-2 in wastewater samples is also performed, initially funded for 6 months. Samples are collected daily in six wastewater treatment plants (WWTP), under the coordination of Eawag. Up to 50 samples per week over the first 26 weeks have been performed. The sequencing and analysis of these samples, including detection of variants, is done under the coordination of Prof Niko Beerenwinkel. It started in December 2020 for Lausanne and Zurich, and in February 2021 for all six WWTP (https://bsse.ethz.ch/cbg/research/computational-virology/sarscov2-variants-wastewater-surveillance.html). The analysis of wastewater samples is envisaged to run until the end of the surveillance program on 31.3.2022.

Immunological characterization of the variants within the surveillance program is coordinated by Professor Trono's team at EPFL.

This report has been produced by Erik Boehm, Pauline Vetter, Marc Friedli, Samuel Cordey, Richard Neher, Christian Althaus, Martina Reichmuth, Cornelius Römer, Niko Beerenwinkel, David Dreifuss, Chaoran Chen, Tanja Stadler, Priscilla Turelli, Didier Trono, Emma Hodcroft, Nadja Wipf, Michael Bel, and Laurent Kaiser. The list of the participants and collaborators of the program can be found at the end of this report in the appendix.

This report covers the period of February 28 to April 3, 2022 (weeks 9, 10, 11, 12, 13). All data presented in this report are based on the sampling date. March 2022 was the last month covered under the original national surveillance program funding. The program has been continued at a lower funding level, so subsequent months will have less data.

3. Variants of concern (VOCs), variant of interest (VOI) and other surveilled variants: brief summary and special focus

Five variants and their sub-lineages are considered VOCs by the WHO, B.1.1.7 (Alpha), B.1.351 (Beta), P.1 (Gamma), B.1.617.2 (Delta), and B.1.1.529 (Omicron). Worldwide, all VOCs except Omicron have essentially disappeared from samples collected within the last 30 days (https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---22-march-2022).

Omicron

The Omicron VOC (B.1.1.529) was first identified in southern Africa during November 2021. It carries an unprecedented number of mutations on the genome (>50), with most being on the gene coding for the Spike protein (>30) and in particular within the receptor binding domain (≥15). These mutations are associated with both immune escape and/or increased transmissibility, conferring this variant a growth advantage. It has split into 5 sublineages: BA.1-5, with BA.1 giving rise to a further sublineage, BA.1.1.

By week 9 (28-February to 6-March 2022) BA.2 was dominant in Switzerland, although BA.1 was initially the most common sub-variant. BA.2 has a unique set of N-terminal Spike mutations compared to BA.1; but the two sublineages share most RBD mutations. BA.2 also has mutations that alter glycosylation (affecting immunogenicity). BA.3 is rare and never achieved widespread circulation. BA.4 and 5 were first detected in South Africa at the start of April, and appear to be displacing BA.2. Notably, BA.4 and BA.5 have identical spike proteins (differing in mutations outside of Spike), that differ significantly from BA.1 but differ from BA.2's spike protein by only a few mutations. Both BA.4 and BA.5 contain the L452R mutation in their RBD, which is also found in Delta, and has been associated with both increased ACEII affinity and decreased neutralization by mAbs/poly-clonal sera.

Detection

All sub-lineages are still detected by RT-PCR tests, but BA.1,3,4, and 5 (but not BA.2) exhibit S-gene target failure with some assays that can be used as a proxy prior to sequencing, as seen with VOC Alpha (and due to the same deletion as found in Alpha). Due to the dominance of Omicron within Switzerland, the absence of S-gene target failure is currently a good proxy for BA.2 infection. All Omicron variants contain deletions in the N-gene that results in N-gene dropout when using the PCR test from Huwel Life Sciences, Hyderabad, India. Antigenic tests are still able to detect this variant.

Immune escape

Extensive data now demonstrates that Omicron variants are able to evade neutralizing antibodies (nAbs) raised against previous variants or after 2 doses of vaccine. Notably, all Omicron sublineages display complete escape from combination of casirivimab/imdevimab (REGN-CoV2), one of the monoclonal antibody treatments available in Switzerland. Sotrovimab is currently the only antibody available in Switzerland that retains substantial neutralizing activity against BA.1. According to *in vitro* data, BA.2 is significantly more resistant than BA.1 and ancestral variants to Sotrovimab. *In vitro* studies using live virus show severe reductions to the IC_{90} titer against BA.2, and a recent study failed to find any beneficial effect of Sotrovimab treatment in the context of BA.2 infections. While all Omicron sublineages largely escape humoral immunity, cell mediated immunity remains mostly intact.

A 3rd vaccine dose or a combination of previous infection and 2 vaccine doses has been shown to retain moderate neutralization of Omicron. In the community setting, this moderately effective humoral response after a 3rd dose and the retained cellular response translates to moderate (>50%) vaccine effectiveness against symptomatic infection, high effectiveness against severe outcomes, and very high efficacy at preventing hospitalization and death. Even after 3 doses, immunity will begin to wane. Four doses have been shown to be highly effective at preventing hospitalization and death. Israeli studies investigating the effect of a 4th dose have found that vaccine efficacy against any infection, relative to a 3rd dose, was relatively low at 30%. Vaccine efficacy of a 4th dose against symptomatic disease was found to be substantially higher, possibly as high as 65%.

Despite both being considered “Omicron”, BA.1 and BA.2 differ from each other (in terms of mutation counts) more than the earlier VOCs differed from the original Wu-1 strain, which raised concerns about cross protection. Studies have found that infection with BA.1 generally offers cross-protection against BA.2, and vice versa, with only a low rate of reinfection with BA.2 following a BA.1 infection. Similarly, some subjects are known to have failed to develop neutralizing antibodies against BA.2 after BA.1 infection. As BA.4/5 are even more divergent from BA.1, at this moment it is unclear to what extent a prior infection with BA.1 will protect against infection by BA.4/5. The spike in cases in South Africa suggests a significant proportion of the population is susceptible to BA.4/5, but it is unclear if these results are applicable to the Swiss population. Notably, the Omicron wave in South Africa was primarily driven by BA.1, in contrast to the Omicron wave in Switzerland had a higher proportion of BA.2 cases.

