Additional File 7

Summary of all included studies

Contents

1 Transmission Focused Model

Table 1: Comparison of Optimal Control Transmission Models

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Anguelov et al. (2018)	SEIRS–SEI human–vector malaria transmission model with backward bifurcation analysis and NSFD numerical schemes	Not Specified	Examines backward bifurcation in both continuous and discrete epidemiological models. Uses nonstandard finite difference (NSFD) schemes to preserve stability properties in numerical simulations.	Focuses mainly on theoretical bifurcation analysis rather than real-world epidemiological applications.	Extends bifurcation analysis to discrete epidemiological models. NSFD schemes preserve the qualitative stability properties of continuous malaria transmission models.	Theoretical transmission modelling	Best suited for theoretical studies on disease persistence and for developing numerical methods for epidemiological models.
Collins and Duffy (2022)	Strain-structured SIRS–SI malaria transmission model incorporating drug resistance	Introduces drug-resistant and drug-sensitive malaria strains alongside treatment and mosquito net use.	Does not include age structure, environmental variables, or stochastic dynamics, limiting representation of real-world complexity.	Explicitly models the role of drug-resistant strains in malaria transmission dynamics.	Best suited for analysing malaria control strategies where drug resistance significantly influences treatment outcomes.		
Uwineza et al. (2024)	Age–sex structured SEIRS–SEI malaria transmission model	Rwanda	Incorporates age and sex structures in malaria transmission dynamics. Sensitivity analysis identifies key drivers of malaria spread.	No intervention strategies included. Lacks empirical validation with large-scale field data.	Highlights the importance of demographic heterogeneity, particularly among children under five and women who face higher malaria risks.	Structured transmission model	Best suited for studies examining malaria dynamics across different age and sex groups and identifying vulnerable populations.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Okuneye and Gumel (2017)	Age-structured SEIR–SI human–vector malaria transmission model with immature mosquito stages (eggs, larvae, and pupae) and climate-dependent dynamics	KwaZulu-Natal Province, South Africa	Considers climate variability in malaria dynamics. Identifies optimal temperature and rainfall conditions for malaria transmission. Implements key transmission parameters using sensitivity analysis.	Assumes fixed climatic conditions within regional boundaries. Omits human movement and socio-economic factors.	Provides insights into climate–malaria relationships and identifies optimal environmental conditions for malaria transmission.	Transmission dynamics modelling	Best suited for investigating the effects of climate variability on malaria transmission dynamics.
Gu et al. (2003)	Individual-based malaria transmission model incorporating immunity development and intervention strategies	Coast of Kenya	Incorporates individual variability in both humans and mosquito vectors. Examines malaria control strategies and immunity development across different age groups.	Requires large amounts of detailed data for implementing individual-based simulations.	Provides more detailed representation of malaria transmission than standard compartmental models. Captures immunity acquisition and individual-level transmission dynamics.	Transmission dynamics modelling	Best suited for evaluating malaria intervention strategies and transmission dynamics across different endemic settings.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Tchoumi et al. (2021)	PDE-based SIRS–SI malaria transmission model incorporating immunity acquisition (premunition) dynamics	Not Specified in malaria-endemic regions	Introduces a partial differential equation framework to model the gradual acquisition of immunity through repeated exposure to malaria. Captures the process of premunition observed in endemic populations.	Does not incorporate vector control strategies, spatial dynamics, or empirical validation with real-world data.	Provides insights into how repeated exposure to mosquito bites leads to partial immunity and reduced disease severity in endemic areas.	Immunity-driven transmission model	Best suited for studying immunity acquisition and disease dynamics in malaria-endemic regions with continuous exposure to infection.
