WEEKLY EPIDEMIOLOGICAL REPORT

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Herd Immunity and SARS-CoV-2

Acquired immunity can be achieved at an individual level in a population, either through natural infection with a pathogen or through immunization with a vaccine. It is worthwhile to understand few principles associated with acquired immunity to understand the rationale behind reaching herd immunity for SARS-CoV-2 in a population.

Herd immunity is a key concept for epidemic control. It refers to the indirect protection from infection conferred to susceptible individuals when a sufficiently large proportion of immune individuals exist in a population[1].

Basic Reproduction Number (R_O) and Effective Reproduction number (R_t/R_e) are important nomenclatures in Epidemiology that provide a working understanding of the achievement of herd immunity in a given community. Basic Reproduction Number (R_O) is the average number of secondary infection caused by a single infection individually when introduced into a completely susceptible population. Effective Reproduction number (R_t/R_e) is an average of secondary cases generated by a single index case over an infection period in a partially immunized population. R_e unlike, R_O is dependent on the current immune status of the population, which will change dynamically over time with out-break events. Herd immunity is achieved when R_e drops below 1 in the absence of interventions where one infected person in the population generates less than one secondary case on average[2].

Since the onset of SARS-CoV-2 spread, numerous studies[3] have estimated the basic reproductive number (R_0) of the virus to be in the range of 2.5 to 3.5. A vaccine with 100% efficacy that gives life-long protection, the level of herd immunity as a proportion of the population, (p_c) which is required to block transmission is 1- (1/ R_0). Assuming an R_0 estimate of 3 for SARS-CoV-2, the herd immunity threshold is approximately 67% (range 60-72%). This means that the incidence of infection will start to decline once the proportion of individuals with acquired immunity to SARS-CoV-2 in the population exceeds 0.67[4]. Further, when considering proportional vaccine efficacy (ε), p_c becomes [1- (1/ R_0)]/ ε [5]. Hence, if we take a vaccine with ε is of 0.8(80%), the herd immunity required becomes 75-90%[6]. Hence, the higher the efficacy of a specific vaccine, the proportionately higher the herd immunity achieved.

Seasonality of the influenza virus and immunity developed by cross-infection to the previously encountered virus, interventions and concurrent vaccination of the vulnerable population had helped in the development of herd immunity for previous flu epidemics[7]. Then, one can wonder whether the same could be applied for SARS-CoV-2. In the absence of an effective vaccination campaign, for COVID-19, the cost of reaching herd immunity through natural infection would be very high. The COVID-19 fatality rate among the elderly population and those with

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comorbidities are reported relatively high, especially in the absence of improved patient management and without optimal shielding of individuals at risk of severe complications. Therefore, if a nation decides to undergo measures other than vaccination, in such case cost due to DALYs and QALYs would account for an enormous amount in the country's economy and also can be regarded as unethical.

Even if the level of herd immunity is achieved, by any means, sustainability of the herd immunity is the main obstacle that would be hard to tackle. Since information on the long-term immune response against SARS-CoV2 is yet scarce, interpretation of the timeline in achieving herd immunity in the community is a difficult task. Nevertheless, factors such as a mutation in the viral structure and changes in the host immunity would lead to barriers in the achievement of herd immunity in a community. Therefore, though herd immunity is achieved in a community through an extensive vaccination campaign, mutation of the virus can call for new onset of a pandemic, which would be hard to counteract with[8].

Achievement of herd immunity in a community depends on many factors; highly effective vaccine brand, a uniform and unbiased vaccination plan, the length and effectiveness of the immune response, vaccine mutations and epitopes, host immunity status are a few of these determinants. Currently, the duration of protection against COVID 19 by vaccination is not reported. Many assume that immunity would persist 12-18 months after vaccination with both doses. Hence, the question arises what proportion of the population will need to be immunized year by year with a COVID-19 vaccine.

