Workshop on

Infectious Disease Modeling

14th & 15th March 2024
Chennai

Organized by

Centre for Excellence in Mathematical Biology, SSSIHL, ICMR-National Institute for Research in Tuberculosis & Department of Health Research, Government of India.

Contents

Acknowledgement

Proceeding of the Workshop on Introduction to Infectious Disease Modeling

Workshop on Infectious Disease Modeling was organized by ICMR-National Institute for Research in Tuberculosis, Chennai, and the Department of Health Research, Ministry of Health and Family Welfare, Government of India in in collaboration with Centre for Excellence in Mathematical Biology, SSSIHL on the 14th and 15th of March 2024 in SPT Conference Hall, ICMR-National Institute for Research in Tuberculosis, Chennai

Agenda

Workshop on Infectious Disease Modeling

Venue : SPT Conference room, ICMR–National Institute for Research in Tuberculosis

No. 1 Sathyamoorthy Road, Chetpet, Chennai

Date : 14th & 15th March 2024

Day 1 (14-03-2024)		
Time	**Session**	**Speaker**
09:30 am - 10:00 am	Registration	
10:00 am - 10:10 am	Welcome address	Dr. M Muniyandi Scientist-E & HOD Health Economics, ICMR-NIRT
10:10 am - 10:30 am	Introduction of Participants	
10:30 am - 11:10 am	Introduction to Infectious Disease Modeling and its Applications	Dr. D. K. K. Vamsi, Coordinator, CEMB, SSSIHL
11:10 am - 11:30 am	Tea Break	
11:30 am - 01:00 pm	Introduction to Deterministic Modeling with and without Demography with reference to SIR, SEIR, SIS, and SIRS models	Dr. D. K. K. Vamsi, Coordinator, CEMB, SSSIHL
01:00 pm - 02:00 pm	Lunch Break	
02:00 pm - 02:45 pm	Deterministic Modeling with and without waning immunity inclusion, Infection induced mortality and latent period with reference to SIR, SEIR, SIS, and SIRS models	Dr. D. K. K. Vamsi, Coordinator, CEMB, SSSIHL
02:45 pm - 03:30 pm	Hands-on: Introduction to Python programming and exploring basic disease models in Python – Session - I	Mr. D. Bhanu Prakash, DMACS, SSSIHL
03:30 pm - 03:45 pm	Tea Break	
03:45 pm - 04:30 pm	Hands-on: Introduction to Python programming and exploring basic disease models in Python – Session - II	Mr. D. Bhanu Prakash, DMACS, SSSIHL

Time	Session	Speaker
Day 2 (15-03-2024)		
09:30 am - 10:45 am	Modeling TB diagnosis, treatment and vaccination	Dr. D. K. K. Vamsi, Coordinator, CEMB, SSSIHL
10:45 am - 11:00 am	Tea Break	
11:00 am - 12:15 pm	Advanced Modeling Studies	Dr. Surabhi Pandey, Associate Professor, Indian Institutes of Public Health
12:15 pm - 01:30 pm	Mathematical Modeling to Ascertain the Estimation of the Inhaled Drug on the Lungs through Probability Distribution Functions	Dr. B. Mayilvaganan, Professor and Head, Department of Applied Mathematics and Statistics Madurai Kamaraj University
01:30 pm - 02:15 pm	Lunch Break	
02:15 pm - 03:30 pm	Hands-on: Introduction to Python programming and exploring basic disease models in Python – Session - III	Mr. D. Bhanu Prakash, DMACS, SSSIHL
03:30 pm - 03:45 pm	Tea Break	
03:45 pm - 04:00 pm	Valedictory	Dr. M Muniyandi Scientist-E & HOD Health Economics, ICMR-NIRT

Registration

Workshop on
INFECTIOUS DISEASE MODELING

📅 14th & 15th March 2024   🕐 09:30 am

📍
CVR conference room
ICMR-National Institute for Research in Tuberculosis
No. 1, Mayor Sathyamoorthy Road, Chetpet, Chennai 600031