Abiodun et al. (2018)	SEIR–ELPA_h A_0EI human–vector malaria transmission model with climate-driven dynamics	KwaZulu-Natal Province, South Africa	Integrates climate variables (temperature and rainfall) into malaria transmission modelling. Validated with observed malaria incidence data. Uses PCA and wavelet analysis to assess climate–malaria interactions.	Excludes human migration and land-use changes among influencing factors.	Provides insight into the impact of climate variability on malaria transmission in seasonal regions.	Climate-driven transmission modelling	Best suited for evaluating the influence of climate variables on malaria transmission dynamics.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Parham and Michael (2010)	SIR–SEI human–vector malaria transmission model with climate-dependent parameters	Tanzania	Includes climate effects (temperature and rainfall) on malaria transmission dynamics. Determines optimal temperature ranges for malaria transmission. Provides a framework for climate–malaria modelling and policy planning.	Limited focus on spatially explicit modelling and intervention strategies.	Predicts malaria transmission windows under climate change scenarios. Provides insights into how environmental conditions influence malaria transmission.	Climate-driven transmission model	Best suited for assessing climate change impacts on malaria transmission and predicting malaria risk under changing environmental conditions.
Ngarakana-Gwasira et al. (2014)	SEIRS–JSEI human–vector malaria transmission model with temperature-dependent dynamics	Not Specified	Captures the effect of temperature on malaria transmission. Identifies optimal temperature ranges for malaria transmission. Uses backward bifurcation analysis to examine malaria persistence.	Ignores other environmental factors such as rainfall. Assumes static population dynamics.	Provides a clear link between temperature and malaria transmission. Demonstrates backward bifurcation, challenging traditional malaria eradication thresholds.	Transmission dynamics modelling	Best suited for studying the impact of climate change and identifying temperature thresholds influencing malaria transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Shalini Priya et al. (2024)	SEITVR–SEI human–vector malaria transmission model with stability analysis for malaria elimination	Central African Republic	Integrates human and mosquito populations in a multi-compartment framework. Incorporates stability analysis to evaluate malaria elimination conditions.	May oversimplify malaria transmission interactions in diverse epidemiological settings.	Provides a modelling framework for malaria elimination by modifying mosquito biting behavior and improving immune response levels.	Transmission dynamics modelling	Best suited for analyzing malaria elimination strategies and long-term disease control policies.
Mukhtar et al. (2018)	SEIAR–SEI human–vector malaria transmission metapopulation model with human mobility	South Sudan	Explores how human migration influences malaria transmission dynamics. Implements a metapopulation framework to model population movements between regions.	Assumes homogeneous mixing within each population patch, which may not capture complex movement patterns.	Provides insights into the role of human mobility in sustaining malaria transmission. Suggests targeted control strategies based on migration patterns.	Mobility-driven transmission model	Best suited for studying malaria dynamics in regions with significant human mobility (e.g., refugees and internally displaced populations) and assessing migration-based control strategies.
Traoré et al. (2021)	SEIRS–JSEI stage-structured human–vector malaria transmission model with temperature dependence	Burkina Faso	Develops a temperature-sensitive model covering the full mosquito life cycle from eggs to pupae. Introduces two reproduction ratios: mosquito reproduction ratio (R_v) and basic reproduction number (R_0).	No intervention strategies included. No stochastic or agent-based modelling approaches.	Captures mosquito life-cycle processes and transmission dynamics more accurately by incorporating temperature-dependent development rates.	Transmission dynamics modelling	Best suited for evaluating how temperature changes affect mosquito populations and malaria transmission dynamics.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Traoré et al. (2020a)	SEIRS–ELPSEI temperature-driven malaria transmission model with stage-structured mosquito populations	Burkina Faso	Evaluates temperature effects on mosquito life cycles and malaria transmission. Incorporates stage-structured mosquito populations including eggs, larvae, pupae, and adults.	Does not include vector control strategies or intervention measures.	Highlights the importance of juvenile mosquito stages in shaping malaria transmission dynamics. Demonstrates how temperature variations influence mosquito development and malaria persistence.	Climate-driven transmission model	Best suited for regions with strong environmental variability and significant temperature-driven malaria transmission dynamics.
