Results of a cross-validation exercise of the Global Influenza B Study (GIBS) and WHO FluNet databases

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Summary

Background: The WHO FluNet database is a publically available database which is being used by researchers around the world to study the epidemiology of influenza. The Global Influenza B Study (GIBS) database was established in 2013 and considering it covers 30 countries and was developed independently from the FluNet database, we aimed to compare the two database in an effort to validate the WHO FluNet database.

Methods: The GIBS database was initially assembled in 2013-14, and contains epidemiological and virological influenza surveillance data from thirty countries around the world. In June 2018, we downloaded the influenza surveillance data available in the WHO-FluNet database for the same countries and years. We performed the following comparative analysis of public health-relevant characteristics of influenza epidemics: 1) the proportion of influenza B over all influenza cases in each country and season; 2) the proportion of B/Victoria and B/Yamagata lineages over all influenza B cases in each season and country; 3) the "typical" timing and amplitude of influenza epidemics (overall and separately for influenza A and B epidemics) in each country using the EPIPOI software

Results: Our analysis was based on 21 countries where there was comparable data from FluNet and GIBS for the post-pandemic period (i.e. from 2010 onwards). For 9 countries, we found the same or very similar data in both datasets. For 12 countries, the FluNet data was very different and, although we did not have enough information to clarify the exact reasons for the differences (e.g. what type of data was reported in the FluNet database (primary care, secondary care, or both)?), the data contained in the two databases were mostly not independent from each other.

Conclusions: After inspecting the two databases in detail, we concluded that it was not possible to validate the FluNet database using the GIBS dataset. The main reasons for this are that they presented different datasets for the same country but the independence of the two databases was

not likely and other factors (e.g. we only had very specific regional data for a country). In order to better interpret and validate the FluNet database in the future, we recommend that WHO carries out routine surveys of the national data sources in each country (e.g. define which populations are included in the database, define the national representativeness of the data) and makes this information available in the public domain.

Background

The WHO FluNet database is a publically available database which is being used by researchers around the world to study the epidemiology of influenza [**1-5**]. The database is web-based and has been maintained by the WHO Global Influenza Surveillance and Response System since 1995. National Influenza Centres (NICs) from countries around the world enter epidemiological and virological data into the FluNet database on a weekly basis. The data are used by WHO to write bi-weekly reports on the epidemiology influenza around the world (e.g. which viruses are circulating in which regions) and these form a general background reference for the WHO vaccine selection meeting that is held in Geneva in February and September of each year. The dataset has also become a very valuable source of information for public health research, with the data used to assess issues like when to vaccinate in the different regions of the world [**6**], vaccine mismatch studies [**7**], modelling studies [**4**] and changes in the epidemiology of influenza over time [**8**].

Despite the frequent use of this dataset there are a number of challenges with the FluNet database. One important challenge is that there is no background information about the data that is being collected at a national level: What case definitions are being used to collect and swab patients (ILI, ARI or SARI)? What is the patient mix of the influenza detections (in- and out-patients)? What laboratory methods are used to make the detections? What coverage is available (national regional, urban)? Another challenge concerns the completeness of the data and our group has noted that many countries and regions lacked data on the characterization of influenza B cases [**9-10**] and some countries (e.g. the Netherlands) [**11**] have missing data. A final challenge is that there is no scientific paper that has assessed the validity of the FluNet dataset.

Considering the GIBS database covers 30 countries (June 2018), has been developed independently [**9**] from the FluNet database, contains more data per country and is documented

more extensively [**9**], we thought this would be an important opportunity to validate the WHO-FluNet database using the GIBS database as the gold standard. The validation procedure would focus in particular on a number of key metrics that have relevance from a public health standpoint (e.g. for their importance in informing influenza control and prevention policies globally). These include the number of influenza reports, the virus mix, peak and length of influenza epidemics, the number of peaks per year, and others. Importantly, this study was endorsed by the Global Influenza Programme surveillance team at WHO HQ (Hirve S, personal communication). Our research aim was to assess the validity of the WHO-FluNet database using the GIBS database as the gold standard, and to determine what could be the research implications regarding data queries based on the two datasets.

Materials and Methods

The GIBS and WHO-FluNet database

The GIBS database was initially assembled in 2013-14, and contained epidemiological and virological influenza surveillance data from thirty countries (June 2018) around the world up to as late as December 2013 (although this varied by country) [**9**]. The database was updated with data until 2016 or 2018 (depending on country) for twenty-two of the thirty participating countries. Data in the GIBS database include the weekly number of laboratory-confirmed influenza cases broken down by virus type (A, B), subtype (H1N1, 2009 pandemic H1N1, H3N2, A not subtyped), and lineage (Victoria, Yamagata, B not characterized) and the weekly influenza-like illness/acute respiratory infection rates (per 100,000 population or 100 consultations, depending on country). Information on age (exact age or age groups) was also available. Data for China were provided separately for the Northern and Southern parts of the country, while Brazil provided data stratified by sub-national regions (north, north-east, central-west, south, and south-east).

Participating countries were also requested to complete a questionnaire on the main characteristics of their national influenza surveillance system. The questionnaire included questions on the ILI/ ARI case definition in use; patients being sampled; representativeness of data; methods used for identification and characterization of influenza virus; and the population denominator (**Table 1**). For most GIBS countries, the influenza surveillance systems covered the whole country, sampled both outpatients and hospitalized patients, and sent isolates to a WHO collaborating centre for reference testing. Most countries in the Northern and Southern hemispheres had data on ILI rates (ARI rates for Singapore), with a mixture of consultation and population denominators, but many countries in the tropics had no such data. For more details, please refer to Caini et al. 2015 [**9**].

In June 2018, we downloaded the influenza surveillance data available in the WHO-FluNet database (i.e. the weekly number of influenza cases by virus type, subtype and lineage) for the same countries and years for which influenza surveillance data was available in the GIBS database. Data collection for the FluNet database is organised differently to GIBS. Whilst the GIBS database was collected via direct contacts with the surveillance teams in each participating country, the FluNet database uses a layered approach working via the WHO regional offices (e.g. WHO Euro in Copenhagen) and the WHO national offices. Our work hypothesis is that by collaborating directly with the countries, including data checks and the writing of common papers (e.g. Caini et al. 2015 [**9**]), the quality of the GIBS data will be higher.