Register Now!!!
https://forms.gle/hGuxupopw5onnzdeA

Last date for registration 5th March 2024

Jointly Organised By
Centre for Excellence in Mathematical Biology, SSSIHL,
ICMR-National Institute for Research in Tuberculosis,
Department of Health Research, Government of India

Welcome

Dr. M Muniyandi
Scientist-E & HOD
Department of Health Economics
ICMR-NIRT

"I am glad to jointly hold this workshop with ICMR-National Institute for Research in Tuberculosis, the Centre for Excellence in Mathematical Biology at SSSIHL, and the Department of Health Research, Government of India. The Workshop includes presentations, panel discussions, and interactive sessions covering various aspects of infectious disease modeling, including mathematical modeling techniques, epidemiological data analysis, and the application of modeling in disease control strategies.

Speakers

Dr. D. K. K. Vamsi,
Coordinator, CEMB, SSSIHL

Dr. Surabhi Pandey, Associate Professor, IIPH

Dr. B. Mayilvaganan, Professor and Head, Department of Applied Mathematics and Statistics
Madurai Kamaraj University

Mr. D. Bhanu Prakash,
DMACS, SSSIHL

Workshop on
Infectious Disease Modeling

14th & 15th March, 2024

Jointly organized by
Centre for Excellence in Mathematical Biology, SSSIHL
ICMR-National Institute for Research in Tuberculosis &
Department of Health Research, Government of India.

Venue
SPT Conference Hall, ICMR-NIRT
No. 1, Mayor Sathyamoorthy Road,
Chetpet, Chennai 600031

Introduction to Infectious Disease Modeling and its Applications
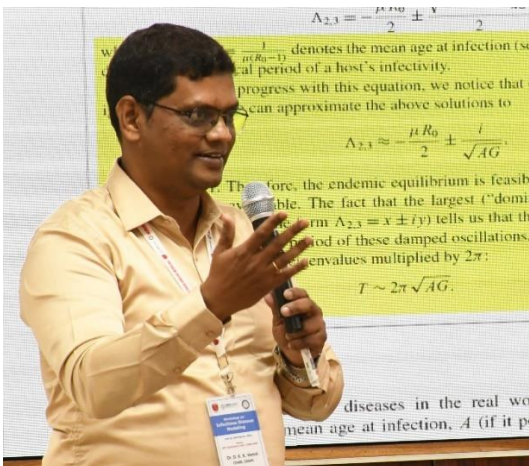
Dr. D. K. K. Vamsi,
Coordinator, CEMB,
SSSIHL

Infectious disease modeling is a powerful tool used by epidemiologists, public health officials, and researchers to understand the spread of infectious diseases within populations and to evaluate potential control strategies. These models employ mathematical and computational techniques to simulate the transmission dynamics of pathogens and to predict the impact of interventions. Basics of modeling includes Population Structure (The most common compartments include:

Susceptible (S): Individuals who are susceptible to infection.

Infected (I): Individuals who are infected and capable of transmitting the disease.

Recovered (R): Individuals who have recovered from the disease and are immune (or removed from the population due to death or other factors), Transmission Dynamics, Incubation Period and Infectious Period, Model Equations, Model Calibration and Validation, Interventions, Model Assumptions and Limitations.

Overall, infectious disease modeling is a valuable tool for understanding and managing infectious disease outbreaks. By combining mathematical principles with epidemiological data, modeling helps inform public health policies and interventions to reduce the burden of infectious diseases on populations.

Hands-on: Introduction to Python programming and exploring basic disease models in Python

Mr. D. Bhanu Prakash, DMACS, SSSIHL

Basic concepts in Python include variables, data types (such as integers, floats, strings, lists, and dictionaries), control flow (if statements, loops), functions, and classes.

Python has a rich ecosystem of libraries, including NumPy, SciPy, Matplotlib, and Pandas, which are commonly used for scientific computing and data visualization.