Witbooi et al. (2020)	SIR–SI stochastic human–vector malaria transmission model with stochastic perturbations	South Africa	Incorporates stochastic procedures to estimate uncertainty and confidence intervals in malaria transmission dynamics. Supports malaria elimination planning by accounting for random disease persistence effects.	Lacks age structure, spatial data, and socioeconomic or demographic factors.	Provides deeper insights into random fluctuations in malaria transmission and long-term elimination projections using stochastic modelling.	Stochastic transmission model	Best suited for situations where malaria transmission fluctuates unpredictably or when evaluating interventions under stochastic conditions.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Traoré et al. (2020b)	SEIRS–ELPSEI stage-structured human–vector malaria transmission model with temperature-dependent mosquito dynamics	Burkina Faso (Not Specified)	Includes maturation delay across mosquito developmental stages (egg, larva, pupa, adult). Accounts for periodic environmental factors such as seasonal temperature variation.	Does not incorporate detailed human immunity dynamics or intervention strategies.	Incorporates temperature-dependent mosquito growth and development. Highlights the critical role of juvenile mosquito stages in shaping malaria transmission dynamics.	Transmission dynamics modelling	Best suited for regions with strong seasonal climate variability where mosquito life-cycle dynamics strongly influence malaria transmission.
Lou and Zhao (2010)	SEIRS–JSEI climate-driven human–vector malaria transmission model with structured mosquito populations	KwaZulu-Natal Province, South Africa	Incorporates age-structured mosquito populations and climate-dependent transmission dynamics. Accounts for seasonal temperature variations influencing mosquito development.	Requires detailed data on mosquito life stages and climate variables for accurate parameterization.	Captures interactions between human hosts and structured mosquito populations, improving understanding of seasonal malaria dynamics.	Climate-driven transmission model	Best suited for regions with strong seasonal malaria patterns and for evaluating climate-dependent vector control strategies.
Agusto et al. (2015)	Multi-stage SEIR–LSEI human–vector malaria transmission model with temperature-dependent dynamics	67 cities across sub-Saharan Africa	Incorporates temperature-dependent transmission dynamics, making it suitable for climate-sensitive regions.	Does not incorporate stochastic effects or human migration dynamics.	Examines how temperature variability influences malaria transmission thresholds and mosquito life-cycle dynamics.	Climate-driven transmission model	Best suited for studying malaria transmission in regions with significant temperature variability and assessing the impact of temperature fluctuations on malaria dynamics.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Mukhtar et al. (2019)	SEIRS–MSEI human–vector malaria transmission model with climate forcing and Bayesian MCMC parameter estimation	South Sudan	Incorporates real-world climate data (temperature and rainfall) for malaria transmission analysis. Uses Bayesian MCMC methods for parameter estimation and model calibration. Examines malaria dynamics in two distinct climatic regions.	Depends on historical malaria incidence data.	Improves parameter estimation accuracy using Bayesian MCMC. Differentiates malaria transmission dynamics across different climate zones.	Climate-driven transmission modelling	Best suited for studying regional climate impacts on malaria transmission and validating models with real-world epidemiological data.
Modu et al. (2023)	Agent-based SEIR–ASEI human–vector malaria transmission model with spatial movement and mosquito breeding dynamics	Tripura (India), Limpopo (South Africa), and Benin City (Nigeria)	Incorporates human movement patterns and mosquito breeding dynamics. Captures spatial heterogeneity and climate-driven malaria transmission patterns.	Requires extensive computational resources and detailed agent-based datasets.	Captures heterogeneities better than traditional compartmental models and allows realistic human–mosquito interaction modelling.	Spatial transmission modelling	Best suited for studying malaria transmission in heterogeneous populations with spatial movement and localized mosquito breeding patterns.