Severity

A multitude of studies show that Omicron BA.1 and BA.2 cause intrinsically milder disease. There is currently no good reason to expect that the few additional mutations in BA.4 and BA.5 will substantially alter this. Severity determinations are complicated by an over representation of reinfections/vaccine breakthroughs in Omicron cases which are already expected to be mild due to the protective effect of prior vaccination/exposure. To date, no study has properly controlled for pre-existing immunity through serology studies. While BA.2 was more severe than BA.1 in an animal study, no clinical difference between BA.1 and BA.2 infections has been noted.

The Delta VOC

Delta has become extremely rare in Switzerland, with only 4 cases detected in March. It is unlikely to continue to be a factor in the epidemic, barring the emergence of a new sub-lineage from an as yet undetected source (chronic infection, animal reservoir, etc.).

Recombinants

Recombinant virus formation occurs by coinfection by 2 different strains within the same host. Numerous verified recombinants between Delta and Omicron BA.1 have been detected, as well as between Omicron BA.1 and BA.2. Some of those recombinants include those with the Pango lineage designations: XD, XE and XF. Data from the UK indicates that the recombinant XE may have a slight (10-20%) replicative advantage over BA.2, but overall case numbers are too small to draw firm conclusions from.

Therapeutic intervention effectiveness

Numerous mutations have been reported to substantially reduce the therapeutic effectiveness of mAbs currently used to treat COVID-19, as well as those under development (Table 1). Notably, BA.2 substantially escapes neutralization by Sotrovimab. As Sotrovimab is still being used, additional mutations causing escape from it will thus be closely followed (Table 1, and section 7).

AA position	World	Europe	Switzerland	Mutations
337	33	17	0	R/L/H/T
340	237	153	12	K/A/G/Q/V
356	93	63	4	T
377	0	0	0	K

Table 1: Positions where mutations are known to result in escape from sotrovimab, and their prevalence, and the specific amino acid mutations known to result in escape, March 2022

In addition to mAbs, there are a number of other antiviral treatments under development, such as 3CL like protease inhibitors like Paxlovid® (PF-07321332) or RNA nucleotide analogues (which interfere with replication of the viral genome, such as Molnupiravir). No data is available regarding mutations enabling escape from these proteases. In contrast, serial passage of virus in the presence of Molnupiravir led to resistance at the cost of significantly reduced overall viral fitness. As such mutations are detrimental when Molnupiravir is not present, limited use is unlikely to lead to resistant strains. Preliminary data confirms that Molnupiravir, Paxlovid, and Remdesivir all retain full *in vitro* efficacy again Omicron.

The circulation of specific mutations leading to decreased effectiveness of known therapeutics available for clinical use in Switzerland will be surveilled (see Section 7), but their prevalence remains low.

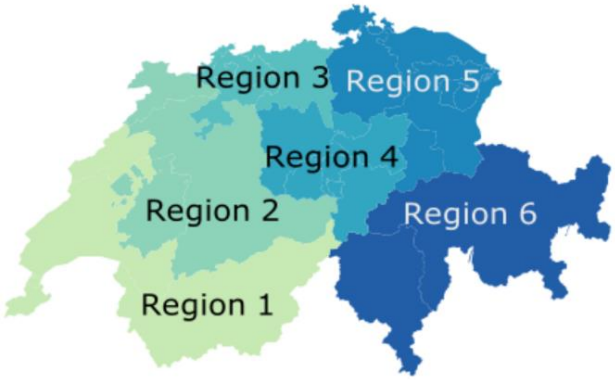
4. Epidemiology in Switzerland and number and origin of sequences produced through the program during the surveilled period

Data in this report comes from 3 sources: 1) The publicly available data on COVID-19 as reported by the FOPH (https://www.covid19.admin.ch), including data that is declared to the FOPH by the different laboratories in Switzerland; 2) data originating from laboratories participating in the surveillance program; and 3) sequences submitted to GISAID, for which the corresponding infected person was in Switzerland (resident or recent travel history to Switzerland).

General caveat: the numbers and denominators are fluid and variable over time; and are subject to change depending notably on the different databases used, and variable declaration delays. All data generated by this program is also submitted to SPSP.

The number and origin of sequences submitted to GISAID by each laboratory during January and February, 2021, prior to the start of the surveillance program can be found in the first report covering the months of March and April 2021.

Data will be presented here by regions, using the same region definitions that are used for the influenza sentinel surveillance system in Switzerland. Data are presented according to residency post-code.



Region 1 includes the cantons of Geneva, Neuchatel, Vaud and Wallis

Region 2 includes the cantons of Bern, Fribourg and Jura

Region 3 includes the cantons of Aargau, Basel (Basel-Stadt and Basel-Land) and Solothurn

Region 4 includes the cantons of Luzern, Unterwalden (Obwalden and Niedwalden), Schwitz, Uri and Zug

Region 5 includes the cantons of Appenzell (Appenzell Ausserrhoden and Appenzell Innerrhoden), Glarus, Sankt Gallen, Schaffhausen, Thurgau and Zurich.

Region 6 includes the cantons of Graubünden and Ticino.

Divisions of the different regions, from https://covariants.org/per-country

Number of cases processed by the laboratories participating in the surveillance program

During March, the FOPH reported a total of 561,374 confirmed SARS-CoV-2 cases in Switzerland, representing a substantial increase from February. Supplementary Table 1 provides an overview of the number and incidence of confirmed cases, the effective reproduction number R_e, the number and incidence of tests, test positivity, the number and proportion of sequenced samples, and the number and proportion of VOCs by canton, region and for Switzerland overall.

