

REVIEW OF EPIDEMIOLOGICAL INVESTIGATION OF MUMPS OUTBREAK THROUGH MATHEMATICAL MODELING (SIR MODEL) IN VILLAGE DARGAHAPUR, BLOCK-LAKSAR, DIST.- HARIDWAR, UTTARAKHAND, DURING DEC 2023

Public Health

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ABSTRACT

Background: Mumps is one of the oldest human illnesses known to humans it is an acute disease of children and young adults, caused by a paramyxovirus of which there is only a single serotype. Humans are the only known host for mumps virus, which is spread via direct contact or by airborne droplets from the upper respiratory tract of infected individuals. Mumps is frequently reported in children aged 5-9 years of age, although both adolescents and adults may be affected. After an incubation period of some 2 to 4 weeks mumps begins with non-specific symptoms such as myalgia, headache, malaise and low-grade fever. **Objective:** Situational analysis of Mumps in Haridwar to confirm the existence of outbreak to describe the epidemiology of the outbreak and provide recommendations to prevent future outbreaks, to control activity and public awareness in affected area. **Methods:** Meeting and discussion with Medical Superintendent of CHC Laksar, Interviewed suspected mumps case patient's/ case, family member's and other villagers, Case survey for epidemiological study and IEC activity for public health awareness.

KEYWORDS

mumps, paramyxovirus, compressive strength, Orchitis, disease surveillance, haridwar

INTRODUCTION:

Mumps is an acute disease of children and young adults, caused by a paramyxovirus of which there is only a single serotype. Humans are the only known host for mumps virus, which is spread via direct contact or by airborne droplets from the upper respiratory tract of infected individuals. Mumps is frequently reported in children aged 5-9 years of age, although both adolescents and adults may be affected. After an incubation period of some 2 to 4 weeks mumps begins with non-specific symptoms such as myalgia, headache, malaise and low-grade fever. Within days, these symptoms are followed by unilateral or bilateral swelling of the parotid salivary glands, with other salivary glands affected in 10% of cases.

Normally mumps is a mild, self-limiting disease and disappears without sequelae. However, complications may occur such as encephalitis or sensorineural deafness. Orchitis (a painful inflammation of the testes) occurs in few of young adult males who develop mumps.

The primary sign and symptoms of mumps include swelling and tenderness of the salivary glands, particularly the parotid glands (located just below and in front of the ears). However, not everyone infected with the mumps virus will experience noticeable symptoms.

Mumps is found worldwide, and prior to the introduction of the mumps vaccine, it was a common childhood illness. The incidence of mumps has decreased significantly in countries with widespread vaccination programs. However, outbreaks can still occur in communities with low vaccination rates.

Transmission:

The mumps virus is highly contagious and spreads from person to person through respiratory secretions, such as saliva, and respiratory droplets. Transmission can occur through coughing, sneezing or direct contact with contaminated surfaces.

Incubation Period:

The incubation period for mumps is typically 14-28 days, but it can range from 12 to 25 days. During this time, an infected individual may not show any symptoms but can still spread the virus to others.

Symptoms:

- The hallmark symptom is swelling and pain in one or more salivary glands, usually the parotid glands. This can cause difficulty in chewing and swallowing.
- Other symptoms may include fever, headache, muscle aches, fatigue, and loss of appetite.
- In some cases, complications can occur, including inflammation of other organs such as the Testicles (Orchitis), Ovaries (Oophoritis), and Meninges (Meningitis).

Vaccination:

- The MMR (Measles, Mumps, Rubella) vaccine is highly effective in preventing mumps. It is usually given in two doses, with the first dose at around 1 year to 1.5 year of age and the second dose at 4-6 years of age.
- High vaccination coverage is essential to control and prevent outbreaks.

Vaccine Effectiveness:

While the MMR vaccine is effective, it may not provide 100% immunity. However, vaccinated individuals who contract mumps are likely to have milder symptoms and a lower risk of complications.