Souleiman et al. (2024)	SIR–SI multi-species human–vector malaria transmission model for *P. falciparum* and *P. vivax* co-infection	Djibouti	Models co-circulation of *P. falciparum* and *P. vivax*. Includes global sensitivity and uncertainty analysis.	Does not incorporate vector control interventions explicitly. Focuses on two malaria species rather than broader transmission dynamics.	Introduces a multi-species framework capturing co-infection dynamics often neglected in single-species models.	Transmission model	Best suited for regions where multiple malaria species circulate simultaneously and for designing species-specific control strategies.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Ngarakana-Gwasira et al. (2016)	SEIRS–JSEI human–vector malaria transmission model with climate change projections and GIS-based risk mapping	Africa	Integrates temperature and rainfall effects into malaria transmission modelling. Uses Geographic Information Systems (GIS) to generate spatial malaria risk projections.	Model projections depend on climate scenario assumptions. Long-term climate predictions introduce uncertainty in malaria forecasts.	Spatial risk mapping improves identification of high-risk areas and supports evidence-based malaria control planning.	Climate-driven transmission modelling	Useful for policy planning under climate change and identifying future malaria risk areas.
Ratti and Wallace (2020)	SIRNRS–ELPAEI human–vector malaria transmission model with seasonal vector dynamics	Western Kenya Highlands	Predicts holoendemic, hyperendemic, and hypoendemic malaria transmission patterns. Incorporates seasonal variation in vector population dynamics and larval habitat availability.	Does not generate mesoendemic transmission patterns. Does not incorporate intervention strategies or spatial modelling.	Demonstrates how seasonal vector dynamics and immunity acquisition shape long-term malaria endemicity patterns.	Transmission dynamics modelling	Useful for studying long-term malaria transmission patterns and environmental variability in endemic regions.
Djidjou-Demasse et al. (2020)	SEIRS–SEI human–vector malaria transmission model with seasonal mosquito life-history dynamics	Mpumalanga Province, South Africa	Incorporates seasonal variations in mosquito life-history traits. Uses thermal-response functions to estimate mosquito parameters.	Requires complete seasonal data to accurately define eradication conditions.	Explicitly incorporates seasonality in mosquito population dynamics and transmission parameters.	Transmission dynamics modelling	Best suited for modeling seasonal malaria transmission patterns and designing temperature-dependent malaria control strategies.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Wang and Zhao (2017a)	SI–SEI human–vector malaria transmission model with periodic delay and temperature-dependent EIP	Maputo Province, Mozambique	Examines temperature-dependent extrinsic incubation period (EIP). Incorporates climate variability and vector-bias effects in malaria transmission.	Does not incorporate intervention strategies or age structure.	Highlights the impact of climate fluctuations and temperature-dependent EIP on malaria transmission dynamics.	Transmission dynamics modelling	Useful for studies assessing the impact of climate variability and temperature on malaria transmission.
Wang and Zhao (2017b)	SI–SEI human–vector malaria transmission model with temperature-dependent delay (EIP)	Maputo Province, Mozambique	Incorporates climate factors and temperature-dependent extrinsic incubation period.	Does not incorporate population age structure or spatial heterogeneity.	Provides more accurate malaria transmission predictions by incorporating temperature-dependent parasite incubation.	Transmission dynamics modelling	Best suited for assessing the effects of climate variability and temperature changes on malaria transmission.
Kamgang and Tchoumi (2015)	SEIRS/SEIS/SIRS/SIS–SEI human–vector malaria transmission model with heterogeneous immune dynamics	Not specified	Integrates multiple immune structures into a single malaria transmission model.	Ignores age structure and seasonal environmental effects.	Allows different immune dynamics to be evaluated simultaneously within the same modelling framework.	Transmission dynamics modelling	Best suited for studies examining how immune structures influence malaria persistence.