As of the writing of this report, the laboratories participating in this program reported 243,669 positive tests during the surveilled program, which represents over 43% of the total number of cases reported in Switzerland (including both PCR and antigen-based tests). Detailed data regarding the total number of tests performed each week by the laboratories participating in the surveillance program (including negative and positive tests numbers, and the number of the positive tests that have been sequenced) are available in supplementary Table 3.

Number of declared SARS-CoV-2 sequences produced through the surveillance program (presented by submission date, further declarations are still ongoing)

A total of 7,977 SARS-CoV-2 sequences have been declared to have been submitted to GISAID during this period. There are 9,962 sequences are available for this period on GISAID as of 29 April 2022, and the difference may be explained by reporting delays.

This represents around 1.1% of all cases detected in Switzerland during the surveilled period (see Supplementary Table 2 and 3 in the Appendix for details). Of note, this number includes sequences from samples received from other laboratories at the request of the Cantonal physician teams.

Table 2 shows the number of sequences successfully submitted to GISAID through the surveillance program during the surveilled period by calendar week (data is incomplete).

Week	Date	Number of sequences declared and successfully submitted to GISAID during the surveilled period, by all laboratories in the program
9	Feb 28 to Mar 6	1 914
10	Mar 7 to Mar 13	1 834
11	Mar 14 to Mar 20	1 707
12	Mar 21 to Mar 27	1 653
13	Mar 28 to Apr 3	869
	Total	7977

Table 2: number of sequences submitted to GISAID through the surveillance program. Note these data are not by sampling date but rather by submission to GISAID date. Data are incomplete due to late reporting by one laboratory

The total number of SARS-CoV-2 sequences declared and submitted to GISAID by each laboratory during the month of February is available in Supplementary Table 3 in the appendix.

Covering of sequencing in Switzerland and contribution of the national SARS-CoV-2 surveillance sequencing program

As shown in Figure 1, the total number of SARS-CoV-2 sequences submitted per week generally declined through March (weeks 9-13), along with the fraction sequenced, reflecting the decrease in sequencing as case numbers climbed. Since the beginning of this program, almost all of the sequences available in GISAID (green curve) and those on which the surveillance is conducted, come from the national surveillance program.

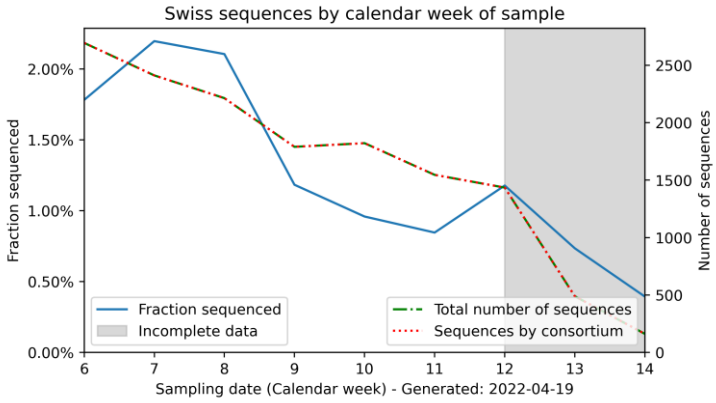


Figure 1: Number of SARS-CoV-2 sequences available for Switzerland (total available Swiss sequences in GISAID in green, Swiss sequences submitted through the program in dotted orange) and fraction of the total number of positive cases declared to the FOPH that have been sequenced (blue curve).

During the surveilled period, the absolute number of sequences generated remained relatively high, but due to high circulation of the virus, the total proportion of positive sequenced cases was low. These sequences include those from sites with hospitalized patients, and thus should be adequate for surveillance.

Figure 2 displays the number and fraction of SARS-CoV-2 cases sequenced for each Swiss region. Regions 4 and 6 continued to have the lowest total number of sequences, while Region 4 continued to have the lowest fraction of cases sequenced.

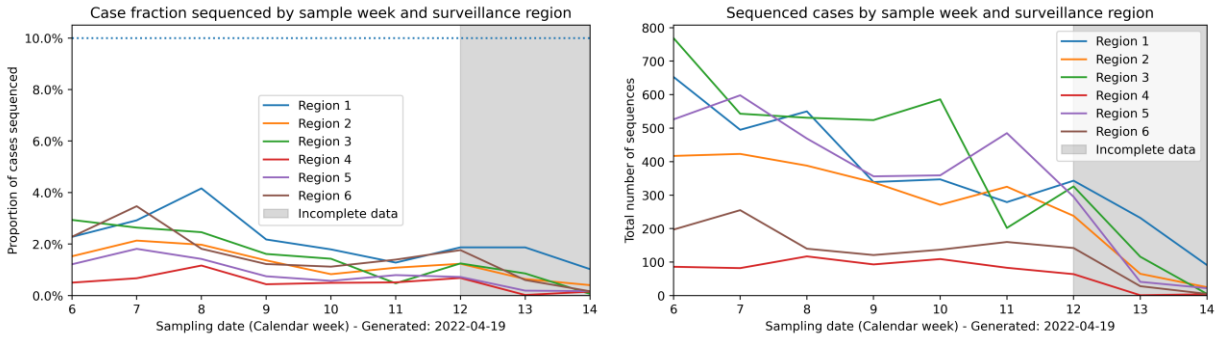


Figure 2: Sequencing coverage among the different Swiss regions per week, presented by fraction of cases sequenced (left) and by number of sequences (right).

5. Variants circulating in Switzerland since January 2021, with a focus on the surveilled period

Determination of the proportion of total number of sequences over time falling into defined variant groups is done by Emma Hodcroft's team and displayed on the CoVariant website (https://covariants.org/per-country). Those results are based on the total number of sequences submitted to GISAID over the time period for Switzerland. Those data mainly, but not exclusively, come from the national genomic surveillance program since its beginning (see Figure 1).

Omicron BA.2 was by far the most commonly retrieved lineage early in March (Figures 3-5, Table 3).

