

Dissertation Presentation

**Comparative analysis of testing strategy for COVID 19 of countries –
identifying the key performers and their management of COVID-19**

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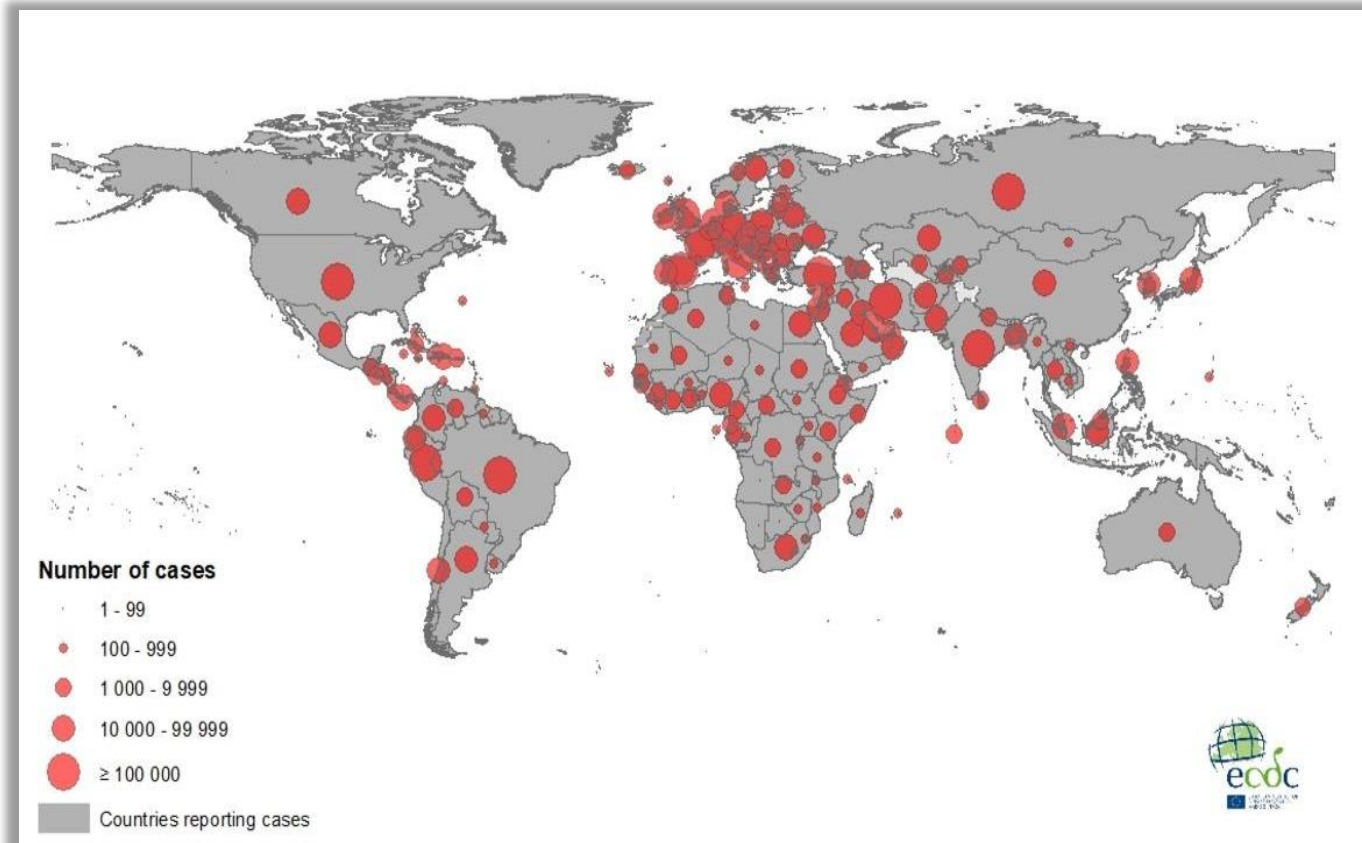
Introduction

COVID-19 Worldwide Scenario

Novel coronavirus (SARS-CoV-2) which was first reported to WHO country office in China on 31st December 2019 as the causative agent of an outbreak of pneumonia cases in Wuhan has rapidly spread around the world causing loss of lives, disruption of economies and lockdown of world leading powers

On March 11, WHO declared the COVID-19 outbreak as a global pandemic as the cases outside of China increased 13- fold and number of countries with cases increased threefold

More than 7.9 million cases of coronavirus have been confirmed worldwide, and more than 433,000 people have died as of 15th June 2020

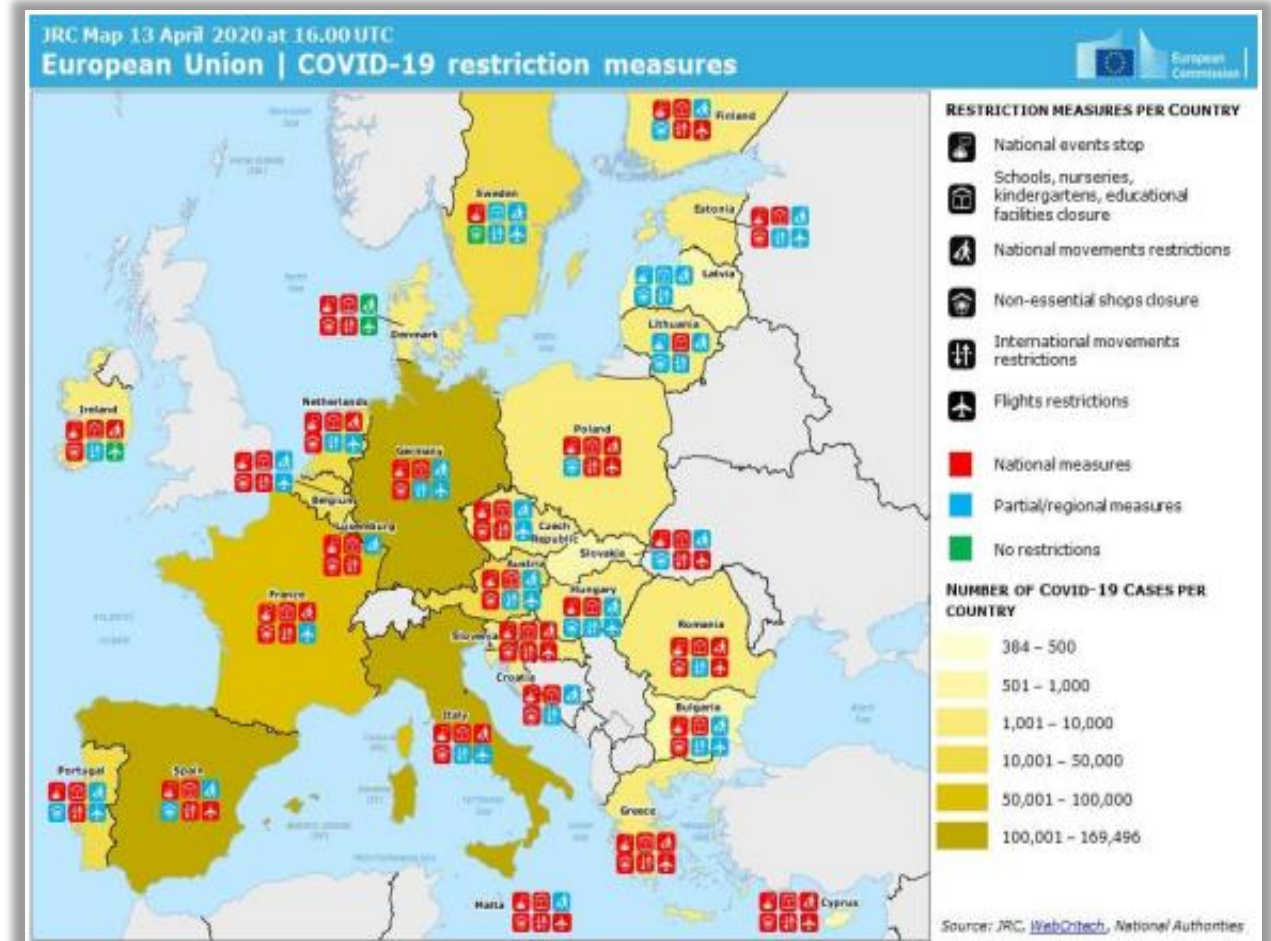


In India cases rose to 3.32 lakh and death toll approached 10,000 mark as of 15th June 2020

COVID-19 Containment Measures

With the virus crossing borders and spreading uncontrollably, countries across the world are prompted to introduce unprecedented measures to contain and control the pandemic. Such measures include:

- Country wide lockdown
- Widespread restriction on travel and mobility
- Strict social distancing measures
- Restrictions on physical attendance at work
- Prohibition of social gatherings
- Closure of schools, universities and public places
- Patient isolation & quarantine
- Contact tracing
- Community Education



To lift confinement restrictions and prevent second wave of infections widespread testing of COVID-19 is extremely crucial

Testing strategies serve 4 purposes

Clinical use – for confirmation of diagnosis

Breaking the transmission chain – through identification of cases and their isolation

Estimate development of herd immunity in community

Planning and allocation of resources – identify epidemiological curve a city/district is

Types of test available for COVID-19

	Molecular test	Antigen Test	Antibody Test
Names	Diagnostic Test, RT-PCR, Nucleic Acid Amplification Test (NAAT)	Rapid Diagnostic Test (RDT)	Serological Test, Serology blood test
Sample Collection Time taken to get the results	Nasal or throat swab	Nasal or throat swab	Blood draw or finger stick
Results	Diagnoses active COVID-19 infection	Diagnoses active COVID-19 infection	Diagnoses previous COVID-19 infection

Nations across the world have focused on increasing testing capacity to control the pandemic

Test, trace, contain: how South Korea flattened its coronavirus curve

South Korea pioneers coronavirus drive-through testing station

Data | Why is it necessary to test more to reduce the impact of COVID-19?

The US economy can't reopen without widespread coronavirus testing. Getting there will take a lot of work and money

PUBLISHED THU, APR 16 2020 3:17 PM EDT | UPDATED THU, APR 16 2020 5:12 PM EDT

The case for ending the Covid-19 pandemic with mass testing

By one estimate, America may need 35 million Covid-19 tests per day for people to return to work.