The number of countries contributing data to the WHO-FluNet database increased greatly in 2009, mainly as a consequence of the surge in influenza surveillance activities in preparation to the A(H1N1) pandemic. Because of this, the comparison of the GIBS and the WHO-FluNet database was conducted focusing on the post-pandemic period only, i.e. from the year 2010 onwards for tropical and Southern hemisphere countries, and from the 2010-2011 season onwards for Northern hemisphere countries. In order to ensure a sufficient number of seasons with data on which to base the comparison, we restricted the analysis to the twenty-two countries that accepted to update the GIBS database by providing data until 2016 or 2017 (**Figure 1**).

Statistical analysis

Similar to previous GIBS publications [**9,12**], the unit of analysis was the "season": this corresponded to the calendar year in tropical countries and countries located in the Southern hemisphere, and was defined as the period between the 27th week of a year and the 26th week of the following year for countries located in the Northern hemisphere. The aim of this approach was to give each "season" an equal weighting in the analysis, thus limiting the impact on results of any differences in reporting between countries (e.g. high- vs. low-resources countries) and over time within the same country.

In each country, we first compared the weekly and seasonal number of influenza cases (overall and broken down by influenza type, subtype and lineage) available in the GIBS and the WHO-FluNet database. In previous GIBS publications, we focused on several public health-relevant characteristics of influenza epidemics, including:

- The proportion of influenza B over all influenza cases in each country and season;
- The proportion of B/Victoria and B/Yamagata lineages over all influenza B cases in each season and country (limited to seasons when influenza B accounted for at least 20% of all influenza cases);
- The "typical" timing and amplitude of influenza epidemics (overall and separately for influenza A and B epidemics) in each country, which were determined using the EPIPOI software [**13**]).

Here, we planned to separately conduct all of the above analyses using the GIBS and the WHO-FluNet database, in order to evaluate whether any differences in the results obtained using either database would have major implications in terms of public health recommendations that could be made based on the results. Since the WHO-FluNet does not contain case-based

information, it was not possible to conduct a comparative analysis of the age distribution of influenza cases by virus (sub)types using the two databases.

Country survey

The GIBS country surveys showed that the data contained in the two databases were identical (or nearly identical) for some of the twenty-two countries included in the study (see **Results** section). Prior to any further analysis, we therefore contacted the other countries to make sure that the data contained in the GIBS and WHO-FluNet database were independent, as required by the planned cross-validation procedure detailed above.

Results

The WHO-FluNet database contained no influenza surveillance data for Brazil in any of the seasons for which data were available in the GIBS database (2010-2016). In addition, there was no influenza surveillance data in the WHO-FluNet database for 2010-2011 in Bhutan and for 2015 in Kenya, which were therefore excluded from the analyses.

For nine countries (Chile, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Singapore, and the USA) the data contained in the GIBS and WHO-FluNet database were largely overlapping (**Table 2**). More specifically, the number of reported influenza cases differed between the two databases by less than 5% in all seasons, with few exceptions that were mostly concentrated in least recent seasons (e.g. 2010-2011 in Guatemala, Honduras and Nicaragua, 2010-2012 in Panama). In addition, the proportion of B over all influenza cases was also very similar, exceeding 5% only sporadically (namely in 2011 in Costa Rica, in 2010 in Guatemala, and in 2010 and 2011 in Panama). Because of this substantial overlap (i.e. non-independence), especially in most recent seasons, data from these nine countries could not be used for the planned cross-validation of the GIBS and WHO-FluNet database.

The number of influenza cases and/or the proportion of B over all influenza cases differed between the GIBS and the WHO-FluNet database in all or most seasons for the remaining twelve countries (**Table 3**). However, the survey results revealed that none of these countries met the criteria necessary to conduct a cross-validation analysis, i.e. that the data in the two databases were truly independent. There were three main reasons for non-independence of data between the GIBS and the WHO-FluNet:

- Data available in the GIBS database originated from only a province (Argentina) or a few selected sentinel sites (Kazakhstan), while the FluNet contained countrywide data (i.e. the

data contained in the GIBS were a subset of the data available in the WHO-FluNet database);

- Data in the two databases originated from the same surveillance network, and differences between databases were merely the consequence of differences in reporting: this occurred in Ecuador and Ivory Coast;
- Either database contained only sentinel (ILI/ARI) data, while the other database contained both sentinel and non-sentinel (e.g. SARI) data. This was the case for Australia, Bhutan (from the season 2014-2015 onwards), Kenya, Madagascar, New Zealand (for this country, the type of data available in the two databases changed over time, so that the WHO-FluNet used to be a subset of the GIBS in less recent seasons, and vice versa more recently), Portugal, South Africa, and Ukraine.

Because of this extensive overlap (i.e. not-independence) of data, it was not possible to conduct a cross-validation of the WHO-FluNet database using the database of the Global Influenza B Study.

Discussion, conclusions and recommendations

We initiated a research project which aimed to validate the WHO-FluNet database using the independently built GIBS database. After reviewing the data, we had to conclude that a proper validation of the two datasets would, ideally, require that the FluNet data is compared to a second (and completely independent) dataset (for example, this could be possible in France with a comparison of the Sentinelles [**14**] and GROG surveillance databases [**15**]). Our assessment revealed that the GIBS and FluNet datasets were not independent of each other (e.g. there was sentinel data in one database and the same sentinel data and non-sentinel data in the other) and a proper validation of the two databases was not possible.

We were, however, able to compare the two databases and some general conclusions can be drawn from this comparative analysis:

1. For 9 out of the 21 countries where we could compare the FluNet and GIBS data, we found that countries provided the same or very similar data in both datasets, which is probably (see next paragraph) a positive finding as it shows that collecting surveillance data in two different ways provided similar data.
2. For 12 countries of the 21 countries, we were not able to draw clear conclusions as the FluNet data were different. Although we did not have enough information to clarify the exact reasons for the differences (e.g. what type of data was reported in the FluNet database (primary care, secondary care, or both)?), the data contained in the two databases were mostly not independent from each other (i.e. there were many data overlaps) and the validation procedure was not possible. In order to better interpret and evaluate the FluNet database, we recommend that WHO carries out routine surveys of the national data sources (e.g. testing methods, testing protocols and national

representativeness of the data) and makes this information available so that researchers can better analyse/interpret the FluNet data.