Complications:

Complications of mumps can include inflammation of the testicles (orchitis), which can lead to infertility in rare cases, as well as inflammation of the ovaries (oophoritis) and the covering of the brain and spinal cord (meningitis).

Deafness is another rare but possible complication of mumps.

Treatment:

- There is no specific antiviral treatment for mumps.
- Supportive care involves rest, adequate hydration, and pain relief to alleviate symptoms.

Prevention:

Besides vaccination, practicing good hygiene, such as frequent handwashing and avoiding contact with infected individuals, can help prevent the spread of mumps.

First Information:

After getting information from MSVC/State IDSP/2023-24 on 12 December 2023, we immediately inform block team on 13th December 2023 after which Staff such as ANM, CHO, ASHA (Block Dargahpur) along with RBSK Team initiated a survey and confirm 51 cases afterwards given preventive and curative treatment. After the visit they inform to District Surveillance Unit Haridwar.



Location of current cluster:

an infected person's saliva. Close living quarters and crowded environments can facilitate the spread of the virus.

C. Clinical Features:

Mumps is characterized by several clinical stages, including the prodromal stage, eruptive stage, and post-mumps stage. Here's an overview of each stage and the associated clinical features:

1. Prodromal Stage:

The prodromal stage is the initial phase of mumps and is characterized by nonspecific symptoms that typically last 1-2 days before the onset of parotitis (swelling of the parotid glands).

- Clinical features during the prodromal stage may include:
- Low-grade fever
- Headache
- Muscle aches
- Loss of appetite
- Fatigue
- Malaise

2. Eruptive Stage:

- The eruptive stage is characterized by the swelling of one or both parotid glands, which are located on the sides of the face just below the ears.
- Clinical features during the eruptive stage may include:
- Pain and tenderness in the parotid gland area
- Swelling of the cheeks or jaw
- Difficulty swallowing or chewing, especially acidic or sour foods
- Earache, particularly when chewing or swallowing
- The swelling of the parotid glands typically peaks within 1-3 days after onset and gradually resolves over the course of about one wee

Village Information:



- Current population of Haridwar District is 22,19,173
- Dargahpur is situated in Laksar block district Haridwar state Uttarakhand, nearest National Highway Reachable is NH 534 and 334, Ganga River is the nearest river.
- It is located 32 KM towards South from District headquarters Haridwar. 6 KM from Laksar. 80 KM from State capital Dehradun.
- Dargahpur Pin code is 247671 and postal head office is Raissi.

Raissi (1 km), Akodha Mukarmatpur (2 km), Niranjanpur (2 km), Maharajpur Kalan (3 km), Maharajpur Khurd (4 km) are the nearby villages to Dargahpur. Dargahpur is surrounded by Khanpur Block towards west, Bahadrabad Block towards North, Najibabad Block towards East, Narsan Block towards west.

Purquazi, Manglaur, Najibabad, Roorkee are the nearby cities to Dargahapur.

Observation:

1. The Dargahpur village is situated in the near PHC Raissi block Laksar district Haridwar.
2. Village Hamlet is moderate.
3. Affected person directly went to the private practitioners (QUACK) and medical store for treatment and not to PHC medical doctor.
4. ANM didn't report mumps cases to IHIP portal and also not informed to higher authority.
5. No proper home isolation. All clothes/bedding are not clean properly at home. Peoples have lack of Knowledge, Practice and Attitude about mumps.
6. No MMR vaccine available in govt. sector for mumps immunization.
7. Mumps case in Age group 0-2 years- Nil
8. Mumps case in Age above 40- Nil