Basic Python Programming Basics:

Python is known for its simple and readable syntax, making it easy to learn for beginners.Basic concepts in Python include variables, data types (such as integers, floats, strings, lists, and dictionaries), control flow (if statements, loops), functions, and classes. Using Python libraries such as NumPy and Matplotlib, we can simulate the dynamics of disease spread, plot results, and analyze the impact of parameters and interventions. Differential equations govern the flow of individuals between compartments, describing how the number of susceptible, infectious, and recovered individuals changes over time.

In Python, we can define functions to represent the differential equations and use numerical solvers (e.g., Euler's method or scipy.integrate.solve_ivp) to simulate the model. Simulation and Analysis: Once the model is implemented, we can simulate disease spread by specifying initial conditions, parameters (e.g., transmission rate, recovery rate), and time steps.

Advanced Modeling Studies

Advanced modeling studies in the context of infectious diseases delve deeper into complex dynamics, incorporating sophisticated mathematical techniques, high-resolution data, and computational simulations. These studies aim to provide more nuanced insights into disease transmission, intervention strategies, and population-level impacts. Here's an overview of some key aspects of advanced modeling studies in infectious diseases:

Agent-Based Modeling (ABM),

Network Modeling,

Spatial Epidemiology,

Epidemiological Data Assimilation,

Integration and Ensemble Modeling,

Complex Adaptive Systems.

Advanced modeling studies in infectious diseases require interdisciplinary collaboration among mathematicians, epidemiologists, computer scientists, and public health experts. By combining mathematical rigor with real-world data and computational simulations, these studies contribute to our understanding of disease dynamics, inform policy decisions, and enhance preparedness for future pandemics.
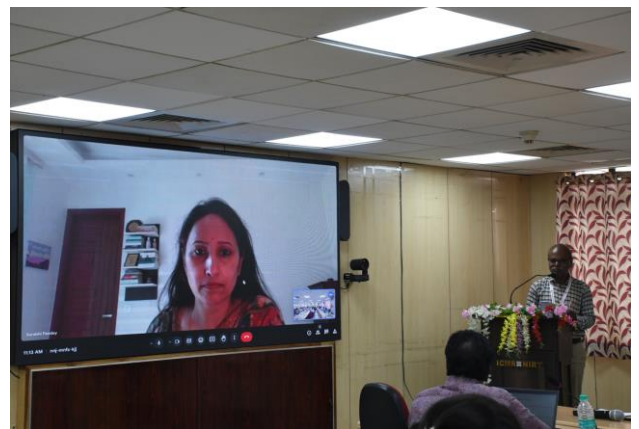
Dr. Surabhi Pandey,
Associate Professor
Indian Institutes of Public Health

Mathematical Modeling to Ascertain the Estimation of the Inhaled Drug on the Lungs through Probability Distribution Functions

Mathematical modeling can be a powerful tool for estimating the distribution of inhaled drugs in the lungs through probability distribution functions (PDFs). This approach involves developing mathematical equations that describe the transport and deposition of the drug particles within the respiratory system. Here's how such a model could be constructed stepwise:

1. Particle Transport Model,
2. Deposition   Mechanisms,
3. Probability Distribution Functions,
4. Parameter Estimation,
5. Numerical Simulations,
6. Validation,
7. Sensitivity Analysis,
8. Application to Drug Delivery Systems.

Dr. Dr. B. Mayilvaganan, Professor and Head, Department of Applied Mathematics and Statistics Madurai Kamaraj University

In summary, mathematical modeling combined with probability distribution functions can provide valuable insights into the estimation of inhaled drug distribution in the lungs. By accurately predicting the spatial distribution of drug particles, these models contribute to the development of effective inhalation therapies for various respiratory conditions.