By Umair Irfan | Apr 13, 2020, 3:20pm EDT

From phone-tracking to drive-thru testing: How Taiwan and Korea are crushing the COVID-19 crisis

They learned their lessons from their bouts with MERS and SARS – and they have foresight By DAHL BENNETT

| Mar 21 2020

Some Nations Look to Mass Testing for Faster Way Out of Coronavirus Crisis

As quarantine fatigue sets in, several countries ramp up test capacity

Objective

This study aims to assess and compare testing strategies adopted by different nations across the world, their effectiveness in containing the spread of virus and comparison with status in India

Methodology

Study Design: Cross sectional study

Study setting and population: The study spans over 7 countries: United States of America, United Kingdom, New Zealand, South Korea, Taiwan, Japan and India

Data collection: COVID-19 cases and tests data were collected starting from Early January till June middle for the above-mentioned countries from ourworldindata.org. Various journals such as Cambridge University Press, Jama Network, The Lancet, Oxford University Press and SSRN along with pubmed was searched extensively using “COVID-19”, “Country Name”, “Testing strategy” as keywords to identify the relevant literature. WHO COVID-19 database, CDC COVID-19 database and other Government sources were used as well

Analyzing and interpreting the data: The data collected was analyzed using basic excel functions. XY scatter plot was constructed and correlation coefficient, R^2 was calculated to estimate effectiveness of testing strategies of countries

Data and Analysis



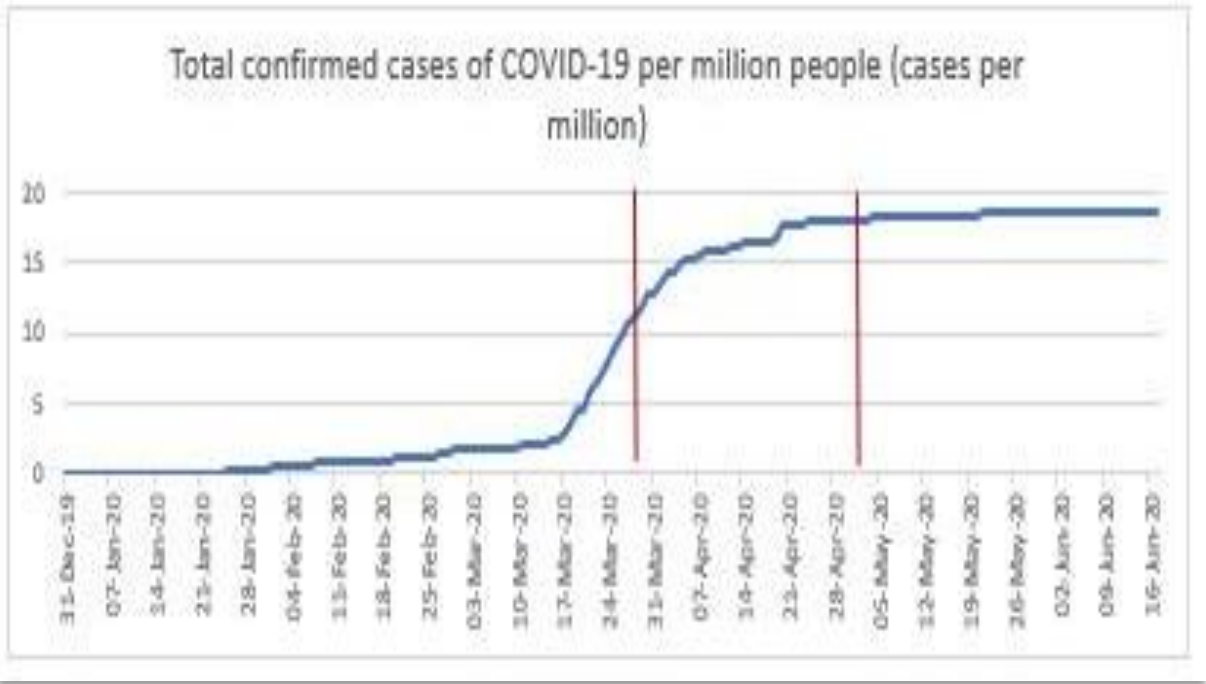
Testing Strategy

US currently allows two types of test: **Viral test (RT-PCR) to test for current infection and Antibody test** to test for previous infection

Viral tests are used for diagnosing purposes and can be performed on 5 categories of people as documented by CDC:

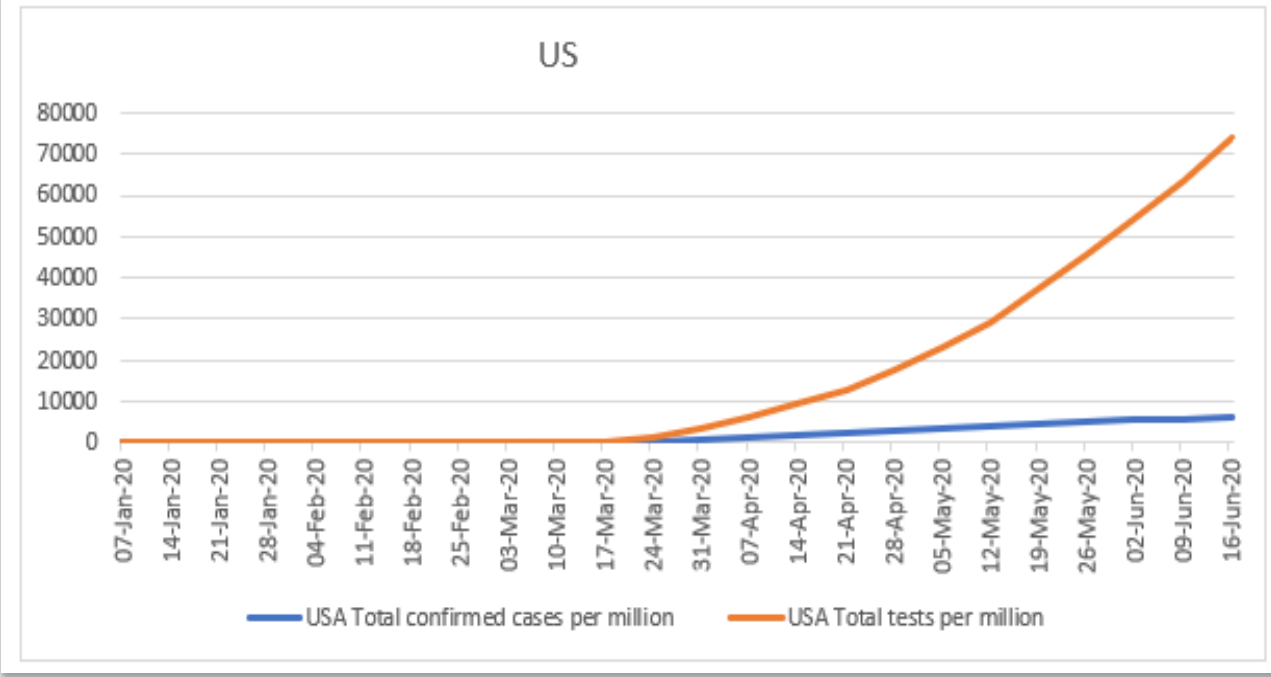
1. Testing individuals with signs or symptoms consistent with COVID-19
2. Testing asymptomatic individuals with recent known or suspected exposure to SARS-CoV-2 to control transmission
3. Testing asymptomatic individuals without known or suspected exposure to SARS-CoV-2 for early identification in special settings
4. Testing to determine resolution of infection (i.e., test-based strategy for Discontinuation of Transmission-based Precautions, HCP Return to Work, and Discontinuation of Home Isolation)
5. Public health surveillance for SARS-CoV-2

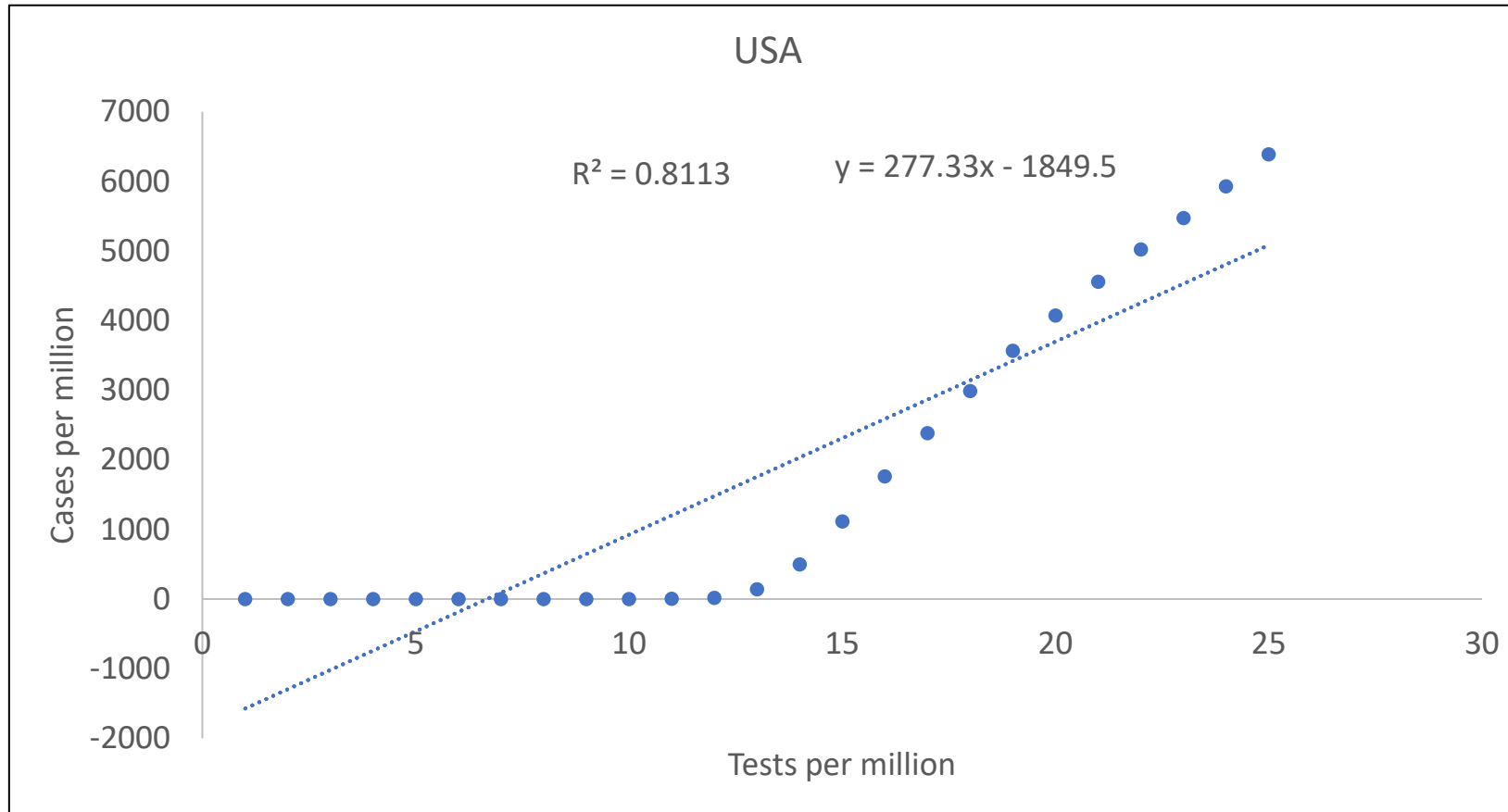
Antibody tests are not recommended for diagnosing purposes but can be used for clinical assessment and to understand the transmission dynamic of virus