3. We found a number of gaps in the FluNet database (e.g. missing data or missing seasons) and we recommend that countries can upload historical data so that this missing data can be corrected in the FluNet database
4. We found no data for a number of countries in FluNet (e.g. Brazil) and recommend that efforts to extend the coverage of FluNet are supported. The collection of regional data and data on the age of influenza detections is also recommended.

Although we used the GIBS database as the gold standard to validate/compare the WHO-FluNet database, it is important to acknowledge that our gold standard may have some limitations. An important limitation is that some countries may have simply sent us a copy of the FluNet database, thus undermining the comparison of the two databases. We think this scenario is unlikely as 1) the GIBS data we received from the 9 countries were very similar but not exactly the same (see **Table 2**), suggesting that a straight copy of the FluNet database did not occur and 2) we collected additional information not collected by FluNet (the age of cases), so the GIBS country contacts needed to do additional data extractions and could not send us a simple copy of the FluNet database.

In terms of repeating this type of validation survey in the future, we feel this will be challenging (see points listed above) but potential solutions might include:

a. Find a sample of countries around the worked that have parallel influenza surveillance systems, with one reporting data to FluNet and the other not reporting to FluNet. Considering the role of the NICS around the world, this is probably not a common situation,

but there might be some larger countries with two surveillance systems that could be used to validate the FluNet data.

b. Carry out a focussed validation exercise using data from neighbouring countries. If one country has an excellent surveillance system (which has been evaluated by WHO or another party), one could use this data as the reference to evaluate the FluNet data provided by neighbouring countries (e.g. assess the viral mix during each season and the patterns (start, end and duration) of seasonal activity in the two countries)

c. Carry out a general validation exercise for a region. If one or more countries in a region have an excellent surveillance data (which has been evaluated by WHO or another party), one could use this data as the reference to evaluate FluNet data provided by other countries in the region (assuming the region does not vary too much by latitude, geography and/or climatic characteristics).

Considering the growing usage of the FluNet database for influenza research projects, we hope this report provides a useful reference for further work in this field.

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References

1. Finkelman BS, Viboud C, Koelle K, Ferrari MJ, Bharti N, Grenfell BT. Global patterns in seasonal activity of influenza A/H3N2, A/H1N1, and B from 1997 to 2005: viral coexistence and latitudinal gradients. PLoS One. 2007 Dec 12;2(12):e1296.
2. Kayali G, Webby RJ, Samhouri D, Mafi AR, Bassili A. Influenza research in the Eastern Mediterranean Region: the current state and the way forward. Influenza Other Respir Viruses. 2013 Nov;7(6):914-21.
3. Alonso WJ, Yu C, Viboud C, Richard SA, et al. A global map of hemispheric influenza vaccine recommendations based on local patterns of viral circulation. Sci Rep. 2015 Dec 1;5:17214.
4. He D, Lui R, Wang L, Tse CK, Yang L, Stone L. Global spatio-temporal patterns of influenza in the post-pandemic era. Sci Rep. 2015 Jun 5;5:11013.
5. He D, Chiu AP, Lin Q, Yu D. Spatio-temporal patterns of proportions of influenza B cases. Sci Rep. 2017 Jan 9;7:40085.
6. Hirve S, Newman LP, Paget J, et al. Influenza seasonality in the tropics and subtropics - When to vaccinate? PLoS One. 2016 Apr 27;11(4):e0153003.
7. Richard SA, Viboud C, Miller MA. Evaluation of Southern Hemisphere influenza vaccine recommendations. Vaccine. 2010 Mar 24;28(15):2693-9.
8. Caini S, Schellevis F, El-Guerche Séblain C, Paget J. Important changes in the timing of influenza epidemics in the WHO European Region over the past 20 years: virological surveillance 1996 to 2016. Euro Surveill. 2018 Jan;23(1).
9. Caini S, Huang QS, Ciblak MA, et al. Epidemiological and virological characteristics of influenza B: results of the Global Influenza B Study. Influenza Other Respir Viruses. 2015 Aug; 9 Suppl 1:3-12.

10. Caini S, Alonso WJ, Balmaseda A, et al. Characteristics of seasonal influenza A and B in Latin America: Influenza surveillance data from ten countries. PLoS One. 2017 Mar 27;12(3):e0174592.
11. Caini S, Alonso WJ, Séblain CE, Schellevis F, Paget J. The spatiotemporal characteristics of influenza A and B in the WHO European Region: can one define influenza transmission zones in Europe? Euro Surveill. 2017 Aug 31;22(35).
12. Caini S, Andrade W, Badur S, et al. Temporal patterns of influenza A and B in tropical and temperate countries: what are the lessons for influenza vaccination? PLoS One. 2016 Mar 31;11(3):e0152310.
13. Alonso WJ, McCormick BJ. EPIPOI: a user-friendly analytical tool for the extraction and visualization of temporal parameters from epidemiological time series. BMC Public Health. 2012 Nov 15;12:982.
14. Mosnier A, Caini S, Daviaud J, et al. Ten influenza seasons in France: distribution and timing of influenza A and B circulation, 2003–2013. BMC. Infect. Dis. 2015;15:357. doi: 10.1186/s12879-015-1056-z.
15. Casalegno J, Eibach D, Valette M, Enouf V, Daviaud I, Behillil S, Vabret A, Soulary JC, Benchaib M, Cohen JM, van der Werf S, Mosnier A, Lina B. Performance of influenza case definitions for influenza community surveillance: based on the French influenza surveillance network GROG, 2009-2014. Euro Surveill. 2017;22(14):pii=30504.

Figure 1. Countries included (in green, n=21) and not included (in gray, n=9) in the study. See text for details.