Region	Delta	Omicron (BA.1)	Omicron (BA.2)	sequences	cases	% sequenced
All	4	847	4420	5292	561374	0.9%
1	1	196	1001	1201	71868	1.7%
2	0	157	738	899	92048	1.0%
3	2	193	1028	1230	122942	1.0%
4	0	50	205	257	52159	0.5%
5	1	162	1012	1180	186000	0.6%
6	0	81	383	467	36357	1.3%

Table 3: number of sequences corresponding to selected variants in each region of Switzerland from 28 February 2022 to 3 April 2022, according to data received by 21 April, 2022. Sequences with poor coverage where lineages could not be assigned are excluded.

No BA.3 was found during the surveilled period. During the surveilled period, 3 XE (BA.1 & BA.2 recombinant) sequences were found in Switzerland. An estimate of the total number of VOCs circulating in Switzerland, corrected by taking in account the fraction of sequencing in Switzerland is available through the covSPECTRUM program, developed at ETHZ, at https://cov-spectrum.ethz.ch/explore/Switzerland.

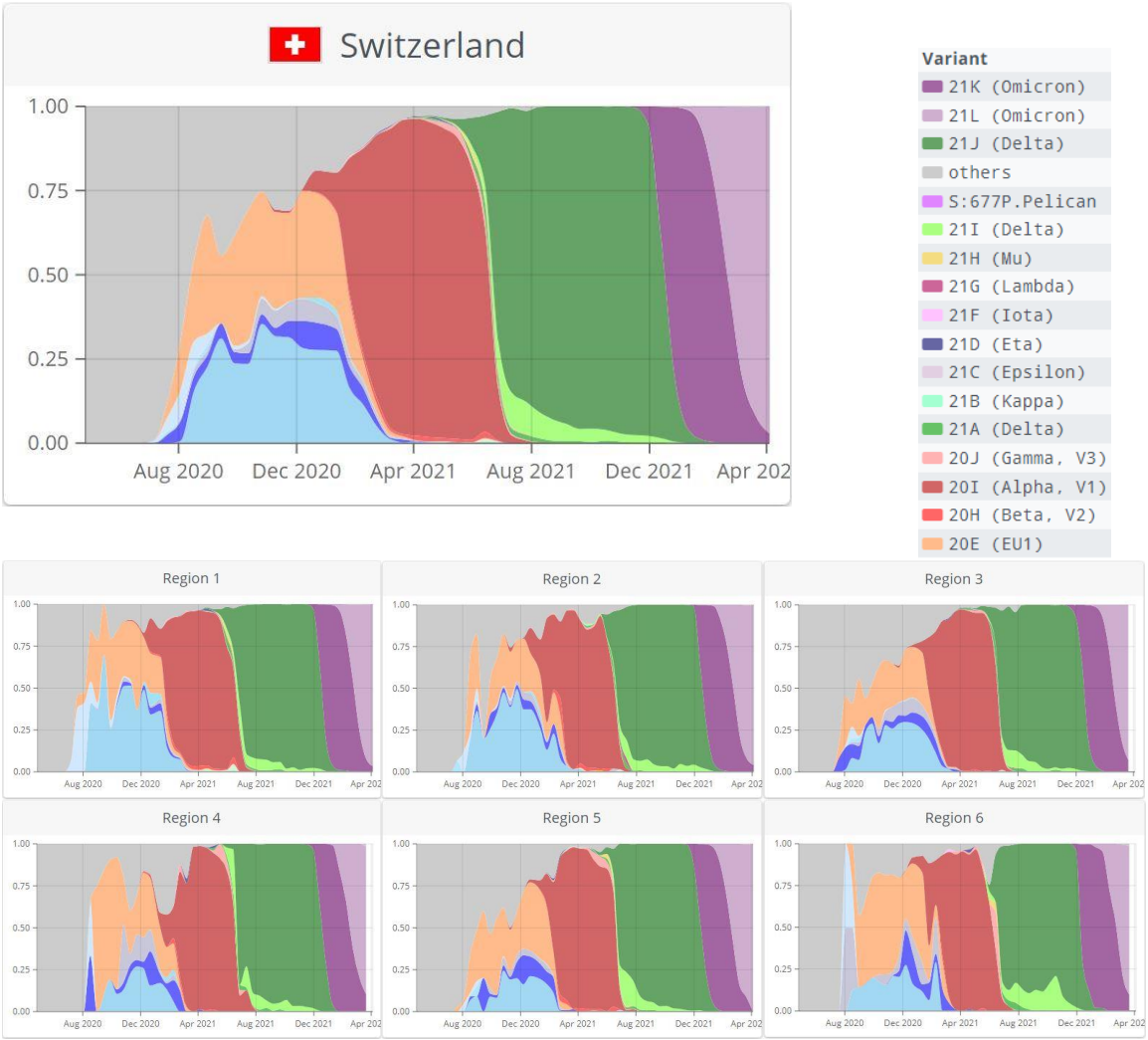


Figure 4: proportion of the total number of sequences (not cases), over time, that fall into defined variant groups, for Switzerland. Screenshot from CoVariants website. Dynamic navigation is available at https://covariants.org/per-country. Dark green indicates the B.1.617.2 (Delta) lineage or its sub-lineages. Dark Red indicates B.1.1.7 (Alpha). Purple indicates BA.1 (Omicron), Light purple indicates Omicron sublineage BA.2, which is currently dominant.