Concluding Remarks & way forward

Dr. M Muniyandi
Scientist-E & HOD
Department of Health Economics
ICMR-NIRT

As we draw to a close on this enriching two-day workshop on Infectious Disease Modeling, First and foremost, I would like to express our gratitude to our distinguished speakers, Dr. D. K. K. Vamsi, Dr. Surabhi Pandey, Dr. B. Mayilvaganan, and Mr. D. Bhanu Prakash, for their invaluable contributions in enlightening us with their expertise and experiences. Their presentations have provided us with a comprehensive understanding of infectious disease modeling, from introductory concepts to advanced studies and practical applications.Throughout the workshop, we have covered a wide range of topics, including the basics of infectious disease modeling, hands-on sessions on Python programming for disease modeling, advanced modeling studies, and the estimation of inhaled drug distribution in the lungs. The diverse range of sessions has equipped us with the necessary tools and knowledge to tackle complex challenges in infectious disease research and public health. As we conclude this workshop. The knowledge and skills gained during these two days will undoubtedly serve as a foundation for further exploration and application of infectious disease modeling in research, policy-making, and public health practice. In closing, I would like to extend my sincere thanks to everyone who has contributed to the success of this workshop – the organizers, speakers, participants, and supporting staff. Your dedication and commitment have made this workshop a resounding success. Thank you once again, and we look forward to continuing our collaboration and sharing of knowledge in the future.
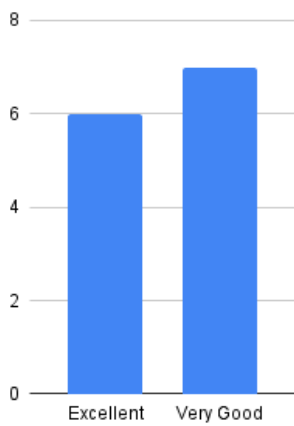
Certificate Distribution
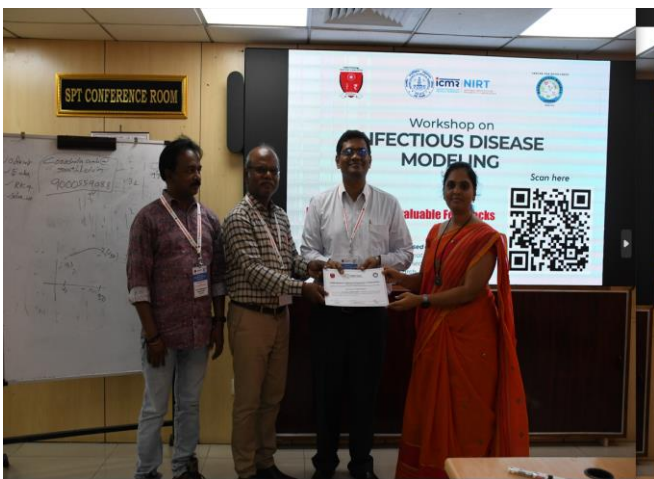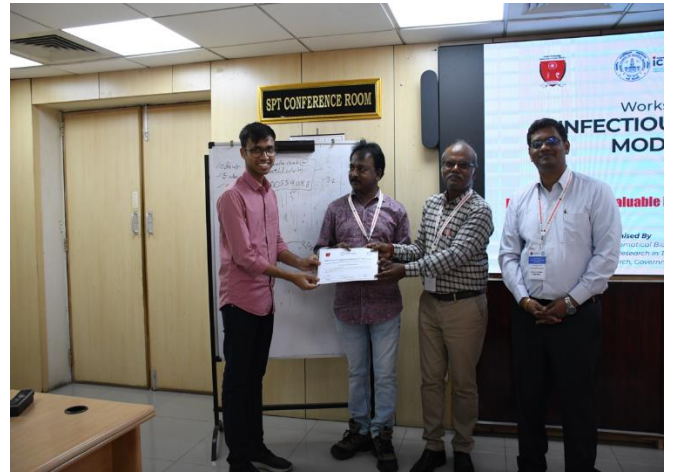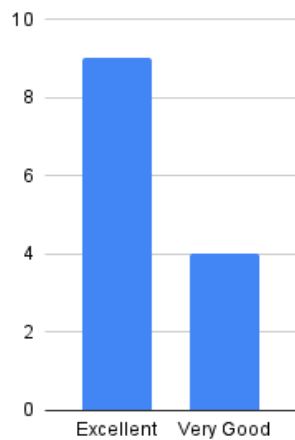
Participants Feedback about the workshop

We developed a feedback from with some questions to measure the participant's satisfaction with the workshop. The summary of the feedback is given in the graph.