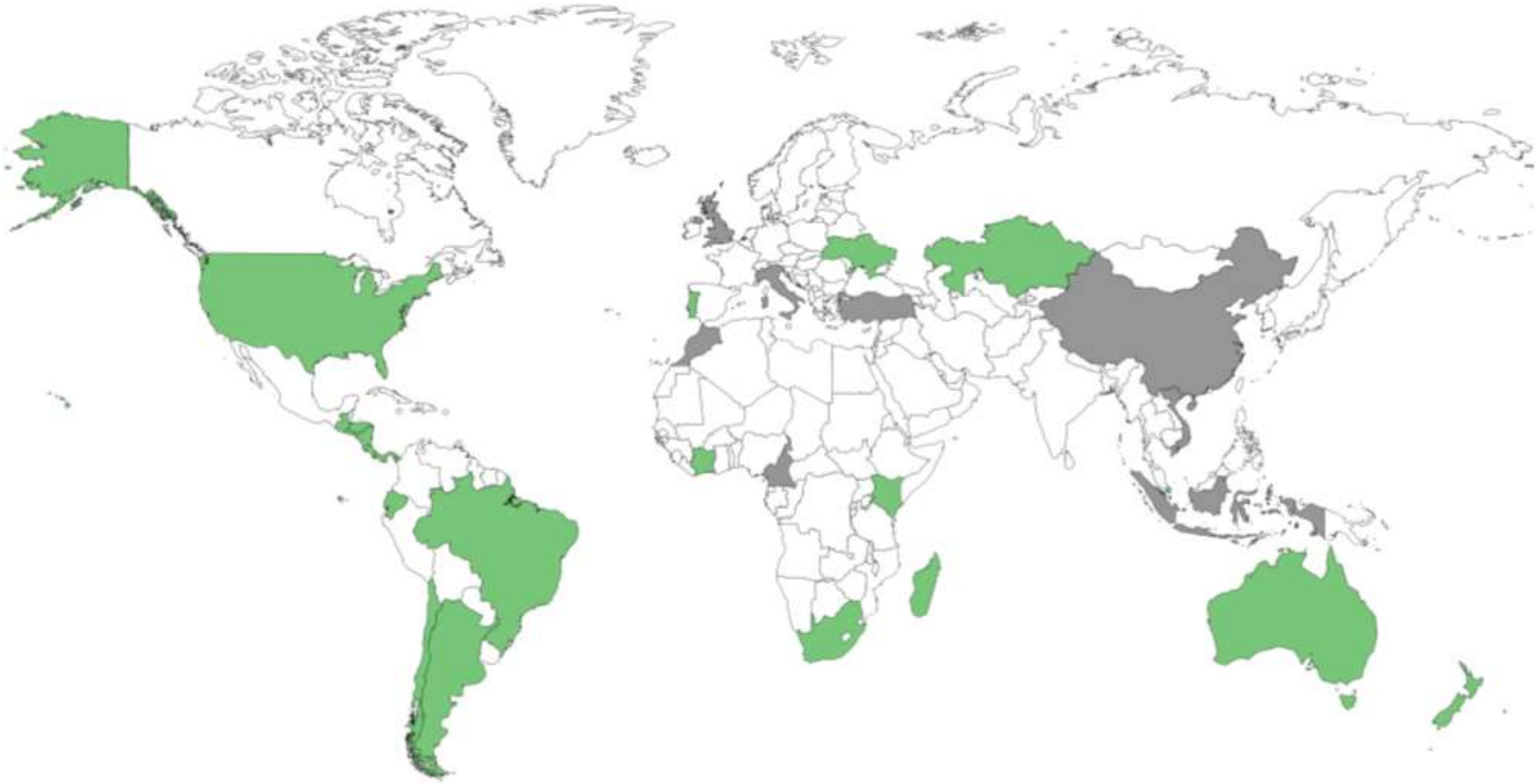

Table 1. Questionnaire on national influenza surveillance systems used for the Global Influenza B Study

Short Survey of Influenza Surveillance Systems participating in the Global Influenza B study (GIBS)

Country:

Institute's name:

Respondent's name: _____

IMPORTANT: Please attach a relevant publication(s), if available, which outlines your surveillance system or surveillance results so that that we could use this for the GIBS publications.

Virological data reported to GIBS:

1. Specimens (more than one response is possible):

□ Outpatients* □ Hospitalised patients (general) □ Hospitalised patients (SARI)

□ Other, please define: _____

Rough distribution (%) of total specimens for a typical flu season:

Outpatients* (%)	Hospitalised patients- general (%)	Hospitalised patients – SARI (%)	Other (%)

*For example, from the sentinel Outpatient (or General Practitioner) surveillance system

2. Method used to identify influenza viruses:

□ PCR □ Serology □ Culture

□ Other, please specify: _____

3. Population denominator

□ Total specimens tested □ Total population

□ Other, please specify: _____

□ Unknown

4. Representativeness of data:

□ National □ Regional, please define: _____

□ Other, please define: _____

5. Characterization data: method

□ Hemagglutination inhibition □ Sequencing □ Isolates sent to Who CC for reference

□ None

6. Characterization data: is a subset of your isolates sent to WHO CC for reference?

□ No □ Yes, please specify: _____

Epidemiological data reported to GIBS:

7. Case definition (more than one response is possible):

□ ILI case definition: _____

_____

□ ARI case definition: _____

_____

8. Population denominator

□ Total population served by reporting sites □ Total number of encounters (consultations)

□ Other, please specify: _____

□ Unknown

9. Representativeness of data:

□ National □ Regional

□ Other, please define: _____

Thank you

Table 2. Countries (n=9) for which there was a substantial overlap of influenza surveillance data contained in the database of the Global Influenza B Study (GIBS) and in the WHO-FluNet database. Namely, the difference in reported influenza cases and proportion of type B influenza (over all influenza cases) were <5% in all seasons, with few exceptions (cells highlighted in light blue).