Tests performed per million compared with total confirmed cases of COVID-19 per million people in USA taken at an interval of 7 days starting from January till mid-June

Total confirmed cases of COVID-19 per million people in USA taken at an interval of 7 days starting from January till mid-June





Best fit equation
 $y = 277.33x - 1849.5$

Value of X at Y = 1
 6.672

Test needed per active case
 6672

Value of R^2
 0.811

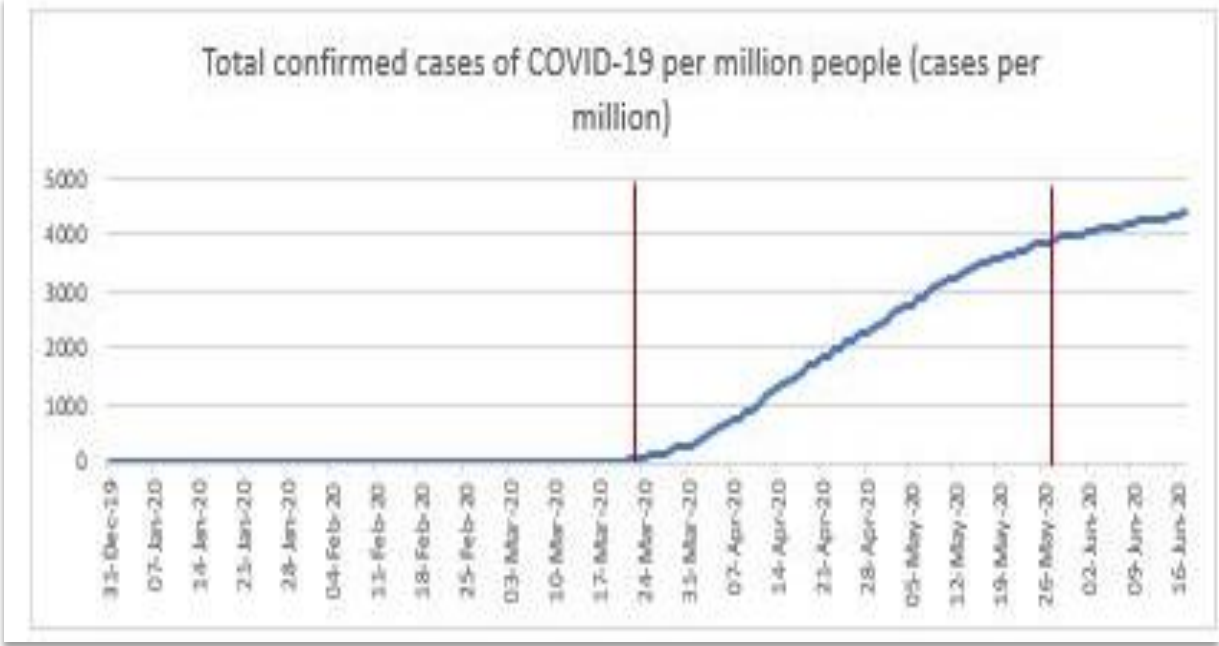
Correlation Coefficient
 0.97

XY Scatter plot– tests and cases per million for USA

Testing Strategy

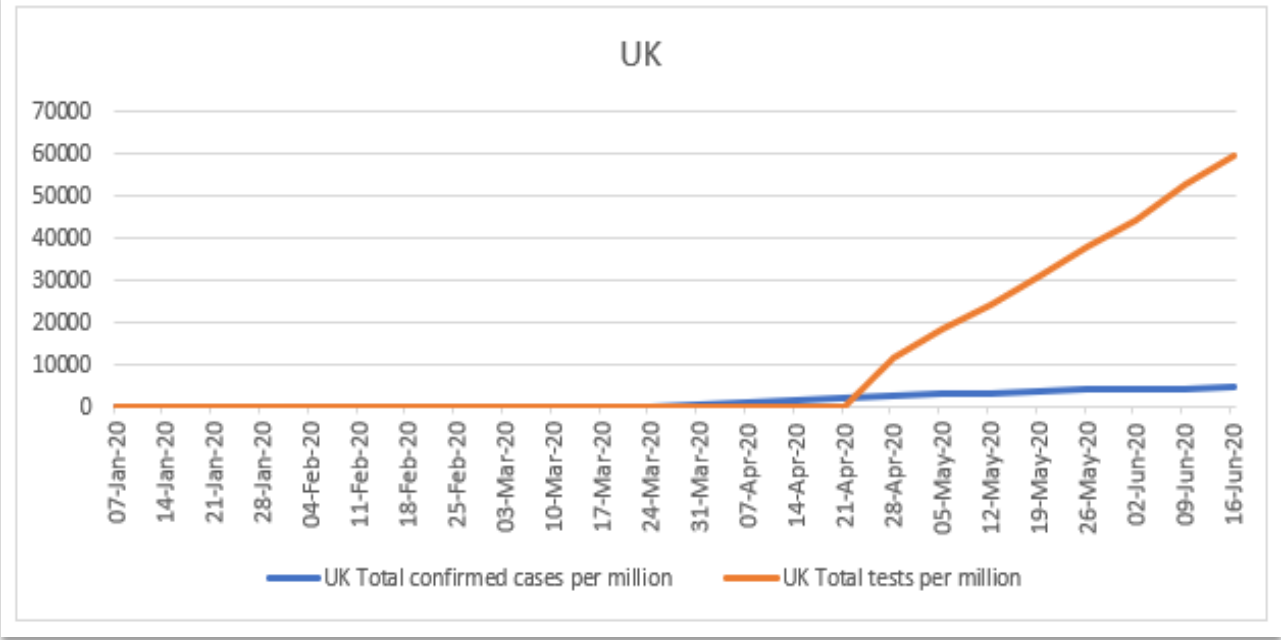
5 pillars of UK testing strategy were announced on 2nd April and involves 5 key steps:

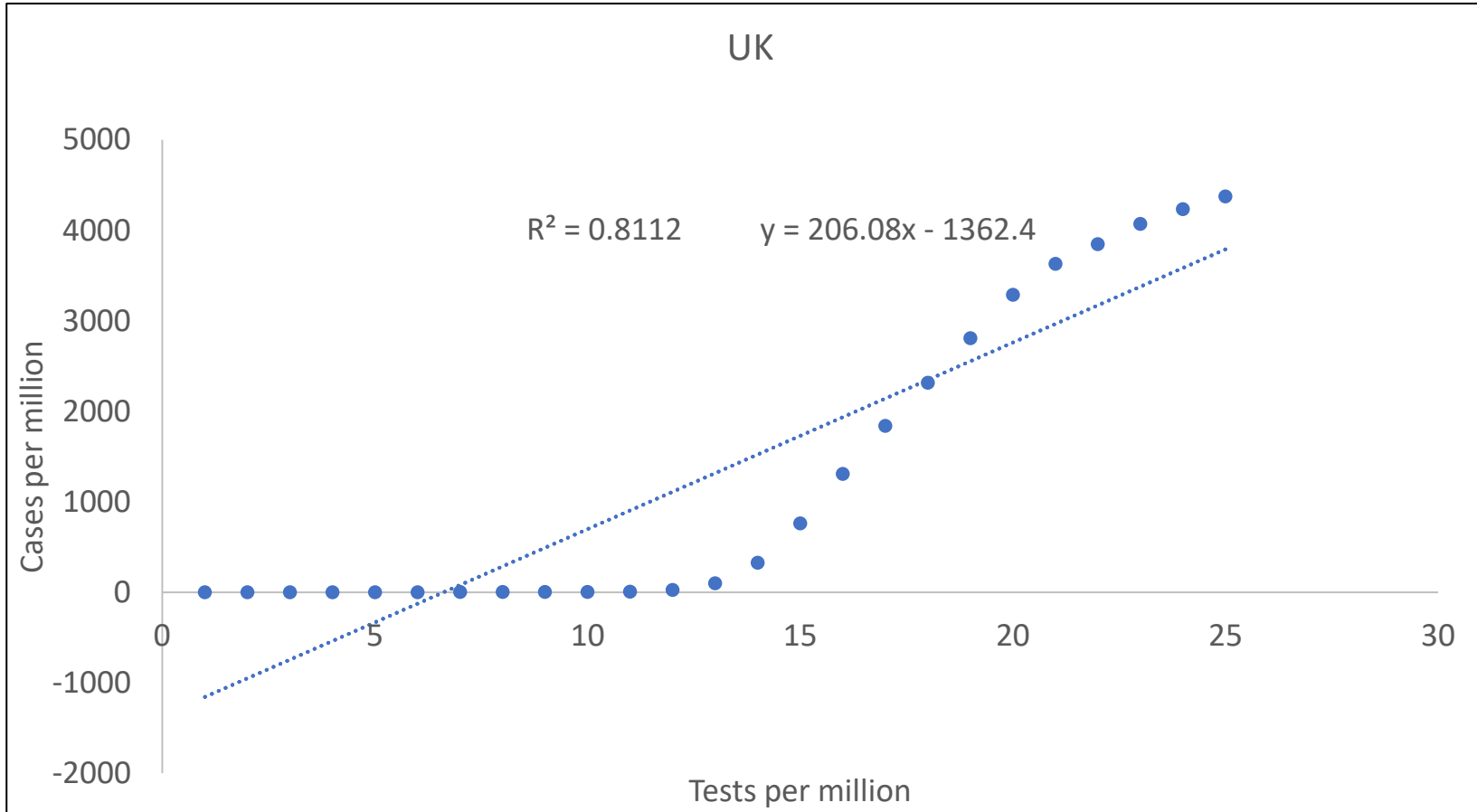
- **Scaling up of NHS swab testing** for the one with medical needs and where possible
- **Mass swab testing for critical key workers** who work in social care, NHS and other sectors
- **Mass antibody testing** to assess immunity among people against Coronavirus
- **Surveillance testing** to understand the disease and to develop new tests and treatments
- **Diagnostic national effort** to build mass testing capacity at a completely new scale



Total confirmed cases of COVID-19 per million people in UK taken at an interval of 7 days starting from January till mid-June

Tests performed per million compared with total confirmed cases of COVID-19 per million people in UK taken at an interval of 7 days starting from January till mid-June