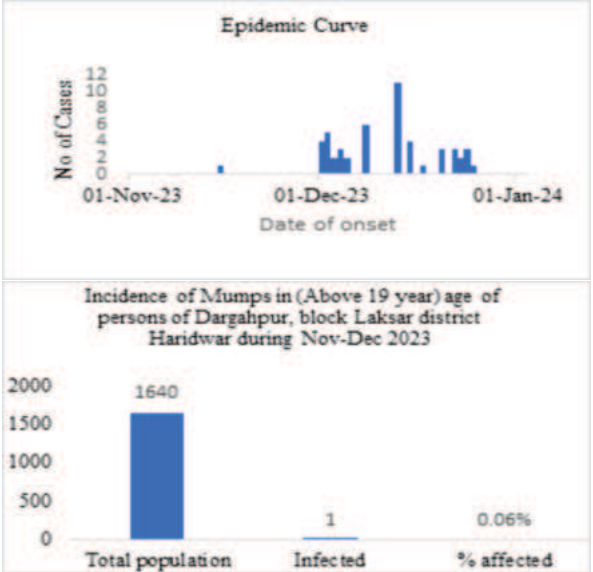
Mumps Surveillance In Dargahpur Village Of Block Laksar, District Haridwar On 2nd January 2024

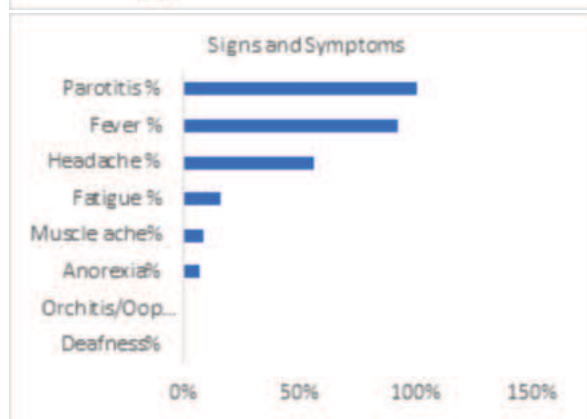
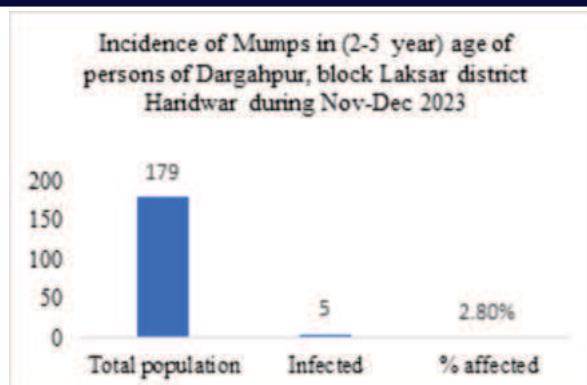
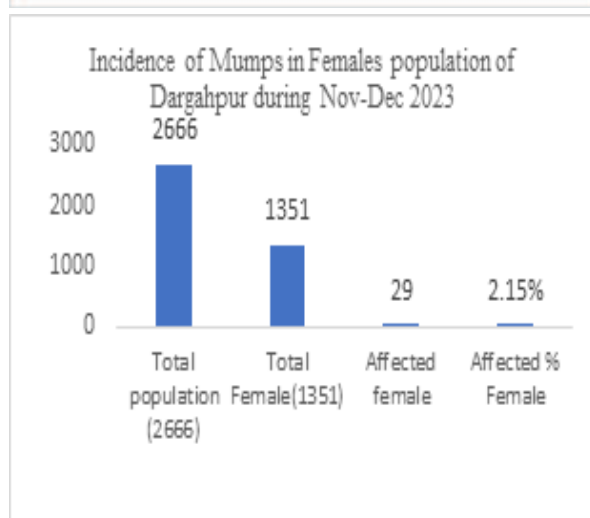
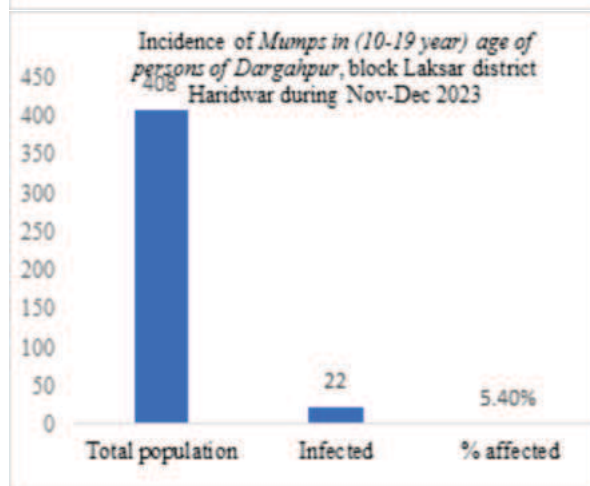
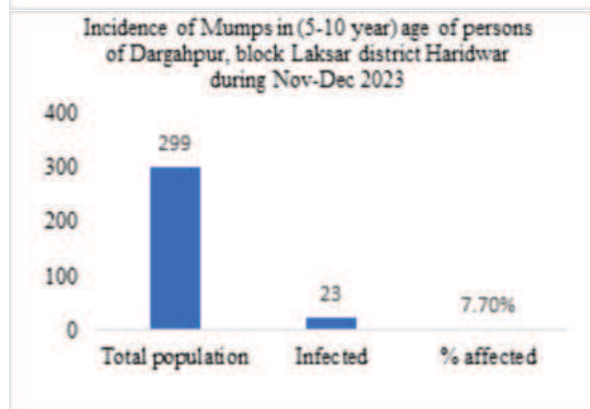
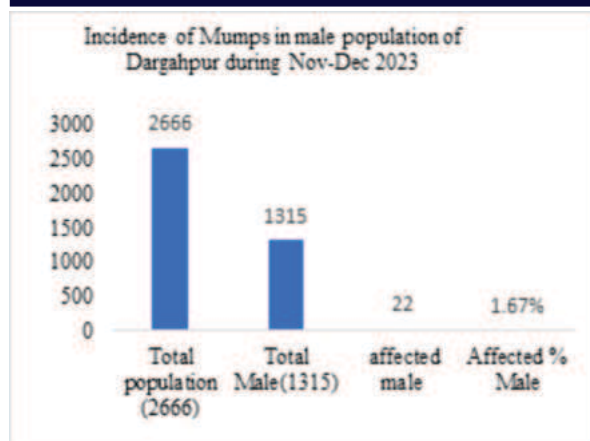
Parameter	Data		
Total Population	2666		
Total No. of House	557		
	Male	Female	Total
Total population	1315	1351	2666
Child (0-1) population	25	31	56
Child (1-2) population	41	43	84
Child (2-5) population	85	94	179
Child (5-10) population	132	167	299
Child (10-19) population	198	210	408
Above 19 population	834	806	1640
Nearest Railway station	Laksar Junction Railway Station		
National Highways Reachable to Dargahpur	NH 534 and 334		
Rivers Near	Ganga		
Altitude	238 meters above sea level		
Latitude/Longitude	29.7104°N, 78.0844°E		



Monitoring/Follow-up visit:

District Level team, CHC Laksar team, Local team





Mathematical Model

To construct a mathematical model for mumps, we can use the susceptible-infected-recovered (SIR) model, which is commonly used to study the spread of infectious diseases. In this model, the population is divided into three compartments: susceptible individuals (S), infected individuals (I) and recovered individuals (R). The reproductive number, denoted as R_0 , represents the average number of secondary cases generated by a single primary case in a completely susceptible population.