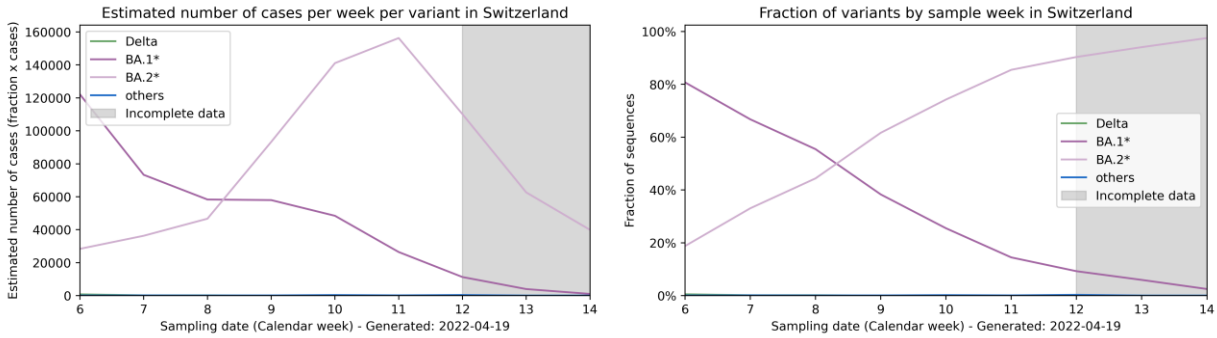


Figure 5: (Left): Percentage of circulating VOCs and VOIs in Switzerland by week, up to the 14 first weeks of 2022 (total number of B.1.617.2 (Delta), BA.1 and BA.2 sequences from Switzerland and successfully submitted to GISAID are shown here). Note the grey shaded area indicates a period of incomplete data.
(Right): Estimated number of sequences of Delta, BA.1, BA.2, and others retrieved during the surveilled period.

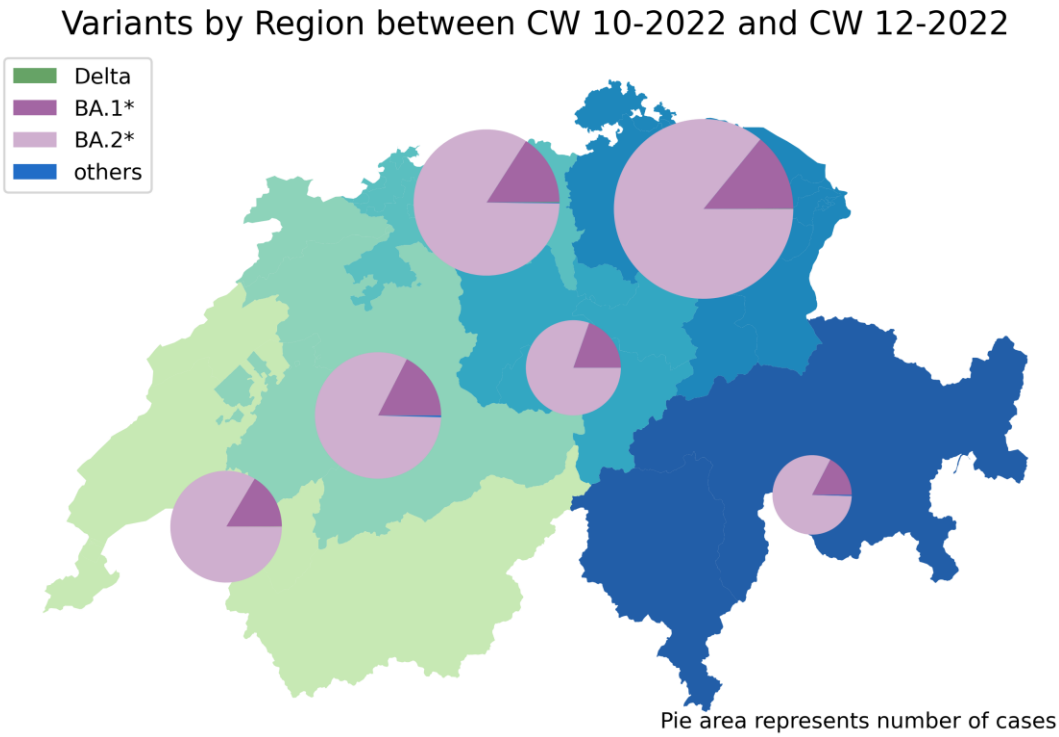


Figure 6: Distribution of variants per region, for March 2022 shown on a map. The size of the pie chart corresponds to the total number of sequences. Note Omicron's extreme dominance, and the large share of the BA.2 sublineage, in all regions as of the time of this report.

6. Assessment of the competition between the different variants in Switzerland

The competition between different SARS-CoV-2 variants can be modelled using multinomial logistic regression. The analysis by Dr. Althaus' group is based on sequences retrieved from CovSPECTRUM. The results correctly predicted that Omicron would be the dominant SARS-CoV-2 variant in Switzerland. These models also correctly predicted that the BA.1 sub-lineage would be replaced by the BA.2 sublineage (figure 7).