Country	Season	GIBS database			FluNet database			Δ n influenza cases (FluNet compared to GIBS)	Δ % influenza B (FluNet compared to GIBS)
		Influenza cases (n)	Influenza A cases (n, %)	Influenza B cases (n, %)	Influenza cases (n)	Influenza A cases (n, %)	Influenza B cases (n, %)		
Chile	2010	3076	2658 (86.4%)	418 (13.6%)	2948	2532 (85.9%)	416 (14.1%)	-4.2%	-0.5%
Chile	2011	1162	1145 (98.5%)	17 (1.5%)	1155	1138 (98.5%)	17 (1.5%)	-0.6%	0.0%
Chile	2012	2101	1463 (69.6%)	638 (30.4%)	2083	1454 (69.8%)	629 (30.2%)	-0.9%	0.2%
Chile	2013	2602	2005 (77.1%)	597 (22.9%)	2600	2005 (77.1%)	595 (22.9%)	-0.1%	0.0%
Chile	2014	1882	1567 (83.3%)	315 (16.7%)	1882	1567 (83.3%)	315 (16.7%)	0.0%	0.0%
Chile	2015	2246	1681 (74.8%)	565 (25.2%)	2240	1681 (75%)	559 (25%)	-0.3%	0.2%
Chile	2016	3727	2851 (76.5%)	876 (23.5%)	3727	2851 (76.5%)	876 (23.5%)	0.0%	0.0%
Chile	2017	3610	2789 (77.3%)	821 (22.7%)	3610	2789 (77.3%)	821 (22.7%)	0.0%	0.0%
Costa Rica	2010	1441	1265 (87.8%)	176 (12.2%)	1357	1207 (88.9%)	150 (11.1%)	**-5.8%**	1.1%
Costa Rica	2011	194	167 (86.1%)	27 (13.9%)	190	153 (80.5%)	37 (19.5%)	-2.1%	**-5.6%**
Costa Rica	2012	444	278 (62.6%)	166 (37.4%)	447	278 (62.2%)	169 (37.8%)	0.7%	-0.4%
Costa Rica	2013	550	540 (98.2%)	10 (1.8%)	550	540 (98.2%)	10 (1.8%)	0.0%	0.0%
Costa Rica	2014	518	276 (53.3%)	242 (46.7%)	518	276 (53.3%)	242 (46.7%)	0.0%	0.0%
Costa Rica	2015	265	265 (100%)	0 (0%)	221	221 (100%)	0 (0%)	**-16.6%**	0.0%
Costa Rica	2016	459	431 (93.9%)	28 (6.1%)	459	431 (93.9%)	28 (6.1%)	0.0%	0.0%

Costa Rica	2017	591	360 (60.9%)	231 (39.1%)	591	360 (60.9%)	231 (39.1%)	0.0%	0.0%
El Salvador	2010	352	231 (65.6%)	121 (34.4%)	326	219 (67.2%)	107 (32.8%)	**-7.4%**	1.6%
El Salvador	2011	202	101 (50%)	101 (50%)	199	94 (47.2%)	105 (52.8%)	-1.5%	-2.8%
El Salvador	2012	421	223 (53%)	198 (47%)	413	216 (52.3%)	197 (47.7%)	-1.9%	-0.7%
El Salvador	2013	234	231 (98.7%)	3 (1.3%)	229	226 (98.7%)	3 (1.3%)	-2.1%	0.0%
El Salvador	2014	77	22 (28.6%)	55 (71.4%)	77	22 (28.6%)	55 (71.4%)	0.0%	0.0%
El Salvador	2015	87	83 (95.4%)	4 (4.6%)	87	83 (95.4%)	4 (4.6%)	0.0%	0.0%
El Salvador	2016	241	220 (91.3%)	21 (8.7%)	241	220 (91.3%)	21 (8.7%)	0.0%	0.0%
El Salvador	2017	288	239 (83%)	49 (17%)	288	239 (83%)	49 (17%)	0.0%	0.0%
Guatemala	2010	584	376 (64.4%)	208 (35.6%)	91	73 (80.2%)	18 (19.8%)	**-84.4%**	**15.8%**
Guatemala	2011	285	256 (89.8%)	29 (10.2%)	119	109 (91.6%)	10 (8.4%)	**-58.2%**	1.8%
Guatemala	2012	416	357 (85.8%)	59 (14.2%)	420	361 (86%)	59 (14%)	1.0%	0.2%
Guatemala	2013	212	169 (79.7%)	43 (20.3%)	212	169 (79.7%)	43 (20.3%)	0.0%	0.0%
Guatemala	2014	109	61 (56%)	48 (44%)	109	61 (56%)	48 (44%)	0.0%	0.0%
Guatemala	2015	88	85 (96.6%)	3 (3.4%)	87	84 (96.6%)	3 (3.4%)	-1.1%	0.0%
Guatemala	2016	210	180 (85.7%)	30 (14.3%)	210	180 (85.7%)	30 (14.3%)	0.0%	0.0%
Guatemala	2017	228	174 (76.3%)	54 (23.7%)	228	174 (76.3%)	54 (23.7%)	0.0%	0.0%
Honduras	2010	405	327 (80.7%)	78 (19.3%)	460	369 (80.2%)	91 (19.8%)	**13.6%**	-0.5%
Honduras	2011	222	160 (72.1%)	62 (27.9%)	206	146 (70.9%)	60 (29.1%)	**-7.2%**	-1.2%
Honduras	2012	142	134 (94.4%)	8 (5.6%)	139	131 (94.2%)	8 (5.8%)	-2.1%	-0.2%
Honduras	2013	245	195 (79.6%)	50 (20.4%)	245	195 (79.6%)	50 (20.4%)	0.0%	0.0%
Honduras	2014	183	57 (31.1%)	126 (68.9%)	183	57 (31.1%)	126 (68.9%)	0.0%	0.0%
Honduras	2015	41	40 (97.6%)	1 (2.4%)	39	38 (97.4%)	1 (2.6%)	-4.9%	-0.2%
Honduras	2016	127	62 (48.8%)	65 (51.2%)	127	62 (48.8%)	65 (51.2%)	0.0%	0.0%