As susceptible individuals is large relative to the number of infected individuals, the differential equations for the SIR model are given by:

$$\begin{aligned} dS/dt &= -\beta SI \\ dI/dt &= \beta SI - \gamma I \\ dR/dt &= \gamma I \end{aligned}$$

Where,

S = number of susceptible individuals

I = number of infected individuals

R = number of recovered individuals

β = transmission rate

γ = recovery rate

To calculate the transmission rate, recovery rate and reproductive number in an SIR (Susceptible-Infectious-Recovered) model for mumps with 15 suspected individuals and 51 infected individuals, the following calculations can be used:

1. Transmission rate (β): The transmission rate is the average rate at which susceptible individuals become infected when they come into contact with infectious individuals. It can be calculated using the formula $\beta = I / (S * N)$, where I is the number of infected individuals, S is the number of susceptible individual sand N is the total population.

Given,

- Suspected (S) = 15

- Infected (I) = 51

- Total Population (N) = 15 + 51 = 66

$$\beta = 51 / (15 * 66) = 0.05$$

2. Recovery rate (γ):

Given:

Incubation period = 14-28 days

Suspected (S) = 15

Infected (I) = 51

We also need to make sure to find a common ground for the incubation period. We can take the average:

Average incubation period = $(14+28)/2 = 21$ days

$\gamma = 1/\text{recovery period (incubation period + the onset time from the symptoms to recovery i.e. 3-10 days, average 6.5 days)}$

$= 1/(21+6.5)$

$= 1/27.5$

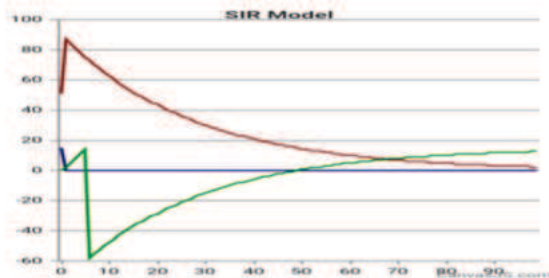
$= 0.036$

3. Reproductive number (R_0):

The basic reproductive number (R_0) is a key parameter in epidemiology that represents the average number of secondary infections produced by a typical infectious individual in a susceptible population. It is calculated as the product of the transmission rate (β) and the average duration of infectiousness ($1/\gamma$).

$0.05 \times 27.5 = 1.375$

If the reproductive number is greater than 1, it indicates that each infected individual is, on average, infecting more than one other individual. In this case, the number of new infections is outpacing the number of recoveries, leading to exponential growth of the epidemic. This situation signifies that the disease is spreading within the population, and without intervention, it will continue to spread and potentially cause an epidemic or outbreak.



No of susceptible	No of infected	No of recovered
Blue	Red	Green
Number susceptible at t=0	15	
Number infected at t=0	51	
Number recovered at t=0	0	
Transmission rate	0.05	
Recovery rate	0.036	
Number time periods	100	

IEC Activity:

1. Meeting with Medical Superintendent of CHC Laksar and intra sectorial department.

2. Door to Door survey and IEC activities for mumps via ANM/Asha.

Recommendation:**1. Health Education**

The primary treatment for mumps is mainly supportive care, as the infection is caused by a virus and cannot be treated with antibiotics. 5 steps to be remembered to break the chain of spreading as it is communicable.

STEPS- Rest + Fluid + Pain Relief + Cold or Warm Compress + Isolation



Re+F+Pa+War+I = "रेफपावरि"

These 5 steps could be announced via mic or by "Nukkar Natak" so that everyone knows about it.

2. Ensure availability of mumps vaccine (MMR) in govt. sector.

3. For School teachers and Parents:

- Monitor students for any signs of mumps and report any suspected cases to the school nurse or local health authorities.

- Promote a clean and healthy environment in the school to prevent the spread of mumps.
 - Teach their children the importance of hand hygiene and respiratory etiquette to prevent the spread of mumps.
 - Stay informed about the signs and symptoms of mumps and seek medical attention if their child shows any symptoms.
4. Strictly recommendation for Home Quarantine of mumps affected persons for 14-21 days.

5. Vitamin A supplementation to the affected persons.

6. We recommend training the healthcare workers ASHA and ANM on the prevention and identification of suspect cases of Mumps to improve early detection and referral of cases.

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