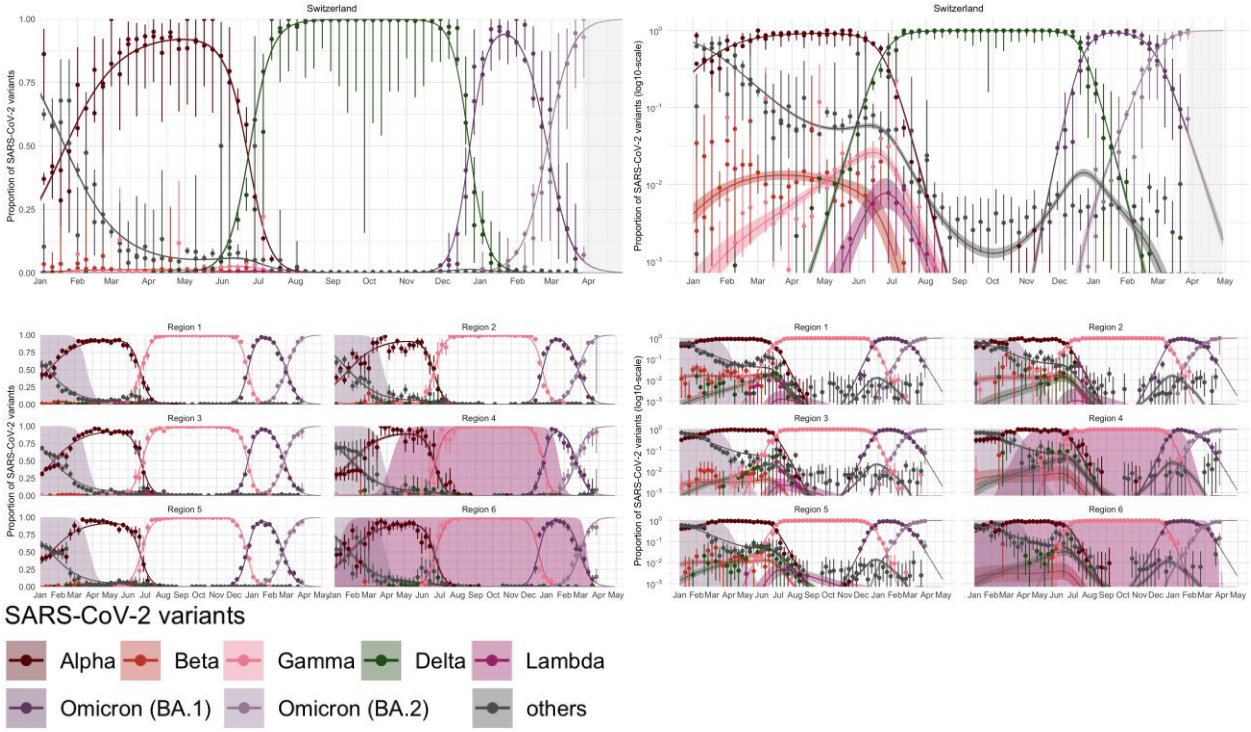


Figure 7: Observed and modeled proportion of SARS-CoV-2 variants over time in Switzerland. Left: graphed by linear proportions. Right: graphed by Log_{10} proportions. In April and May 2021, Gamma and Delta started to replace Alpha, with Delta outcompeting all other variants. At the end of October, more than 99.9% of the retrieved sequences in Switzerland were due to Delta or one of its sub-lineages. In late November, BA.1 arrived in Switzerland and began to rapidly displace Delta. Omicron BA.1 achieved dominance by the end of December, but was then replaced by Omicron BA.2. Model fits are based on a multinomial logistic regression with splines.

7. Surveillance of mutations associated with reduced mAb treatment efficacy

A number of mutations have been reported to result in significantly reduced *in vitro* effectiveness of the Sotrovimab and Casirivimab/Imdevimab association monoclonal antibodies used to treat patients in Switzerland. Notably, Omicron is completely resistant to neutralization by Casirivimab/Imdevimab, and Sotrovimab remains the only mAb available in Switzerland that retains effectiveness against Omicron BA.1. Unfortunately, this effectiveness is expected to be significantly decreased for the BA.2 sublineage (which has replaced BA.1), on the basis of various disparate experiments reporting 8.5 to 340 fold reductions of *in vitro* neutralizing titers. The escape is however not complete, and Sotrovimab retains significant activity against BA.2 at higher titers – thus the frequencies of mutations reported to escape neutralization by Sotrovimab are still being followed (Table 4).

	337H		337L		337R		337T	
Week	Global	Switzerland	Global	Switzerland	Global	Switzerland	Global	Switzerland
28.02.2022	0	0	3	0	5	0	1	0
07.03.2022	0	0	4	0	5	0	1	0
14.03.2022	1	0	3	0	5	0	0	0
21.03.2022	0	0	2	0	1	0	0	0
28.03.2022	0	0	2	0	0	0	0	0

	340A		340K		340G		340Q	
Week	Global	Switzerland	Global	Switzerland	Global	Switzerland	Global	Switzerland
28.02.2022	15	1	33	0	2	0	1	0
07.03.2022	11	0	36	2	4	0	8	0
14.03.2022	9	0	29	3	1	0	3	1
21.03.2022	12	0	24	2	1	0	4	0
28.03.2022	10	0	16	3	2	0	7	0

	340V		356T		377K	
Week	Global	Switzerland	Global	Switzerland	Global	Switzerland
28.02.2022	1	0	21	0	0	0
07.03.2022	7	0	13	0	0	0
14.03.2022	0	0	21	2	0	0
21.03.2022	0	0	22	1	0	0
28.03.2022	1	0	16	1	0	0

Table 4: Global and Swiss counts of sequences bearing escape mutations from therapeutic mAbs used in Switzerland

As seen in table 4, additional known mutations enabling escape from Sotrovimab have been detected in Switzerland, but remain rare. Notably, 3 of the 340K escape mutations originate from Geneva. All 3 had been treated with Sotrovimab 7-10 days before sampling, suggesting that these mutations emerged in response to Sotrovimab treatment

8. Wastewater surveillance program

Sequences are obtained from six wastewater treatment plants (WWTPs) that are tested on a daily basis. Signatures of the BA.1 (Omicron) variant were first detected at the earliest in sequenced sewage samples of the Basel-Stadt cantonal wastewater surveillance project, dating from November 21 onwards. Since then, Omicron has been detected in all other surveyed WWTPs, and quickly grew in relative prevalence during the month of December to become the major variant in wastewater samples in most of the surveyed locations by the end of the year, and in all surveyed locations by the beginning of January. Since the end of January, BA.2 has been steadily increasing in all wastewater treatment plants of the program. By the end of the month of February, the BA.2 variant was dominating in all surveyed areas. By the end of March, BA.1 had almost completely disappeared, having been replaced by replaced by BA.2.

Quantification of Omicron in sewage has exhibited some peculiar challenges (in Switzerland and in other countries): some data indicates that this variant is less shed in faeces compared to Delta. The differential shedding could lead to an underestimation of the prevalence of Omicron relative to Delta when using wastewater sequencing data. This bias is not expected at the moment to impact quantification of BA.2 relative to BA.1. Other challenges in the quantification of variants from wastewater sequencing data stem from shared mutations between lineages, which can under some conditions lead to inferring spurious low frequency prevalence of some variants, and our methodology is evolving to mitigate these effects.