Honduras	2017	62	60 (96.8%)	2 (3.2%)	62	60 (96.8%)	2 (3.2%)	0.0%	0.0%
Nicaragua	2010	646	427 (66.1%)	219 (33.9%)	585	372 (63.6%)	213 (36.4%)	**-9.4%**	-2.5%
Nicaragua	2011	928	919 (99%)	9 (1%)	859	851 (99.1%)	8 (0.9%)	**-7.4%**	0.1%
Nicaragua	2012	473	121 (25.6%)	352 (74.4%)	473	121 (25.6%)	352 (74.4%)	0.0%	0.0%
Nicaragua	2013	939	893 (95.1%)	46 (4.9%)	939	893 (95.1%)	46 (4.9%)	0.0%	0.0%
Nicaragua	2014	989	422 (42.7%)	567 (57.3%)	989	422 (42.7%)	567 (57.3%)	0.0%	0.0%
Nicaragua	2015	362	362 (100%)	0 (0%)	360	360 (100%)	0 (0%)	-0.6%	0.0%
Nicaragua	2016	267	198 (74.2%)	69 (25.8%)	267	198 (74.2%)	69 (25.8%)	0.0%	0.0%
Nicaragua	2017	762	334 (43.8%)	428 (56.2%)	762	334 (43.8%)	428 (56.2%)	0.0%	0.0%
Panama	2010	328	272 (82.9%)	56 (17.1%)	207	193 (93.2%)	14 (6.8%)	**-36.9%**	**10.3%**
Panama	2011	59	54 (91.5%)	5 (8.5%)	44	44 (100%)	0 (0%)	**-25.4%**	**8.5%**
Panama	2012	269	92 (34.2%)	177 (65.8%)	205	62 (30.2%)	143 (69.8%)	**-23.8%**	-4.0%
Panama	2013	188	188 (100%)	0 (0%)	188	188 (100%)	0 (0%)	0.0%	0.0%
Panama	2014	141	86 (61%)	55 (39%)	140	85 (60.7%)	55 (39.3%)	-0.7%	-0.3%
Panama	2015	95	93 (97.9%)	2 (2.1%)	92	91 (98.9%)	1 (1.1%)	-3.2%	1.0%
Panama	2016	810	806 (99.5%)	4 (0.5%)	810	806 (99.5%)	4 (0.5%)	0.0%	0.0%
Panama	2017	262	121 (46.2%)	141 (53.8%)	262	121 (46.2%)	141 (53.8%)	0.0%	0.0%
Singapore	2010	3563	2778 (78%)	785 (22%)	3499	2750 (78.6%)	749 (21.4%)	-1.8%	0.6%
Singapore	2011	1201	915 (76.2%)	286 (23.8%)	1129	882 (78.1%)	247 (21.9%)	**-6.0%**	1.9%
Singapore	2012	1007	525 (52.1%)	482 (47.9%)	982	513 (52.2%)	469 (47.8%)	-2.5%	0.1%
Singapore	2013	770	598 (77.7%)	172 (22.3%)	757	585 (77.3%)	172 (22.7%)	-1.7%	-0.4%
Singapore	2014	1002	612 (61.1%)	390 (38.9%)	998	611 (61.2%)	387 (38.8%)	-0.4%	0.1%
Singapore	2015	790	650 (82.3%)	140 (17.7%)	773	638 (82.5%)	135 (17.5%)	-2.2%	0.2%
Singapore	2016	1181	766 (64.9%)	415 (35.1%)	1176	768 (65.3%)	408 (34.7%)	-0.4%	0.4%

Singapore	2017	998	692 (69.3%)	306 (30.7%)	998	692 (69.3%)	306 (30.7%)	0.0%	0.0%
USA	2010-2011	56143	41501 (73.9%)	14642 (26.1%)	56006	41351 (73.8%)	14655 (26.2%)	-0.2%	-0.1%
USA	2011-2012	25689	21189 (82.5%)	4500 (17.5%)	25124	20687 (82.3%)	4437 (17.7%)	-2.2%	-0.2%
USA	2012-2013	80406	56454 (70.2%)	23952 (29.8%)	74681	52510 (70.3%)	22171 (29.7%)	**-7.1%**	0.1%
USA	2013-2014	58553	50205 (85.7%)	8348 (14.3%)	53829	46371 (86.1%)	7458 (13.9%)	**-8.1%**	0.4%
USA	2014-2015	128925	106995 (83%)	21930 (17%)	128418	106503 (82.9%)	21915 (17.1%)	-0.4%	-0.1%
USA	2015-2016	99381	67501 (67.9%)	31880 (32.1%)	98389	66884 (68%)	31505 (32%)	-1.0%	0.1%
USA	2016-2017	175150	125752 (71.8%)	49398 (28.2%)	173768	123543 (71.1%)	50225 (28.9%)	-0.8%	-0.7%

[a] Differences were calculated by comparing the WHO-FluNet to the GIBS database.

Table 3. Countries (n=12) for which there were substantial differences in influenza surveillance data contained in the database of the Global Influenza B Study (GIBS) and in the WHO-FluNet database (in terms of number of reported cases and/or proportion of B over all influenza cases) in most seasons.

Country	Season	GIBS database			FluNet database			Δ n influenza cases (FluNet compared to GIBS)	Δ % influenza B (FluNet compared to GIBS)
		Influenza cases (n)	Influenza A cases (n, %)	Influenza B cases (n, %)	Influenza cases (n)	Influenza A cases (n, %)	Influenza B cases (n, %)		
Argentina	2000	16	16 (100%)	0 (0%)	364	334 (91.8%)	30 (8.2%)	2175,0%	8,2%
Argentina	2001	33	33 (100%)	0 (0%)	874	769 (88%)	105 (12%)	2548,5%	12,0%
Argentina	2002	7	3 (42.9%)	4 (57.1%)	390	127 (32.6%)	263 (67.4%)	5471,4%	10,3%
Argentina	2003	94	94 (100%)	0 (0%)	1329	1309 (98.5%)	20 (1.5%)	1313,8%	1,5%
Argentina	2004	59	59 (100%)	0 (0%)	828	721 (87.1%)	107 (12.9%)	1303,4%	12,9%
Argentina	2005	61	46 (75.4%)	15 (24.6%)	844	749 (88.7%)	95 (11.3%)	1283,6%	-13,3%
Argentina	2006	0	-	-	684	541 (79.1%)	143 (20.9%)	-	-
Argentina	2007	56	56 (100%)	0 (0%)	973	953 (97.9%)	20 (2.1%)	1637,5%	2,1%
Argentina	2008	12	6 (50%)	6 (50%)	781	448 (57.4%)	333 (42.6%)	6408,3%	-7,4%
Argentina	2009	240	240 (100%)	0 (0%)	10993	10991 (100%)	2 (0%)	4480,4%	0,0%
Argentina	2010	67	51 (76.1%)	16 (23.9%)	2115	1219 (57.6%)	896 (42.4%)	3056,7%	18,5%
Argentina	2011	260	260 (100%)	0 (0%)	2166	2121 (97.9%)	45 (2.1%)	733,1%	2,1%
Argentina	2012	337	229 (68%)	108 (32%)	3039	1899 (62.5%)	1140 (37.5%)	801,8%	5,5%
Argentina	2013	210	207 (98.6%)	3 (1.4%)	6847	6321 (92.3%)	526 (7.7%)	3160,5%	6,3%
Argentina	2014	100	25 (25%)	75 (75%)	2349	1803 (76.8%)	546 (23.2%)	2249,0%	-51,8%
Argentina	2015	63	56 (88.9%)	7 (11.1%)	2286	2001 (87.5%)	285 (12.5%)	3528,6%	1,4%
Argentina	2016	165	138 (83.6%)	27 (16.4%)	7057	6247 (88.5%)	810 (11.5%)	4177,0%	-4,9%