Best fit equation
 $y = 206.08x - 1362.4$

Value of X at Y = 1
 6.615

Test needed per active case
 6615

Value of R^2
 0.811

Correlation Coefficient
 0.92

XY Scatter plot– tests and cases per million for UK



New Zealand

Testing Strategy

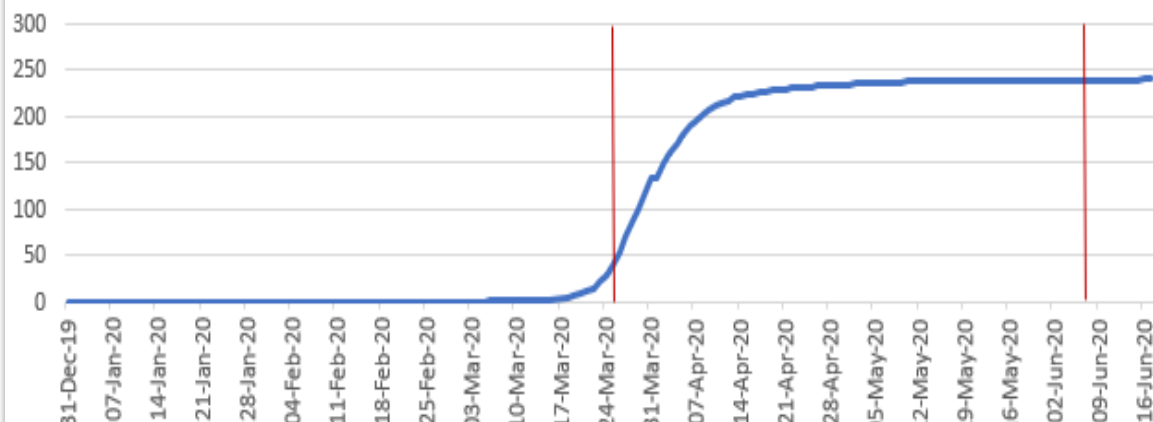
New Zealand's elimination strategy to combat COVID-19 has testing as one of its crucial steps to identify and isolate COVID-19 cases. Testing strategy involves:

- **Asymptomatic people**, mainly close contacts of cases and isolating them. Regular population testing will help to measure population susceptibility
- Testing of people who had **travelled to or from a country or area of concern**, or contact with a suspect, probable or confirmed COVID-19 case in the 14 days before onset of illness
- Testing of people who have **fever $\geq 38.0^{\circ}\text{C}$ OR any acute respiratory infection** with symptoms of at least one of: shortness of breath, cough or sore throat with or without fever
- **Healthcare workers** with moderate or severe community acquired pneumonia and critically patients in ICU/HDU with severe community acquired pneumonia
- Testing is also done if **clinical judgement warrants the requirement**



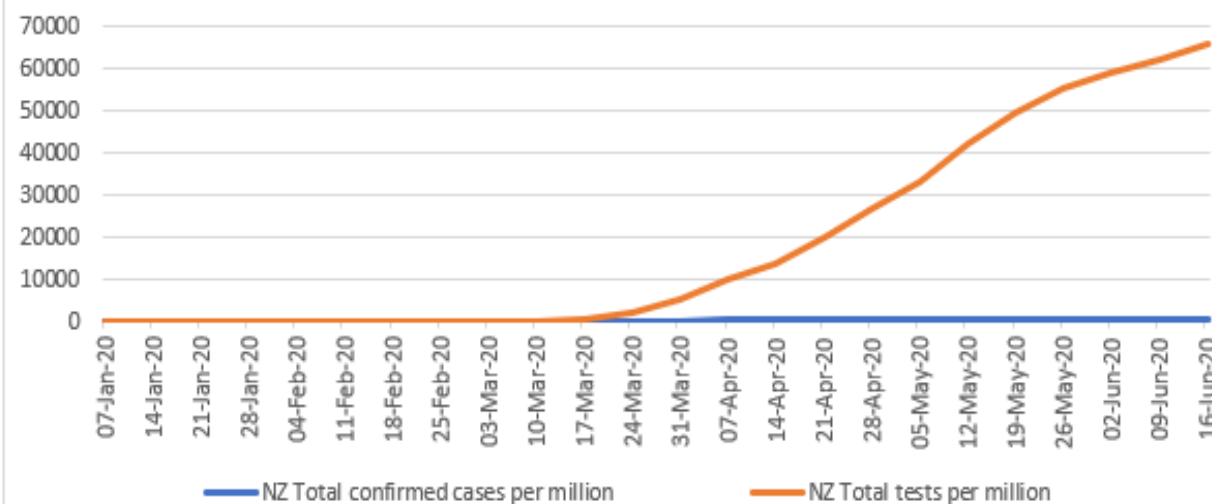
New Zealand

Total confirmed cases of COVID-19 per million people (cases per million)



Total confirmed cases of COVID-19 per million people in New Zealand taken at an interval of 7 days starting from January till mid-June

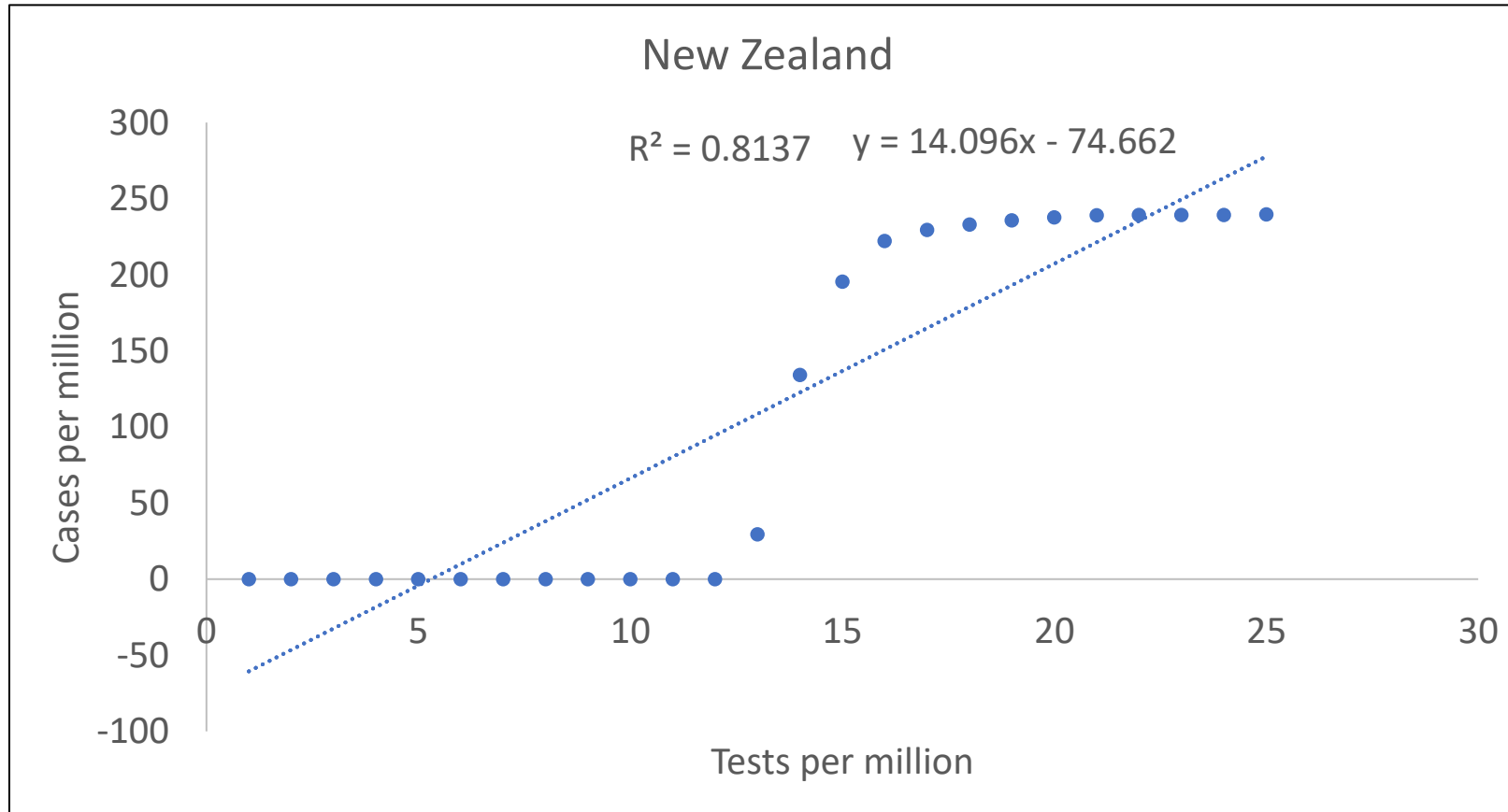
New Zealand



Tests performed per million compared with total confirmed cases of COVID-19 per million people in New Zealand taken at an interval of 7 days starting from January till mid-June



New Zealand



Best fit equation
 $y = 14.096x - 74.662$

Value of X at Y = 1
 5.367

Test needed per active case
 5367

Value of R^2
 0.813

Correlation Coefficient
 0.84

XY Scatter plot– tests and cases per million for New Zealand



South Korea

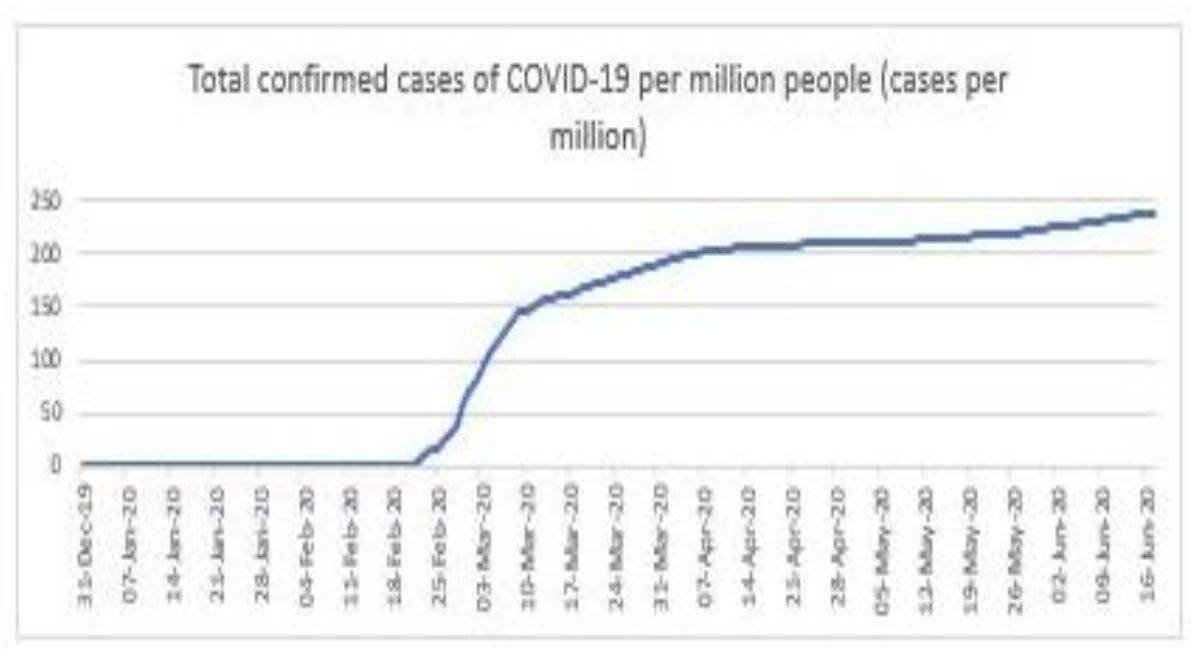
Testing Strategy

South Korea worked on 3 guiding principle to control COVID-19 outbreak: **test, trace and contain** which helped it to contain virus without lockdown. Some of the key points of its testing strategy includes:

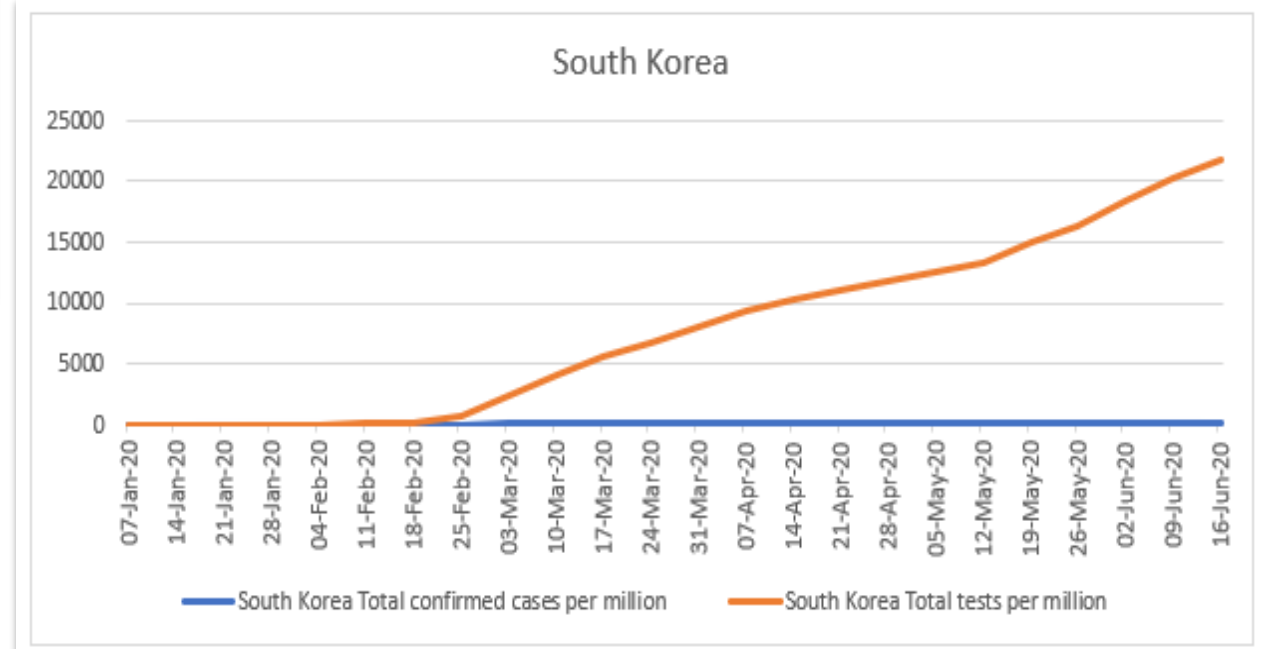
- It quickly ramped up its testing facilities and tested thousands of people in a day at its **drive through centers and walk in testing centers**. South Korea already tested more than 2,70,000 people by mid-March
- Approval was granted to private firms developing diagnostic kits (RT-PCR)
- Extensive use of **mobile technology** – people tested positive were asked to describe their movements which along with GPS phone tracking, credit card transactions and surveillance camera records helped KCDC to issue real time alerts of movement details of infected people
- **Text alerts** – information about newly confirmed patients and their recent trajectories was made available through texts to the population



South Korea



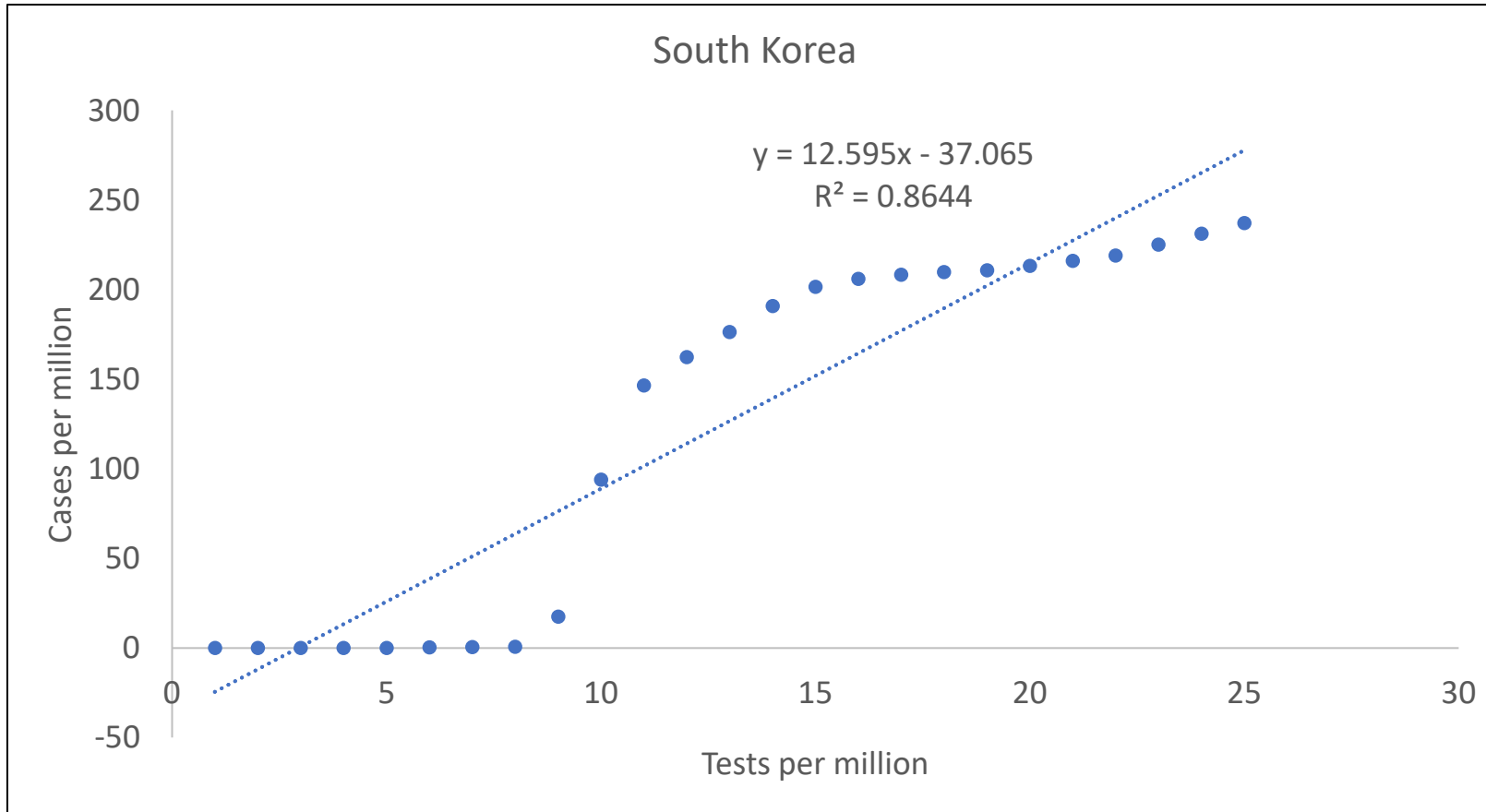
Total confirmed cases of COVID-19 per million people in South Korea taken at an interval of 7 days starting from January till mid-June



Tests performed per million compared with total confirmed cases of COVID-19 per million people in South Korea taken at an interval of 7 days starting from January till mid-June



South Korea



XY Scatter plot– tests and cases per million for South Korea

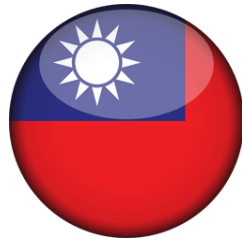
Best fit equation
 $y = 12.595x - 37.065$

Value of X at Y = 1
3.022

Test needed per active case
3022

Value of R^2
0.864

Correlation Coefficient
0.9



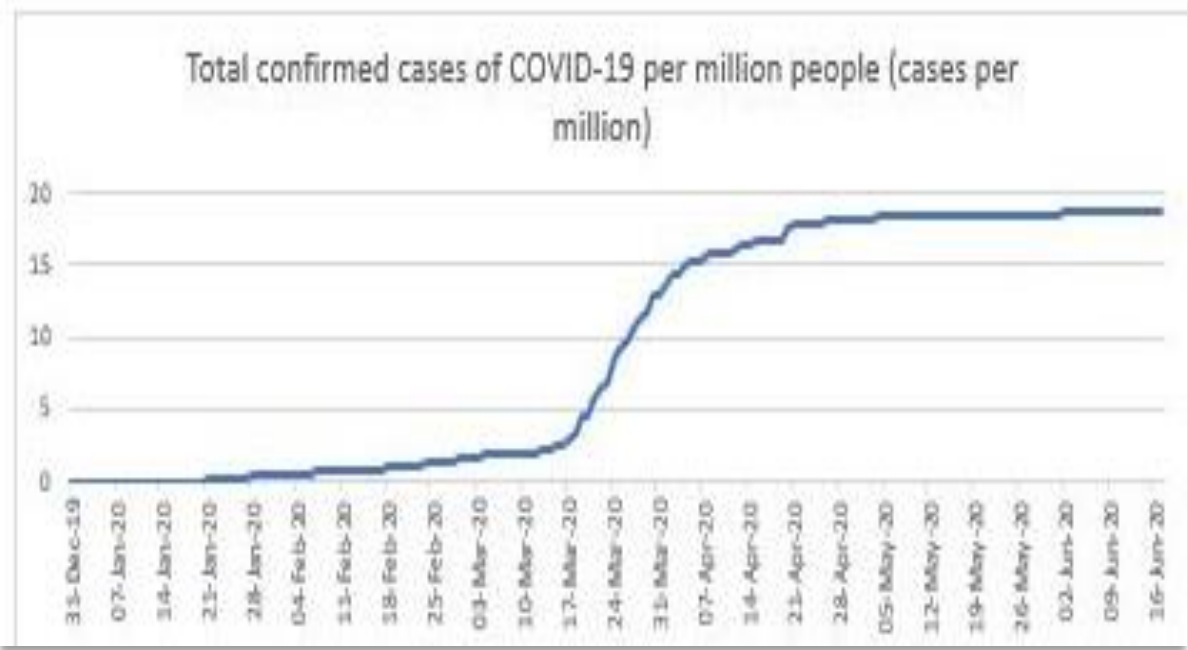
Taiwan

Testing Strategy

- Taiwan proactively **seek out patients with severe respiratory symptoms** (based on information from the National Health Insurance [NHI] database) who had tested negative for influenza and retested them for COVID-19
- Taiwan aggressively expanded its testing capacity. A **national testing network** has been established to improve Taiwan's testing capacity which allows the maximum testing capacity per day to reach 3,800 specimen tests and to reduce the wait time for results testing was performed in different areas
- Prompt response- Taiwan acted swiftly as early as January and began testing in huge numbers