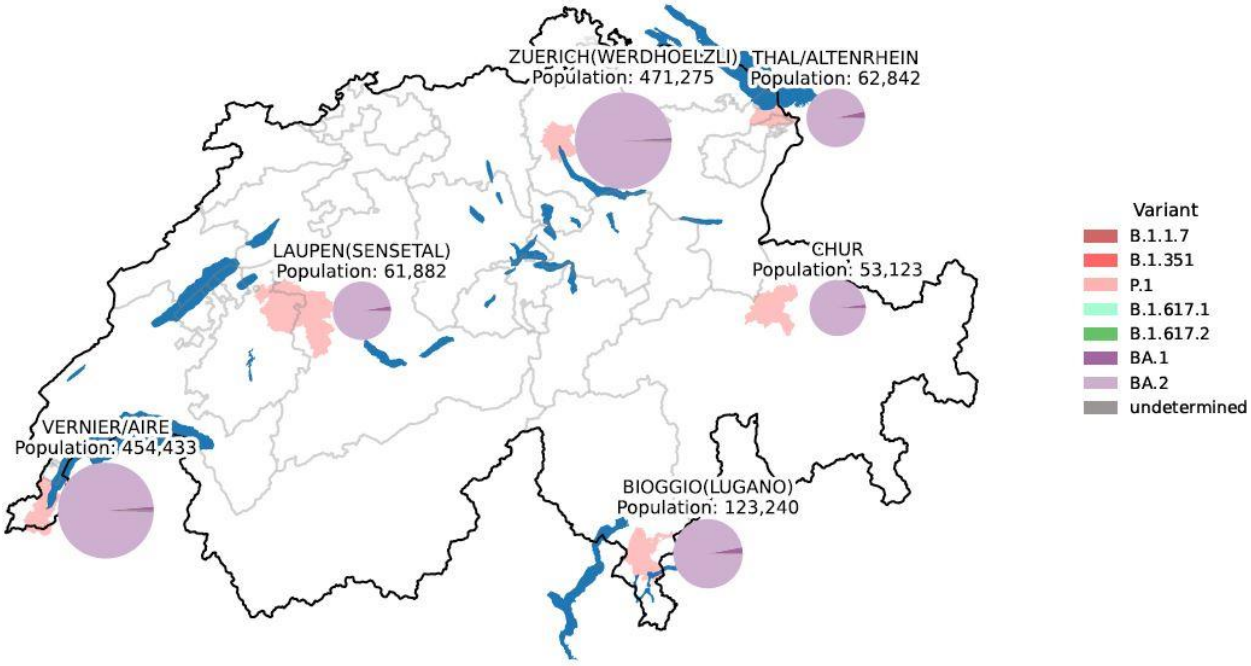


Figure 8:
Overview of the prevalence of variants of SARS-CoV-2 at the end of March 2022, estimated from wastewater samples collected daily during the month in WWTPs located in 6 different Swiss locations. Pie chart areas are proportional to population connected to the wastewater treatment plants. Pink shaded areas represent catchment areas (boundaries from 2017). Population connected to Vernier (GE) wastewater treatment plant also includes ~44,000 inhabitants from neighbouring French communities. B.1.617.2 (Delta) is represented in in dark green, B.1.617.1 in light green (Kappa), B.1.617.3 in purple, B.1.1.7 (Alpha) in dark red, B.1.351 (Beta) in light red, P.1 (Gamma) in pink, BA.1 (Omicron) in dark purple, and BA.2 (Omicron) in light purple.