Australia	2010	13270	11983 (90.3%)	1287 (9.7%)	1252	792 (63.3%)	460 (36.7%)	-90,6%	27,0%
Australia	2011	27003	19710 (73%)	7293 (27%)	2040	1650 (80.9%)	390 (19.1%)	-92,4%	-7,9%
Australia	2012	44363	33864 (76.3%)	10499 (23.7%)	4798	3333 (69.5%)	1465 (30.5%)	-89,2%	6,8%
Australia	2013	27560	17360 (63%)	10200 (37%)	2002	1634 (81.6%)	368 (18.4%)	-92,7%	-18,6%
Australia	2014	66335	58395 (88%)	7940 (12%)	3473	3011 (86.7%)	462 (13.3%)	-94,8%	1,3%
Australia	2015	99228	39016 (39.3%)	60212 (60.7%)	3619	1819 (50.3%)	1800 (49.7%)	-96,4%	-11,0%
Australia	2016	89138	79544 (89.2%)	9594 (10.8%)	6705	5566 (83%)	1139 (17%)	-92,5%	6,2%
Bhutan	2010-2011	464	324 (69.8%)	140 (30.2%)	0	0 (0%)	0 (0%)	-100,0%	-
Bhutan	2011-2012	89	78 (87.6%)	11 (12.4%)	54	53 (98.1%)	1 (1.9%)	-39,3%	-10,5%
Bhutan	2012-2013	234	102 (43.6%)	132 (56.4%)	258	110 (42.6%)	148 (57.4%)	10,3%	1,0%
Bhutan	2013-2014	92	87 (94.6%)	5 (5.4%)	82	80 (97.6%)	2 (2.4%)	-10,9%	-3,0%
Bhutan	2014-2015	22	6 (27.3%)	16 (72.7%)	335	183 (54.6%)	152 (45.4%)	1422,7%	-27,3%
Bhutan	2015-2016	86	79 (91.9%)	7 (8.1%)	255	229 (89.8%)	26 (10.2%)	196,5%	2,1%
Bhutan	2016-2017	243	120 (49.4%)	123 (50.6%)	299	134 (44.8%)	165 (55.2%)	23,0%	4,6%
Ecuador	2011	466	466 (100%)	0 (0%)	777	776 (99.9%)	1 (0.1%)	66,7%	0,1%
Ecuador	2012	410	225 (54.9%)	185 (45.1%)	410	229 (55.9%)	181 (44.1%)	0,0%	-1,0%
Ecuador	2013	838	765 (91.3%)	73 (8.7%)	1264	1173 (92.8%)	91 (7.2%)	50,8%	-1,5%
Ecuador	2014	158	86 (54.4%)	72 (45.6%)	210	107 (51%)	103 (49%)	32,9%	3,4%
Ecuador	2015	143	111 (77.6%)	32 (22.4%)	119	100 (84%)	19 (16%)	-16,8%	-6,4%
Ecuador	2016	966	874 (90.5%)	92 (9.5%)	948	859 (90.6%)	89 (9.4%)	-1,9%	-0,1%
Ivory Coast	2010	176	114 (64.8%)	62 (35.2%)	214	168 (78.5%)	46 (21.5%)	21,6%	-13,7%
Ivory Coast	2011	669	322 (48.1%)	347 (51.9%)	417	190 (45.6%)	227 (54.4%)	-37,7%	2,5%
Ivory Coast	2012	246	221 (89.8%)	25 (10.2%)	256	229 (89.5%)	27 (10.5%)	4,1%	0,3%
Ivory Coast	2013	439	286 (65.1%)	153 (34.9%)	351	200 (57%)	151 (43%)	-20,0%	8,1%
Ivory Coast	2014	228	115 (50.4%)	113 (49.6%)	212	109 (51.4%)	103 (48.6%)	-7,0%	-1,0%

Ivory Coast	2015	335	266 (79.4%)	69 (20.6%)	285	225 (78.9%)	60 (21.1%)	-14,9%	0,5%
Ivory Coast	2016	396	153 (38.6%)	243 (61.4%)	360	133 (36.9%)	227 (63.1%)	-9,1%	1,7%
Ivory Coast	2017	375	340 (90.7%)	35 (9.3%)	337	306 (90.8%)	31 (9.2%)	-10,1%	-0,1%
Kazakhstan	2010-2011	238	164 (68.9%)	74 (31.1%)	118	91 (77.1%)	27 (22.9%)	-50,4%	-8,2%
Kazakhstan	2011-2012	245	208 (84.9%)	37 (15.1%)	379	365 (96.3%)	14 (3.7%)	54,7%	-11,4%
Kazakhstan	2012-2013	411	248 (60.3%)	163 (39.7%)	602	355 (59%)	247 (41%)	46,5%	1,3%
Kazakhstan	2013-2014	301	291 (96.7%)	10 (3.3%)	607	590 (97.2%)	17 (2.8%)	101,7%	-0,5%
Kazakhstan	2014-2015	195	126 (64.6%)	69 (35.4%)	549	352 (64.1%)	197 (35.9%)	181,5%	0,5%
Kazakhstan	2015-2016	173	131 (75.7%)	42 (24.3%)	932	887 (95.2%)	45 (4.8%)	438,7%	-19,5%
Kazakhstan	2016-2017	246	151 (61.4%)	95 (38.6%)	1272	796 (62.6%)	476 (37.4%)	417,1%	-1,2%
Kenya	2010	1361	1187 (87.2%)	174 (12.8%)	947	804 (84.9%)	143 (15.1%)	-30,4%	2,3%
Kenya	2011	1326	759 (57.2%)	567 (42.8%)	1191	637 (53.5%)	554 (46.5%)	-10,2%	3,7%
Kenya	2012	545	368 (67.5%)	177 (32.5%)	448	280 (62.5%)	168 (37.5%)	-17,8%	5,0%
Kenya	2013	526	357 (67.9%)	169 (32.1%)	303	213 (70.3%)	90 (29.7%)	-42,4%	-2,4%
Kenya	2014	664	579 (87.2%)	85 (12.8%)	210	195 (92.9%)	15 (7.1%)	-68,4%	-5,7%
Kenya	2015	500	363 (72.6%)	137 (27.4%)	0	0 (0%)	0 (0%)	-100,0%	-
Kenya	2016	431	168 (39%)	263 (61%)	65	65 (100%)	0 (0%)	-84,9%	-61,0%
Madagascar	2010	310	275 (88.7%)	35 (11.3%)	336	295 (87.8%)	41 (12.2%)	8,4%	0,9%
Madagascar	2011	472	233 (49.4%)	239 (50.6%)	543	297 (54.7%)	246 (45.3%)	15,0%	-5,3%
Madagascar	2012	442	218 (49.3%)	224 (50.7%)	527	286 (54.3%)	241 (45.7%)	19,2%	-5,0%
Madagascar	2013	490	205 (41.8%)	285 (58.2%)	526	244 (46.4%)	282 (53.6%)	7,3%	-4,6%
Madagascar	2014	655	461 (70.4%)	194 (29.6%)	717	509 (71%)	208 (29%)	9,5%	-0,6%
Madagascar	2015	404	252 (62.4%)	152 (37.6%)	492	297 (60.4%)	195 (39.6%)	21,8%	2,0%
Madagascar	2016	375	147 (39.2%)	228 (60.8%)	440	175 (39.8%)	265 (60.2%)	17,3%	-0,6%
New Zealand	2010	2012	2002 (99.5%)	10 (0.5%)	326	325 (99.7%)	1 (0.3%)	-83,8%	-0,2%