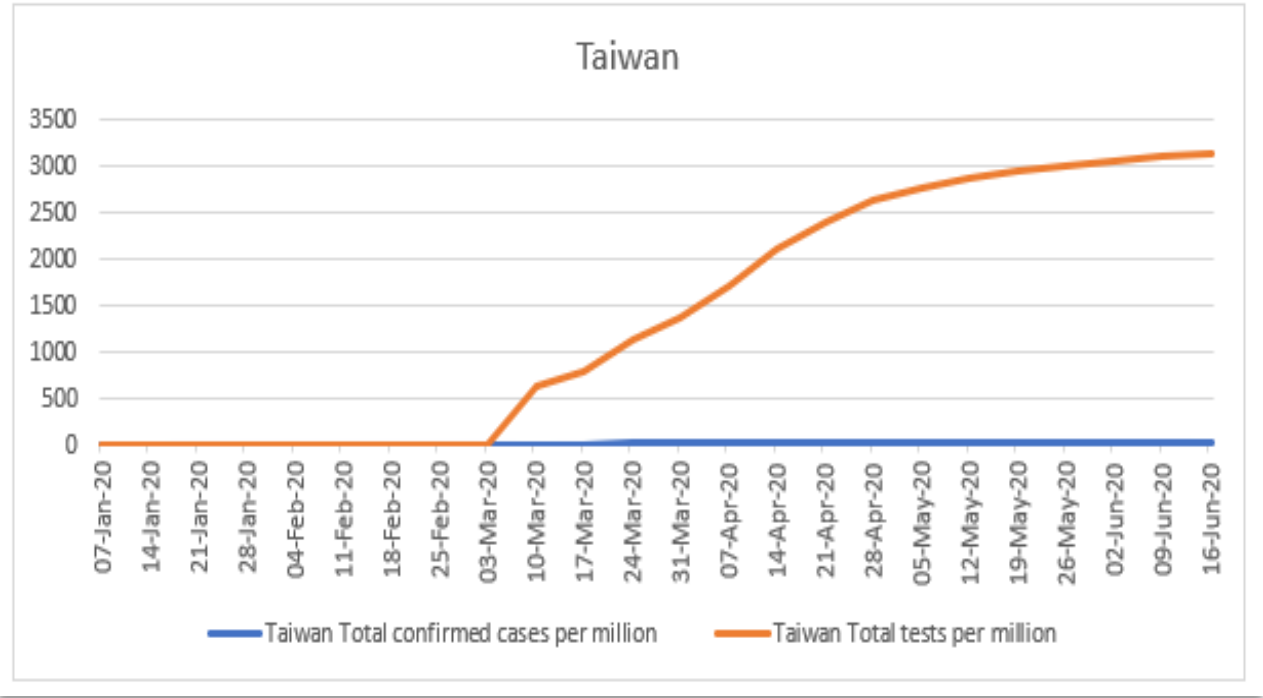


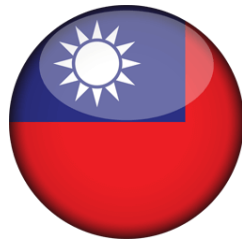
Taiwan



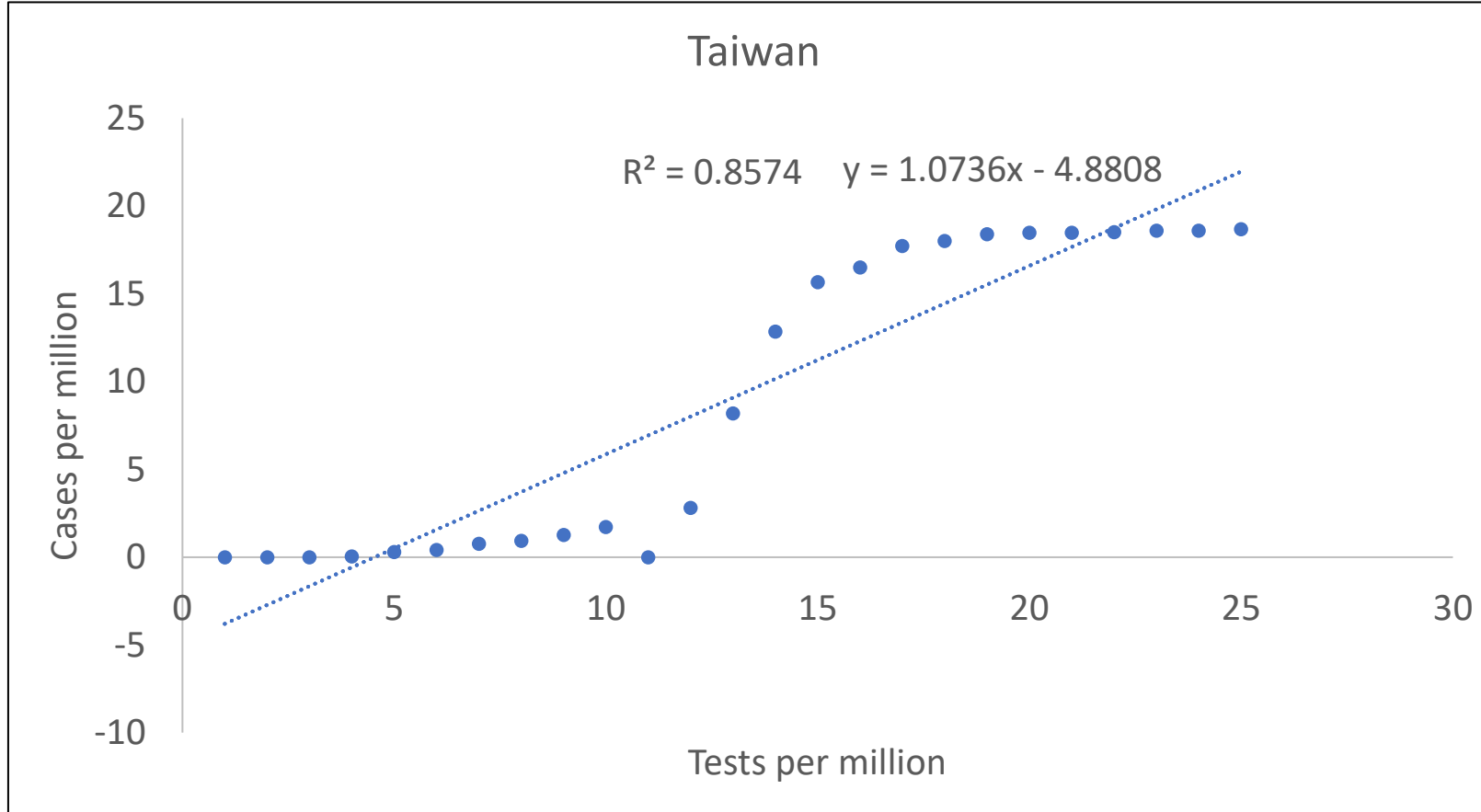
Total confirmed cases of COVID-19 per million people in Taiwan taken at an interval of 7 days starting from January till mid-June

Tests performed per million compared with total confirmed cases of COVID-19 per million people in Taiwan taken at an interval of 7 days starting from January till mid-June





Taiwan



XY Scatter plot— tests and cases per million for Taiwan

Best fit equation
 $y = 1.0736x - 4.8808$

Value of X at Y = 1
5.477

Test needed per active case
5477

Value of R^2
0.857

Correlation Coefficient
0.97



Japan

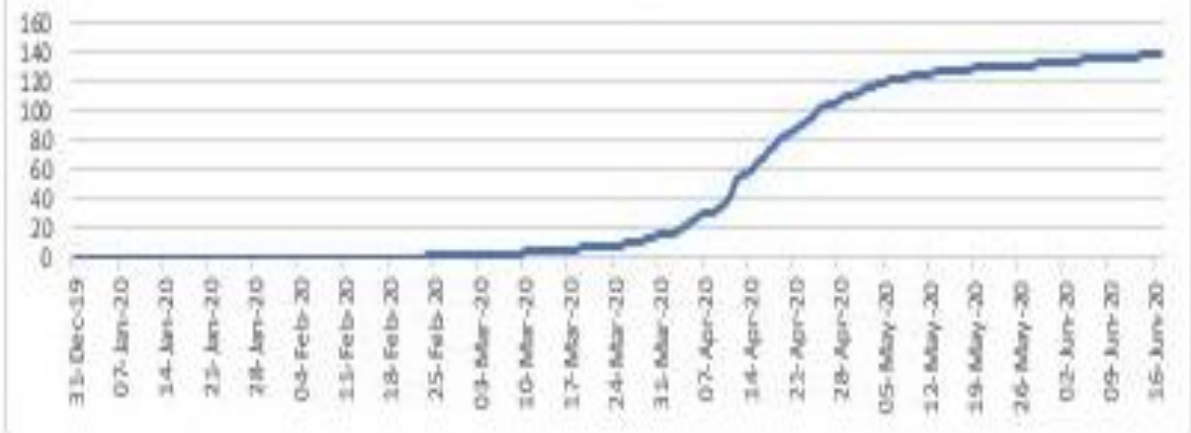
Testing Strategy

- Japan adopted a **cluster-based approach** to deal with spread of infection
- This approach tracks original infection source and people with high transmissibility are isolated to prevent the virus from spreading. This allows **pinpoint testing** rather than broad testing
- This cluster-based approach can only work when there are only a few infected persons and clusters are detectable at an early stage
- Testing of only symptomatic carriers – limited testing to prevent false negatives and healthcare facilities getting overwhelmed