The mathematical modelling[9] shows that the percentage of the population that must be vaccinated in year 1 is much larger than the percentage that must be vaccinated once the system has stabilized after a few years since most of the population will be susceptible as mass immunization starts, but after a few years, hopefully, a high proportion will be immunized such that effective herd immunity is created. In summary, the protection given by the vaccine needs to outrun the duration of natural infection of COVID 19.

Therefore, the achievement of long-lived herd immunity against COVID 19 is a complicated but yet achievable task.

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Table 1: Selected notifiable diseases reported by Medical Officers of Health 23rd – 29th Jan 2021 (5th Week)

RDHS	Dengue Fever		Dysentery		Encephaliti		Enteric Fever		Food Poi-		Leptospirosis		Typhus Fe-		Viral Hep-		Human		Chickenpox		Meningitis		Leishmania-		WRCD	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	T*	C**
Colombo	21	127	0	3	0	0	0	0	0	0	4	18	0	0	0	1	1	1	0	3	0	2	0	0	**57**	**95**
Gampaha	20	94	0	0	0	1	0	1	0	0	0	4	0	0	0	0	0	0	1	1	1	2	0	1	**20**	**80**
Kalutara	12	82	1	2	0	0	0	0	0	0	2	21	0	0	0	0	0	0	3	11	0	0	0	0	**29**	**100**
Kandy	17	67	0	2	0	1	0	0	0	0	4	40	0	7	0	1	0	0	3	8	1	2	0	5	**58**	**100**
Matale	1	12	0	1	0	1	0	0	0	0	0	9	0	3	0	1	0	0	0	3	0	1	4	23	**71**	**100**
NuwaraEliya	1	5	0	0	0	0	0	0	0	0	0	7	1	11	0	0	0	0	2	6	0	0	0	1	**33**	**98**
Galle	2	19	1	1	0	1	0	0	0	0	9	82	0	6	0	2	0	0	2	2	0	6	0	1	**40**	**100**
Hambantota	3	18	0	2	0	1	0	0	0	0	5	23	5	10	0	4	0	0	1	3	2	6	3	54	**75**	**100**
Matara	3	28	0	0	0	0	0	1	0	0	3	28	0	3	0	0	0	0	3	10	0	0	8	33	**32**	**100**
Jaffna	12	44	0	10	0	0	1	5	0	0	1	6	67	191	0	0	0	0	1	4	1	2	0	0	**17**	**88**
Kilinochchi	3	10	0	3	0	0	0	0	0	2	3	14	5	18	0	0	0	0	0	2	0	0	1	1	**55**	**100**
Mannar	1	4	0	0	0	0	0	2	0	0	0	7	0	1	0	0	0	0	0	0	0	6	1	1	**35**	**80**
Vavuniya	1	4	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	**20**	**100**
Mullaitivu	0	2	0	0	0	0	0	0	0	0	2	7	0	2	0	0	0	0	0	1	0	1	0	0	**3**	**100**
Batticaloa	237	1132	1	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	2	0	3	0	0	**53**	**100**
Ampara	1	2	2	3	0	0	0	1	0	0	0	4	0	0	0	0	0	0	1	13	0	1	0	0	**54**	**100**
Trincomalee	4	13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3	0	1	0	0	**28**	**100**
Kurunegala	7	62	0	0	1	1	0	0	0	2	5	62	0	6	0	0	0	0	1	7	7	29	14	57	**41**	**100**
Puttalam	12	49	0	1	0	1	0	0	0	0	0	6	0	3	0	0	0	0	1	3	0	8	1	2	**44**	**97**
Anuradhapur	3	13	0	3	0	0	0	0	0	0	25	63	1	13	0	0	0	0	1	5	1	6	1	41	**32**	**96**
Polonnaruwa	0	2	0	0	0	0	0	0	0	0	4	20	0	0	0	0	0	0	1	3	0	1	6	37	**43**	**100**
Badulla	1	12	0	0	0	0	0	0	0	0	8	37	2	8	0	1	0	0	2	6	1	1	0	4	**45**	**96**
Monaragala	0	5	1	2	0	0	0	1	0	0	5	16	1	4	0	4	0	0	1	4	4	6	0	3	**0**	**100**
Ratnapura	14	38	0	5	0	0	0	0	0	0	26	98	2	3	1	1	1	1	0	7	6	19	1	9	**36**	**100**
Kegalle	4	23	0	1	0	0	0	0	0	0	3	28	0	1	0	0	0	0	0	11	0	2	0	0	**40**	**100**
Kalmune	9	36	0	3	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**45**	**100**
SRILANKA	**389**	**1903**	**6**	**43**	**1**	**8**	**1**	**11**	**0**	**4**	**111**	**607**	**84**	**290**	**1**	**15**	**2**	**2**	**25**	**120**	**24**	**105**	**40**	**273**	**41**	**97**