New Zealand	2011	1268	676 (53.3%)	592 (46.7%)	1218	640 (52.5%)	578 (47.5%)	-3,9%	0,8%
New Zealand	2012	2425	2119 (87.4%)	306 (12.6%)	2261	2028 (89.7%)	233 (10.3%)	-6,8%	-2,3%
New Zealand	2013	791	503 (63.6%)	288 (36.4%)	2185	1284 (58.8%)	901 (41.2%)	176,2%	4,8%
New Zealand	2014	981	815 (83.1%)	166 (16.9%)	3418	3085 (90.3%)	333 (9.7%)	248,4%	-7,2%
New Zealand	2015	1059	580 (54.8%)	479 (45.2%)	5102	2444 (47.9%)	2658 (52.1%)	381,8%	6,9%
New Zealand	2016	449	408 (90.9%)	41 (9.1%)	3098	2745 (88.6%)	353 (11.4%)	590,0%	2,3%
New Zealand	2017	1351	834 (61.7%)	517 (38.3%)	945	536 (56.7%)	409 (43.3%)	-30,1%	5,0%
Portugal	2010-2011	131	97 (74%)	34 (26%)	198	134 (67.7%)	64 (32.3%)	51,1%	6,3%
Portugal	2011-2012	82	67 (81.7%)	15 (18.3%)	182	173 (95.1%)	9 (4.9%)	122,0%	-13,4%
Portugal	2012-2013	64	46 (71.9%)	18 (28.1%)	1060	621 (58.6%)	439 (41.4%)	1556,3%	13,3%
Portugal	2013-2014	467	460 (98.5%)	7 (1.5%)	1291	1270 (98.4%)	21 (1.6%)	176,4%	0,1%
Portugal	2014-2015	498	170 (34.1%)	328 (65.9%)	1273	594 (46.7%)	679 (53.3%)	155,6%	-12,6%
Portugal	2015-2016	449	412 (91.8%)	37 (8.2%)	1872	1586 (84.7%)	286 (15.3%)	316,9%	7,1%
Portugal	2016-2017	473	472 (99.8%)	1 (0.2%)	2178	2165 (99.4%)	13 (0.6%)	360,5%	0,4%
South Africa	2010	326	127 (39%)	199 (61%)	1333	614 (46.1%)	719 (53.9%)	308,9%	-7,1%
South Africa	2011	466	287 (61.6%)	179 (38.4%)	1512	1242 (82.1%)	270 (17.9%)	224,5%	-20,5%
South Africa	2012	287	131 (45.6%)	156 (54.4%)	1308	690 (52.8%)	618 (47.2%)	355,7%	-7,2%
South Africa	2013	174	143 (82.2%)	31 (17.8%)	1362	1162 (85.3%)	200 (14.7%)	682,8%	-3,1%
South Africa	2014	74	49 (66.2%)	25 (33.8%)	844	705 (83.5%)	139 (16.5%)	1040,5%	-17,3%
South Africa	2015	176	131 (74.4%)	45 (25.6%)	871	701 (80.5%)	170 (19.5%)	394,9%	-6,1%
South Africa	2016	232	124 (53.4%)	108 (46.6%)	982	529 (53.9%)	453 (46.1%)	323,3%	-0,5%
South Africa	2017	220	150 (68.2%)	70 (31.8%)	1210	890 (73.6%)	320 (26.4%)	450,0%	-5,4%
Ukraine	2010-2011	83	27 (32.5%)	56 (67.5%)	2289	1200 (52.4%)	1089 (47.6%)	2657,8%	-19,9%
Ukraine	2011-2012	184	177 (96.2%)	7 (3.8%)	562	553 (98.4%)	9 (1.6%)	205,4%	-2,2%
Ukraine	2012-2013	336	266 (79.2%)	70 (20.8%)	490	381 (77.8%)	109 (22.2%)	45,8%	1,4%

Ukraine	2013-2014	185	170 (91.9%)	15 (8.1%)	709	607 (85.6%)	102 (14.4%)	283,2%	6,3%
Ukraine	2014-2015	284	101 (35.6%)	183 (64.4%)	1249	361 (28.9%)	888 (71.1%)	339,8%	6,7%
Ukraine	2015-2016	399	398 (99.7%)	1 (0.3%)	2144	2125 (99.1%)	19 (0.9%)	437,3%	0,6%
Ukraine	2016-2017	73	73 (100%)	0 (0%)	826	826 (100%)	0 (0%)	1031,5%	0,0%

[(a)] Differences were calculated by comparing the WHO-FluNet to the GIBS database.