Bimbiga et al. (2019)	Strain-structured human–vector malaria transmission model with superinfection dynamics	Not specified	Examines drug-sensitive and drug-resistant malaria strains.	Does not include vector control interventions.	Highlights emergence and persistence of drug-resistant malaria strains.	Transmission model	Best suited for studying malaria dynamics in regions with high levels of drug resistance.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Olaniyi and Obabiyi (2013)	SEIRS–SEI malaria transmission model with nonlinear force of infection	Not specified	Incorporates saturated incidence rates capturing nonlinear infection dynamics.	Does not include intervention strategies or spatial dynamics.	Highlights role of nonlinear infection forces and immune responses in malaria transmission dynamics.	Nonlinear transmission model	Best suited for theoretical studies examining nonlinear infection dynamics.
Mbogo et al. (2018)	Stochastic SIRS–SI human–vector malaria transmission model using Galton–Watson branching process	Not specified	Compares stochastic and deterministic malaria models highlighting randomness in disease dynamics.	Omits environmental factors such as seasonality.	Provides more realistic representation by incorporating stochastic transmission effects.	Stochastic transmission model	Best suited for examining malaria extinction probabilities under random transmission dynamics.
Gellow et al. (2023)	SEI/SEIR–SEI human–vector malaria transmission model with immune heterogeneity	Not specified	Incorporates non-immune and semi-immune human populations.	Neglects spatial dynamics and climate variability.	Provides structured framework for evaluating malaria persistence among immune groups.	Transmission dynamics modelling	Best suited for assessing malaria control strategies based on reproduction number.
Gebremeskel (2018)	SIR–SI human–vector malaria transmission model with logistic population growth	Not specified	Implements logistic growth models for human and mosquito populations.	Lacks integration of social and environmental factors.	Provides simple framework with clear stability conditions for malaria eradication.	Transmission model	Best suited for studying global stability conditions in malaria dynamics.
Gizaw and Deressa (2024)	Fractional age-structured SI–SEI human–vector malaria transmission model using ABC fractional operators	Not specified	Employs fractional calculus and incorporates age structure in human populations.	Lacks empirical validation with epidemiological data.	More flexible than classical models and captures memory effects in disease dynamics.	Transmission dynamics modelling	Best suited for understanding impact of age structure and memory effects on malaria transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Ngwa (2004)	SEIRS–SEI human–vector malaria transmission model incorporating population growth and asymptomatic carriers	Not specified	Combines population growth, disease-induced mortality, and asymptomatic carriers.	Does not explicitly account for spatial transmission dynamics.	Explores malaria persistence under demographic changes and asymptomatic infections.	Transmission model	Best suited for studying effects of population growth on malaria transmission persistence.
Tumwiine et al. (2010)	SIRS–SI human–vector transmission model with infective immigrants	Uganda	Tracks malaria transmission dynamics between humans and mosquitoes and incorporates temporary immunity.	Does not include intervention strategies or age-structured dynamics.	Provides insight into how infective immigration sustains malaria transmission.	Transmission dynamics modelling	Useful for analysing malaria persistence in endemic settings where infected individuals migrate into the population.
Bakare (2015)	SEIRS–SEI malaria transmission model incorporating multiple vector control strategies	Not specified	Incorporates multiple malaria control strategies including insecticide-treated bed nets (ITNs), indoor residual spraying (IRS), educational campaigns, and fungal bio-pesticides.	Assumes homogeneous mixing and does not incorporate spatial heterogeneity or demographic structures.	Demonstrates that combined vector control interventions significantly reduce malaria transmission.	Intervention transmission model	Best suited for evaluating the combined effects of vector control interventions on malaria transmission dynamics.
Traoré et al. (2017)	SEIRS–ELPSEI stage-structured human–vector malaria transmission model with seasonal mosquito dynamics	Not specified	Accounts for mosquito seasonality and structured vector populations (immature and mature stages).	Lacks intervention modelling and empirical validation with field data.	Captures real-world mosquito population fluctuations better than models without seasonality.	Transmission dynamics modelling	Best suited for studying the effects of climatic variability on malaria transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Traoré et al. (2018)	SEIRS–ELPSEI stage-structured malaria transmission model with logistic mosquito growth in a periodic environment	Not specified	Incorporates age and developmental structure in mosquito populations. Accounts for logistic growth constraints and periodic environmental effects.	Evaluates mosquito population behaviour while ignoring protection mechanisms among humans.	Applies Floquet theory and persistence analysis to study periodic malaria dynamics.	Transmission dynamics modelling	Best suited for regions with seasonal variations in mosquito activity.