Source: Weekly Returns of Communicable Diseases (esurvillance.epid.gov.lk).

*T=Timeliness refers to returns received on or before 29th January , 2021 Total number of reporting units 357 Number of reporting units data provided for the current week: 352 C**-Completeness

Table 2: Vaccine-Preventable Diseases & AFP

23rd - 29th Jan 2021 (5th Week)

Disease	No. of Cases by Province									Number of cases during current week in 2021	Number of cases during same week in 2020	Total number of cases to date in 2021	Total number of cases to date in 2020	Difference between the number of cases to date in 2021& 2020
	W	C	S	N	E	NW	NC	U	Sab					
AFP*	01	01	00	00	00	00	00	00	00	02	01	06	04	50%
Diphtheria	00	00	00	00	00	00	00	00	00	00	00	00	00	0%
Mumps	00	00	00	00	01	00	00	00	00	01	09	07	14	-50%
Measles	00	00	00	00	00	00	00	00	00	00	00	03	02	50%
Rubella	00	00	00	00	00	00	00	00	00	00	00	00	00	0%
CRS**	00	00	00	00	00	00	00	00	00	00	00	00	00	0%
Tetanus	00	00	00	00	00	00	00	00	00	00	00	00	01	-100%
Neonatal Tetanus	00	00	00	00	00	00	00	00	00	00	00	00	00	0%
Japanese Encephalitis	00	00	00	00	00	00	00	00	00	00	01	00	03	-100%
Whooping Cough	00	00	00	00	00	00	00	00	00	00	00	00	00	0%
Tuberculosis	38	04	07	07	10	10	04	15	12	107	144	629	629	0%

Key to Table 1 & 2

Provinces: **W**: Western, **C**: Central, **S**: Southern, **N**: North, **E**: East, **NC**: North Central, **NW**: North Western, **U**: Uva, **Sab**: Sabaragamuwa.

RDHS Divisions: **CB**: Colombo, **GM**: Gampaha, **KL**: Kalutara, **KD**: Kandy, **ML**: Matale, **NE**: Nuwara Eliya, **GL**: Galle, **HB**: Hambantota, **MT**: Matara, **JF**: Jaffna, **KN**: Killinochchi, **MN**: Mannar, **VA**: Vavuniya, **MU**: Mullaitivu, **BT**: Batticaloa, **AM**: Ampara, **TR**: Trincomalee, **KM**: Kalmunai, **KR**: Kurunegala, **PU**: Puttalam, **AP**: Anuradhapura, **PO**: Polonnaruwa, **BD**: Badulla, **MO**: Moneragala, **RP**: Ratnapura, **KG**: Kegalle.

Data Sources:

Weekly Return of Communicable Diseases: Diphtheria, Measles, Tetanus, Neonatal Tetanus, Whooping Cough, Chickenpox, Meningitis, Mumps., Rubella, CRS,

Special Surveillance: AFP* (Acute Flaccid Paralysis), Japanese Encephalitis

CRS =**Congenital Rubella Syndrome

Covid-19 Prevention & Control
For everyone's health & safety, maintain physical distance, often wash hands, wear a face mask and stay home.

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