Participants Feedback about the workshop

1.How would you rate the workshop?

2.How would you rate the organiation of the workshop?

3.How would you rate the quality of the presentations and materials provided?
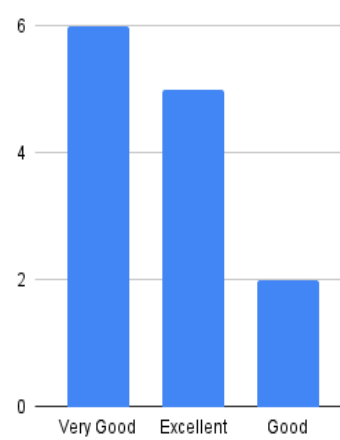
4.Did you find the hands-on activities (Python) and practical exercises helpful?
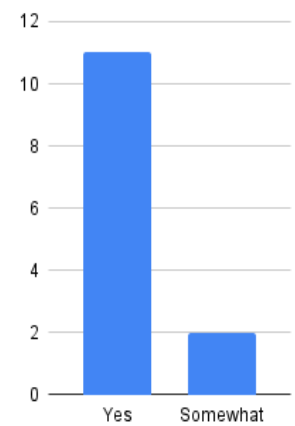
5.How did you hear about this workshop?

6.How would you rate the food provided during the workshop?
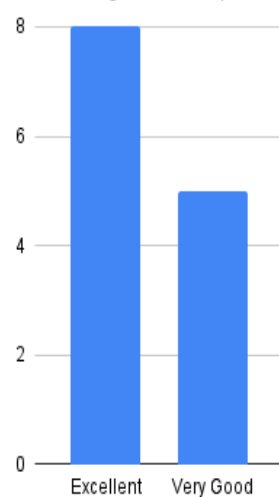
7.How much useful this workshop has been in your current work?
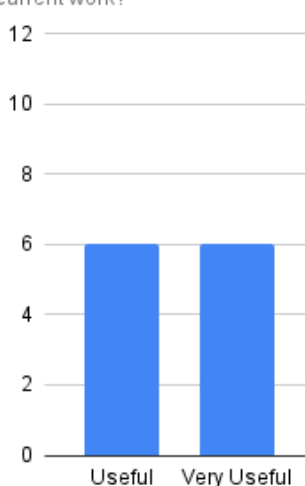
8.Do you think attending this workshop has enhanced your modeling know-how?
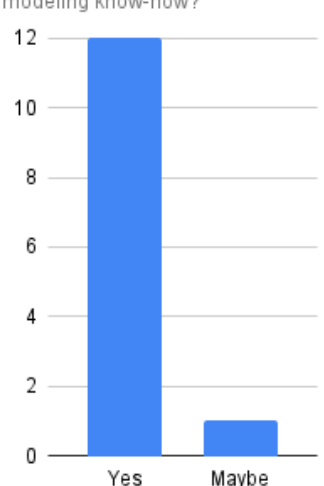
Annexure - A
Participant list

List of Participants

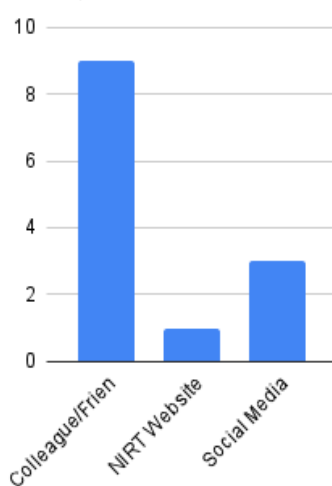| S. No.	Name / Designation / Department / Institute /Mobile No. / Email ID
1	Dr. Muthukumar. R Faculty Public Health Sri Ramachandra Medical College & Research Institute, Chennai
2	Nagayazhini Faculty Statistics / Biostatistics Christian Medical College
3	Dr Porchelvan P Assistant Professor Siddha Medicine JSA Medical College For Siddha and Research Centre
4	Sirshendu Chaudhuri Faculty Public Health Indian Institute of Public Health Hyderabad
5	Jansi Rani.N Faculty Statistics / Biostatistics CMC
6	Nithyamala I Faculty Siddha National institute of Siddha