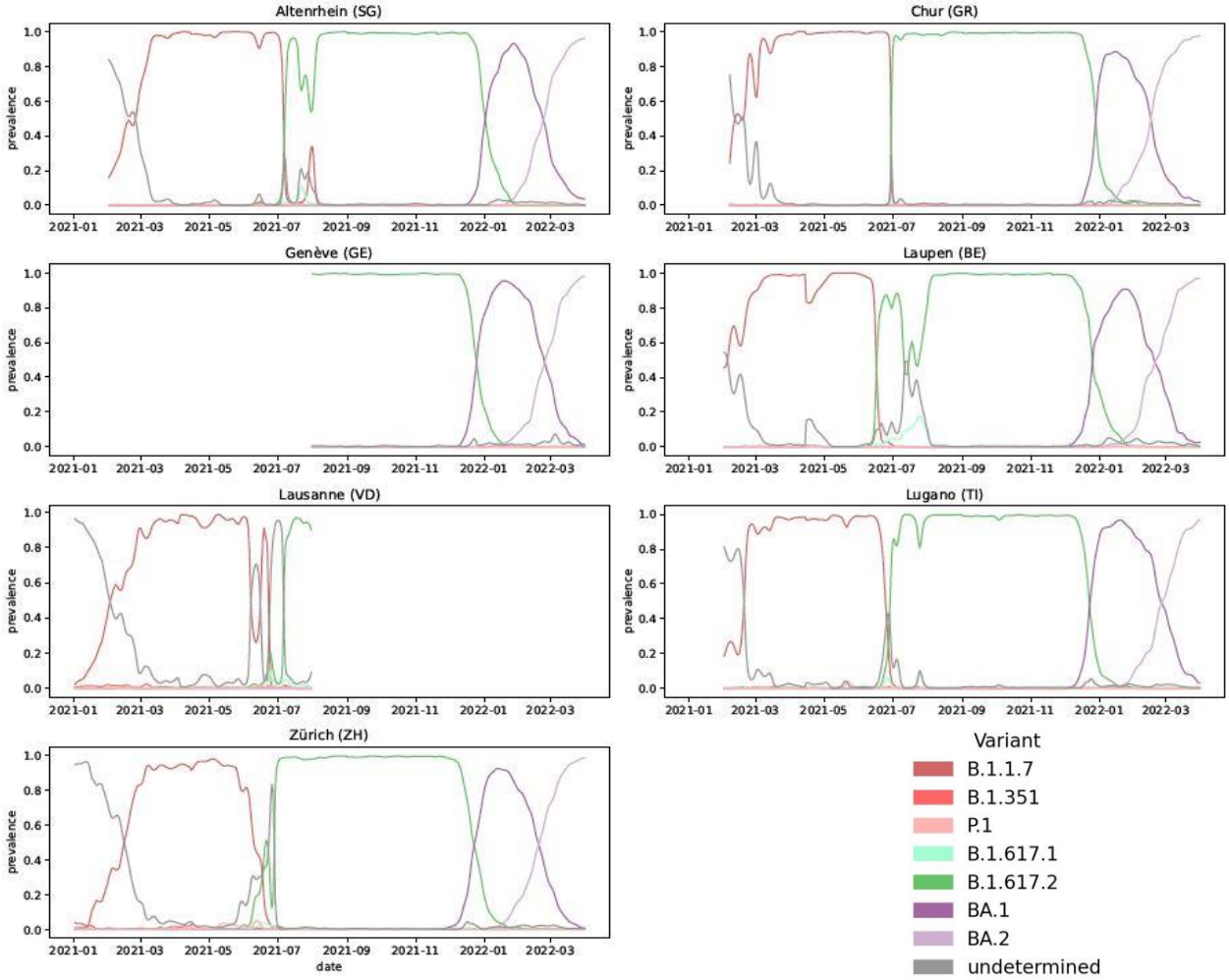


Figure 9: Prevalence of variants of SARS- CoV-2 estimated from wastewater samples collected daily until March 31 (except Lausanne: July 31) in WWTPs located in 7 different Swiss cantons. B.1.617.2 (Delta) is represented in dark green, B.1.617.1 (Kappa), in light green, B.1.617.3 in purple, B.1.1.7 (Alpha) in dark red, B.1.351 (Beta) in light red, P.1 (Gamma) in pink, BA.1 (Omicron) in orange, and BA.2 (Omicron) in light blue. An online dynamic navigation is available at https://bsse.ethz.ch/cbg/research/computational-virology/sarscov2-variants-wastewater-surveillance.html.

Acknowledgements:

https://bsse.ethz.ch/cevo/research/sars-cov-2/swiss-sars-cov-2-sequencing-consortium.html

Meriem Bekliz, Kenneth Adea, Pauline Vetter, Christiane S Eberhardt, Krisztina Hosszu-Fellous, Diem-Lan Vu, Olha Puhach, Manel Essaidi-Laziosi, Sophie Waldvogel-Abramowski, Caroline Stephan, Arnaud G. L'Huillier, Claire-Anne Siegrist, Arnaud M Didierlaurent, Laurent Kaiser, Benjamin Meyer, Isabella Eckerle for the characterization neutralization of Omicron by patient sera.

Erik Boehm, Marc Friedli, Pauline Vetter, Samuel Cordey, Richard Neher, Christian Althaus, Emma Hodcroft, Tanja Stadler, Philippe Lemercier, Ioannis Xenarios, Lorenzo Cerutti, Louis Du Plessis, Nadja Wipf, Michael Bel, Laurent Kaiser, for the Swiss national SARS-CoV-2 genomic and variants surveillance program coordination committee.

Appendix:

SARS-CoV-2 epidemiology in Switzerland:

We used publicly available data on COVID-19 as reported by FOPH (https://www.covid19.admin.ch) and sequence data submitted to GISAID to provide a summary of the SARS-CoV-2 epidemiology in Switzerland. Data presented here cover the period from 28 February 2022 to 3 April 2022.

sup_table_overview_Mar.xlsx

Supplementary Table 1: Epidemiological data for Switzerland, its regions and cantons for January: population, number and incidence of confirmed cases, effective reproduction number R_e, number and incidence of tests, test positivity, number and proportion of sequenced samples, and number and proportion of VOCs. R_e by region is represented as the median and range of the daily R_e values for all cantons within a region.

week	Date	Total PCR tests	Positive tests	Sequenced	% positives	% positives sequenced
9	Feb 28 to Mar 6	102 055	54 397	1 914	53.3%	3.52%
10	Mar 7 to Mar 13	121 546	69 735	1 834	57.4%	2.63%
11	Mar 14 to Mar 20	99 231	57 261	1 707	57.7%	2.98%
12	Mar 21 to Mar 27	74 177	39 850	1 653	53.7%	4.15%
13	Mar 28 to Apr 3	47 339	22 426	869	47.4%	3.87%
	Total	444 348	243 669	7 977	54.8%	3.27%

Supplementary Table 2: Total number of tests performed by the laboratories participating in the surveillance program from 28 February 2022 to 3 April 2022.

Week	Date	Basic Surveillance						Augmented Surveillance						Sentinella Laboratories		
		EOC	St-Gallen	Labor Team W	Risch	SRO	Synlab	USB	IFIK	Diana labs	CHUV	UZH	ICH-VS*	HUG	ETH/ Viollier	All
9	Feb 28 to Mar 6	58	48	0	23	85	0	201	179	84	90	214	88	135	709	1 914
10	Mar 7 to Mar 13	76	48	186	46	55	0	179	176	87	86	217	94	143	441	1 834
11	Mar 14 to Mar 20	104	48	186	0	55	0	158	180	87	84	139	94	143	429	1 707
12	Mar 21 to Mar 27	95	47	186	0	56	0	160	177	78	63	90	94	142	465	1 653
13	Mar 28 to Apr 3	28	48	0	0	0	0	199	46	82	74	85	24	138	145	869
	Total	361	239	558	69	251	0	897	758	418	397	745	394	701	2189	7 977

*Supplementary Table 3: number of sequences submitted to GISAID by each laboratory during the surveilled period (28 February 2022 to 3 April 2022). *including sequencing sent to high-throughput platforms. ND = No data*

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