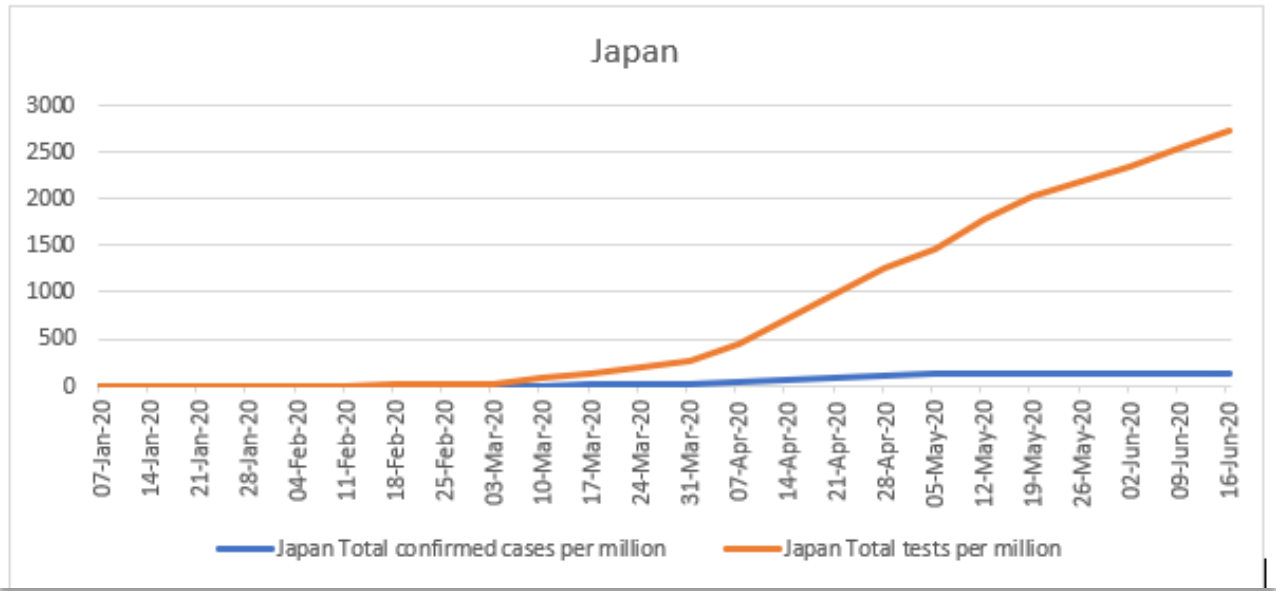
Japan

Total confirmed cases of COVID-19 per million people (cases per million)



Total confirmed cases of COVID-19 per million people in Japan taken at an interval of 7 days starting from January till mid-June

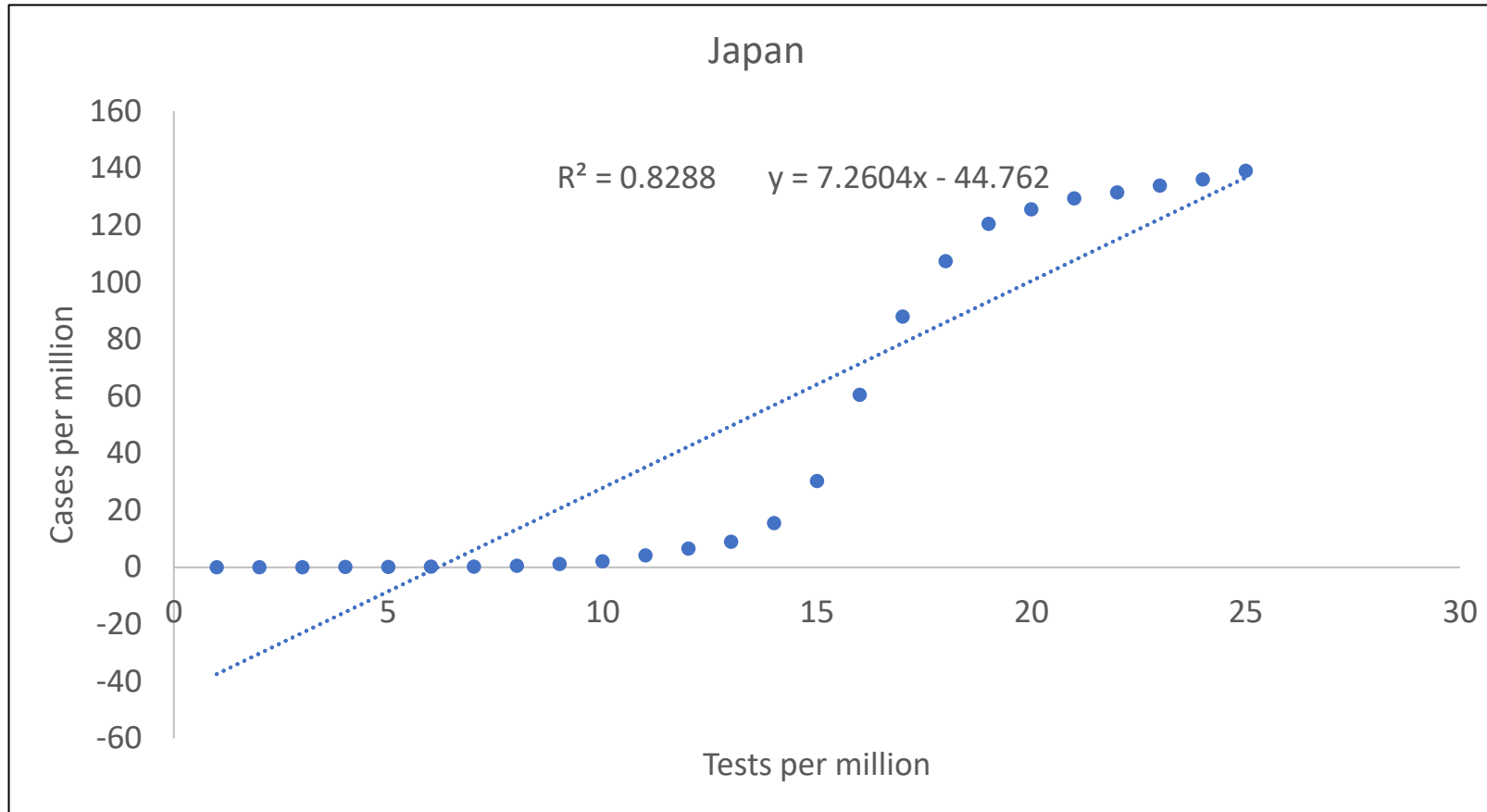
Japan



Tests performed per million compared with total confirmed cases of COVID-19 per million people in Japan taken at an interval of 7 days starting from January till mid-June



Japan



Best fit equation
 $y = 7.2604x - 44.762$

Value of X at Y = 1
6.302

Test needed per active case
6302

Value of R^2
0.828

Correlation Coefficient
0.97

XY Scatter plot– tests and cases per million for Japan



India

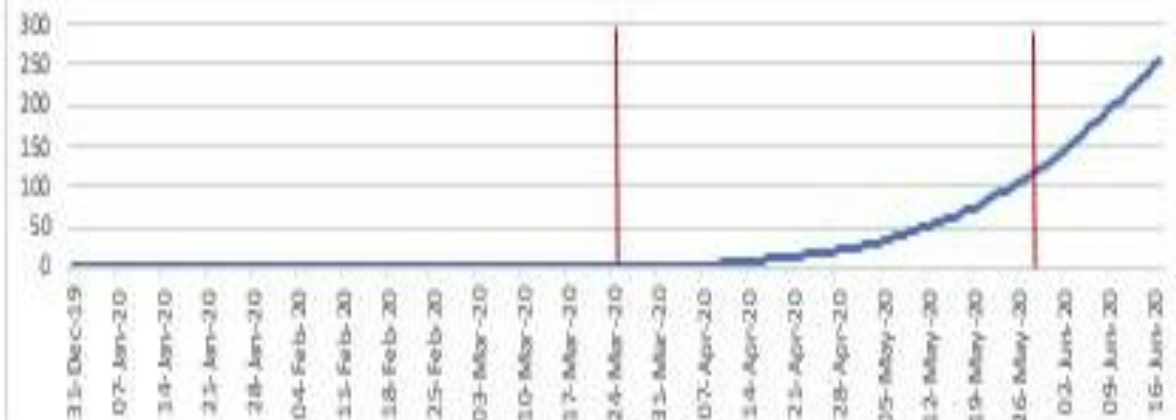
Testing Strategy

- India's testing strategy evolved over the months since the first case was identified
- Testing labs for COVID-19 **increased from 13 in mid-February to 609 by May** – when infection was entering the country from across the world efforts were laid to set up burst of laboratories across cities increasing the number of tests done per day to approximately 1 lakh by end of May
- **TrueNAT machines** that are used to detect Tuberculosis virus was approved by ICMR to be used for COVID-19 detection in districts where advanced virological laboratory doesn't exist
- **All symptomatic ILI cases** with history of international travel, those with contacts of laboratory cases, healthcare and frontline workers, within hotspot/containment zones and those among returnees and migrants within 7 days of illness
- **All SARI cases and hospitalized patients who develop ILI** are also tested



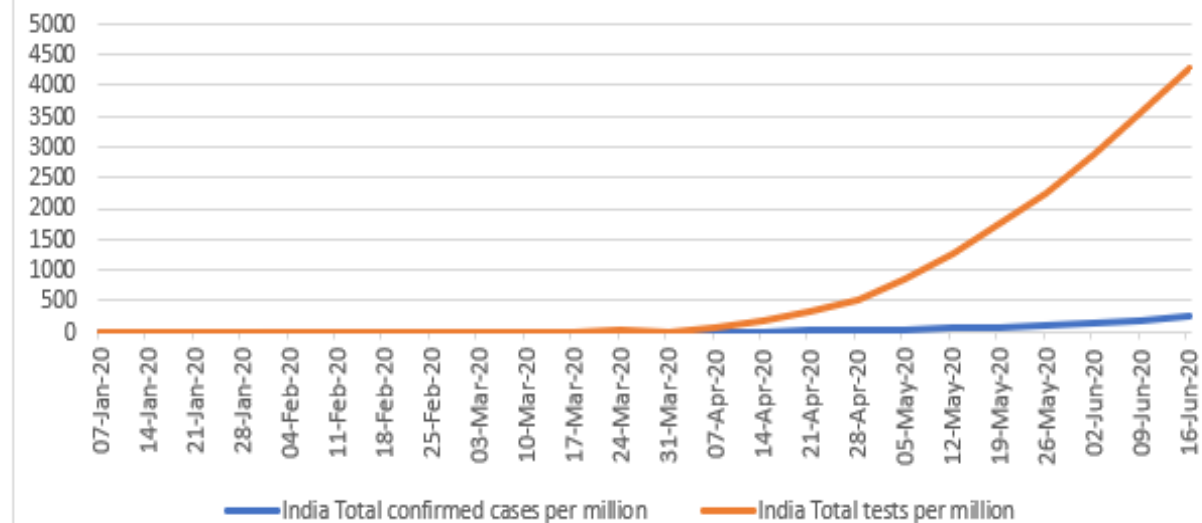
India

Total confirmed cases of COVID-19 per million people (cases per million)



Total confirmed cases of COVID-19 per million people in India taken at an interval of 7 days starting from January till mid-June