7	Dr M Santhosh Kumar Scientist Public Health ICMR-National Institute of Epidemiology
8	Maya P. G. Faculty Statistics / Biostatistics Christian Medical College Vellore
9	Ramalingam Bethunaickan Scientist Immunology ICMR-NIRT
10	Dr Asim Kumar Padhan Scientist Epidemiology ICMR NIRRCH
11	Dr. Rashmi Shinde Scientist Medicine ICMR-National AIDS Research Institute
12	Kiruthika G Scientist Statistics / Biostatistics ICMR-National Institute of Epidemiology
13	Bithia.R Research Scholar Biomedical Genetics Vellore Institute of Technology, Vellore
14	Ankur Datta Research Scholar Bio-Informatics Vellore Institute of Technology

15	Mohanraj G Scientist Biotechnology Vellore Institute of Technology
16	Praveen Hoogar Faculty Medical Anthropology The Apollo University, Chittoor
17	Dr P Rama Faculty Medicine PSG College of Pharmacy, coimbatore
18	Dr. Pankaj B Shah Professor Epidemiology SRMC & RI, SRIHER
19	Dr.S.Kirubakaran Faculty Public Health Government Omandurar Medical College, Chennai
20	Taruna Yadish Student Biotechnology Nims
21	Suganila D Student Microbiology NIMS UNIVERSITY RAJASTHAN
22	Saranya Rajamanickam Faculty Public Health PSG IMSR COIMBATORE

23	Syed Hissar Scientist Public Health ICMR- NIRT
24	Dr.V.Damodaran Faculty Community Medicine Institute of Community Medicine, Madras Medical College, Chennai
25	Dr. Rajesh Jayanandan Faculty Public Health Kilpauk Medical College, Chennai
26	Preetam B Mahajan Faculty Public Health J ipmer Karaikal
27	Arvinth Ram. A Faculty COMMUNITY MEDICINE MADRAS MEDICAL COLLEGE
28	Dr.V.M.Anantha Eashwar Faculty Public Health Sree Balaji Medical College and Hospital
29	Saranya K Faculty Statistics / Biostatistics Sree balaji medical college Chennai
30	DEVARAJULU REDDY S Scientist Epidemiology ICMR-NIRT,CHENNAI

31	Taruna yadish Student Biotechnology Nims
32	Dr.R.Uma Maheswari Professor Community Medicine Madras medical college
33	Dr Akila G V Doctor Medicine Sri Ramachandra Institute of Higher Education and Research
34	Dr. V Samya Faculty Community medicine Sri Ramachandra institute of higher education and research
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36	Dr. M.Muniyandi Scientist - E Health Economics ICMR-NIRT, CHENNAI
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38	Venkateshprabhu J Project Scientist Health Economics ICMR-NIRT, CHENNAI

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40	Sathishkumar V Project Technical Officer Health Economics ICMR-NIRT, CHENNAI
41	Sahil A Project Technical Officer Health Economics ICMR-NIRT, CHENNAI
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43	Dr. Adhin Bhaskar Scientist - C Statistics ICMR-NIRT, CHENNAI
44	Ms. Basilea Watson Scientist - B Epidemiology Statistics ICMR-NIRT, CHENNAI
45	Dr M. Muthu Vijayalakshmi Technical Officer - A Statistics ICMR-NIRT, CHENNAI
46	Dr. D. K. K. Vamsi Coordinator CEMB, SSSIHL
47	Dr. N Karikalan Scientist-C DSBR, ICMR- NIRT

48	P. Charulatha Intern student MPH			
49	R. Harini Intern student MPH			
50	G. Prudvi Raj Intern student SRIHER			
51	Dr. A. Stephon Scientist-C DSBR, ICMR- NIRT			
52	Sreedhanya MPH Intern student SRIHER, Porur			

ANNEXURE B- Photos