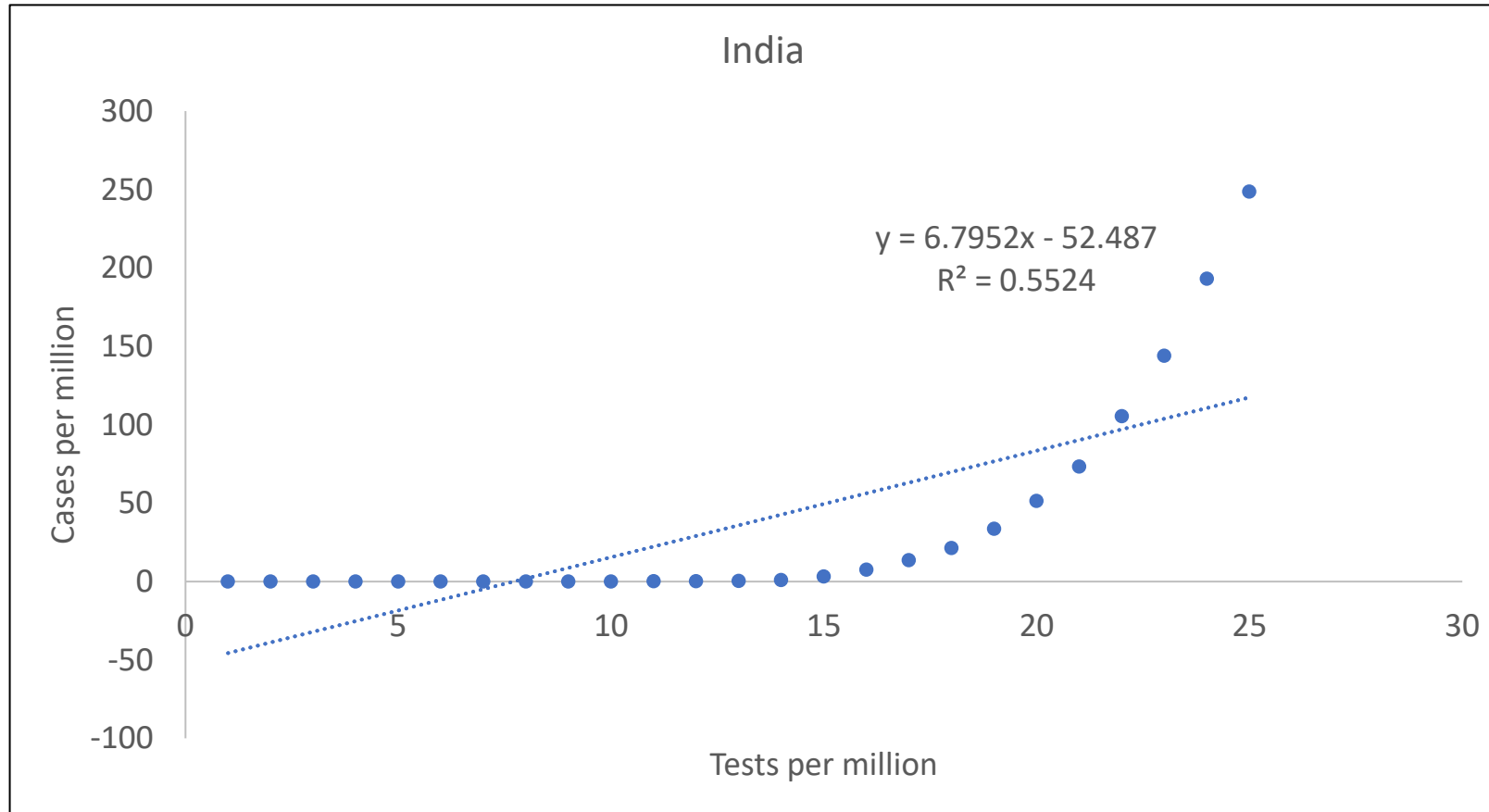
India



Tests performed per million compared with total confirmed cases of COVID-19 per million people in India taken at an interval of 7 days starting from January till mid-June



India



Best fit equation
 $y = 6.7952x - 52.487$

Value of X at Y = 1
 7.871

Test needed per active case
 7871

Value of R^2
 0.552

Correlation Coefficient
 0.99

XY Scatter plot– tests and cases per million for India

Calculations

Country	Best fit equation	Value of X at Y = 1	Tests needed per active case	Value of R ²	Correlation Coefficient
USA	$y = 277.33x - 1849.5$	6.672	6672	0.811	0.97
UK	$y = 206.08x - 1362.4$	6.615	6615	0.811	0.92
New Zealand	$y = 14.096x - 74.662$	5.367	5367	0.813	0.84
South Korea	$y = 12.595x - 37.065$	3.022	3022	0.864	0.9
Taiwan	$y = 1.0736x - 4.8808$	5.477	5477	0.857	0.97
Japan	$y = 7.2604x - 44.762$	6.302	6302	0.828	0.97
India	$y = 6.7952x - 52.487$	7.871	7871	0.552	0.99

Interpretation

Values of X i.e., tests needed for identifying 1 case – Lower the value of X higher is the efficiency of testing strategy of the country which gives us South Korea as the best performing country with the most efficient testing strategy to deal with the pandemic followed by Taiwan, New Zealand, Japan, UK, USA and India

R² value is telling us how much of cases is explained by tests i.e., how much of cases are dependent on tests. Higher the value higher the dependency of cases on tests.

South Korea has the highest value of R² which shows high dependency of its cases on testing numbers – 86.4% dependency on testing measures, rest 13.6% dependency on other variables. It is followed by Taiwan which has 85.7% dependency of its cases on testing numbers. Country with lowest value of R² is India. It shows only 55.2% dependency of its cases on testing numbers.

Correlation shows how strongly Cases and tests numbers are dependent on each other. All the countries (except for New Zealand which has a lower correlation number, 0.84) show strong dependency of cases on tests >90%

Inter country comparison of testing strategies and its consequences - adopted by countries (Green– performing)

	Viral/ Antigen Testing	Antibody Testing	Testing of asymptomatic cases	Early Response	Population sero- surveillance	Use of technology	Lockdown	Cases Curve Flattened
USA								Curve has begun to flatten but cases still reported in large numbers (~26,000+ cases each day)
UK						Mobile apps		
New Zealand		Study among high risk individuals to begin using Ab tests ³⁵						
South Korea						Mobile apps, credit card tracking, GPS		
Taiwan						Use of GPS, AI labs etc. ³⁶		
Japan				Japan started early but kept its testing numbers low – focused on pin-point testing	Started in early June (June 1-June 7) ³⁷			
India		ICMR recently approved some ELISA and RDT kits for surveillance ³⁸			Maharashtra Government to launch surveillance study among HCWs ³⁹	Arogya Setu App		

Result

South Korea came out as the country with the best testing strategy compared to the other 6 countries. Its test needed per active case is lowest (3022), R2 value is highest (86.4%) and correlation coefficient is also high (0.9) which indicates that number of cases are highly and strongly dependent on number of tests performed proving the effectiveness of its testing strategy

On the other hand, **India has highest number of tests per active case** (7871), R2 value is lowest (55.2%) and correlation coefficient highest (0.99) which indicates that rate of increase of cases closely follows increase in tests and many other factors other than tests are responsible for increased cases indicating higher number of testing is required

Countries in the order of highly effective testing strategies to least effective

South Korea > Taiwan > New Zealand > Japan > UK > USA > India

Conclusion

South Korea, Taiwan, Japan and New Zealand came out as successful models which implemented different testing strategies to control spread of infection at an early stage without imposing full time lockdown

South Korea

began to ramp up its testing capacity as early as January. It adopted open public testing available to asymptomatic individuals as well and contact tracing of all confirmed cases. This led to early identification of cases and their isolation to prevent the spread of infection. By middle of March South Korea achieved peak of its outbreak far ahead than most of the countries. As the number of cases fell, testing continued at same rates

Taiwan

Taiwan's cases per million stands at 18 and deaths at 0.29 attributed to its expanded testing capacity and use of technology for contact tracing. Taiwan particularly learned lessons from the MERS outbreak and implemented those to deal with COVID – 19. All this helped Taiwan to achieve peak of its outbreak by early April and flatten its curve without imposing any nationwide restrictions

Japan

Japan came out as an exception. It kept its testing numbers low and still contained the outbreak achieving peak of the outbreak by April. It focused on clustered approach and pin point testing strategy and identified and tracked original infection source isolating people with high transmissibility. Though initially criticized for low testing numbers Japan showed how targeted approach can help to deal with the pandemic without resorting to Lockdown, disrupting economies

New Zealand

with its elimination strategy has showed how successfully a pandemic can be controlled. By imposing strict lockdown restrictions, banning flights coming from suspected countries, inclusion of widespread tests and isolating them played an effective role in controlling the infection spread

Comparison with India

- India came a long way with its testing journey. Starting from 13 labs in mid-February Government increased the capacity to 609 by May which have significantly contributed to its increased testing numbers which by mid-June stands at 4,530 per million.
- But unlike South Korea, Taiwan etc. India was unable to increase its testing numbers in early stage of the pandemic. A strict timely lockdown was imposed towards the end of March and continued till June 1st, but cases began to rise with huge addition in daily numbers as testing numbers increased. Daily cases increased from ~70 in March end to ~11,000 in June. India soon will cross the mark of 4,00,000 cases and will be one of the top 3 most affected country in the world.
- India refrained from testing asymptomatic population which have resulted in increased transmission through these unidentified cases.
- Government of India imposed timely lockdown to prevent the transmission of infection, but reduced testing capacity prevented timely identification of cases in early stage.
- Moreover, antibody testing and surveillance programs in India haven't rolled out at the national level until June mid compared to other countries where such programs have been running and their results helping the nations to devise strategies

Comparing India cases and tests numbers with other countries

	Cases /million – 15 th March	Tests/mill ion – 15 th March	Cases/million – 15 th Apr	Tests/ million – 15 th Apr	Cases/ million – 15 th May	Tests/ million – 15 th May	Cases/million – 15 th Jun	Tests/milli on – 15 th Jun
USA	8.9	125	1841.42	9930	4238	32557	6458	79302
UK	16.7	593	1382.80	4622	3434	24504	4391	104930
New Zealand	1.65	151	223.54	14549	238	46438	239	64210
South Korea	159	5231	206.57	10426	214	14175	237	22348
Taiwan	2.4	723	16.58	2129	18.4	2897	18.6	3137
Japan	6.1	103	64.04	199	128	1825	139	2752
India	0.06	NA	8.28	745	59.4	1478	256	4530

Suggestions

- Early interventions by Government is required to ramp up the numbers of testing – Just like South Korea and Taiwan which learned from their previous outbreaks and implemented timely measures to increase testing capacity
- Testing, tracing and isolation of asymptomatic individuals is must to break the chain of transmission – Current strategies need to be revised to include asymptomatic individuals and testing capacity need to be ramped up accordingly
- Similar to what Taiwan did, utilizing the power of data for decision making and developing strategies
- Rolling out of national plans for antibody testing and surveillance programs
- Similar to what Japan did, using targeted approach towards testing in green zones to identify case clusters and isolate them. This will allow judicious use of resources in other areas of high importance (containment zones)

THANK YOU