Yiga et al. (2020)	SEIRS–SEI malaria transmission model with vector control and treatment interventions	Uganda	Examines combined vector control interventions and treatment strategies in malaria transmission dynamics.	Does not incorporate spatial heterogeneity or stochastic dynamics.	Evaluates intervention strategies and their impact on malaria prevalence.	Intervention modelling	Best suited for evaluating integrated malaria control strategies in endemic settings.
Tchoumi et al. (2023b)	SEIS/SEIRS–SEI age-structured human–vector malaria transmission model with vaccination and optimal control	Not specified	Examines reinfection dynamics and immunity loss across age groups.	No empirical validation with epidemiological data.	Integrates vaccination, treatment, and personal protection using optimal control theory.	Optimal control modelling	Useful when studying vaccination strategies and immunity dynamics in malaria transmission.
Ducrot et al. (2009)	SEIS/SEIRS–SEI human–vector malaria transmission model with immune heterogeneity	Not specified	Differentiates between non-immune and semi-immune individuals and analyzes disease equilibria.	Does not incorporate intervention strategies.	Examines how immune status influences malaria persistence in endemic populations.	Transmission dynamics modelling	Best suited for analyzing malaria persistence in partially immune populations.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Cai et al. (2013)	SIR–SI human–vector malaria transmission model incorporating partial immunity and reinfection	Not specified	Integrates partial immunity and reinfection mechanisms into malaria transmission dynamics.	Focuses mainly on theoretical analysis without empirical validation.	Highlights role of reinfection and partial immunity in sustaining malaria transmission.	Transmission modelling	Best suited for studying persistence dynamics driven by reinfection.
Wallace et al. (2014)	Comparative SEIRS–SEI malaria transmission modelling framework evaluating multiple classical models	Not specified	Provides systematic comparison of several malaria transmission models.	Some models may not align well with empirical epidemiological data.	Helps identify the most appropriate malaria model depending on research objectives.	Comparative modelling study	Best suited for selecting appropriate malaria models for research and policy planning.
Abboubakar et al. (2016)	SEIRS–SEI human–vector malaria transmission model with relapse dynamics	Not specified	Includes relapse mechanisms and disease-induced mortality.	Does not incorporate intervention strategies or climate variability.	Provides insights into relapse-driven malaria persistence.	Transmission modelling	Best suited for studying relapse effects in malaria transmission dynamics.
Abioye et al. (2020b)	SEIRS–SEI human–vector malaria transmission model solved using the Adomian Decomposition Method	Not specified	Provides semi-analytical approximations with strong computational efficiency.	Requires expertise in decomposition techniques for implementation.	Faster computational performance compared with traditional numerical methods.	Analytical transmission modelling	Best suited for solving nonlinear malaria transmission models.
Abioye et al. (2023)	SEIRS–SEI malaria transmission model with global stability and sensitivity analysis	Not specified	Investigates sustainability of malaria transmission using stability analysis.	Omits spatial dynamics and environmental variability.	Applies sensitivity analysis to determine key parameters influencing malaria control.	Transmission modelling	Best suited for identifying influential parameters in malaria transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Obabiyi and Olaniyi (2019)	SEIV–SEI human–vector malaria transmission model incorporating behavioural vigilance	Karonga District, Malawi	Incorporates behavioural change through vigilant human compartment.	May oversimplify complex human behaviour dynamics.	Highlights the role of preventive awareness and behavioural compliance.	Behavioural transmission modelling	Best suited for studying behavioural influence on malaria control strategies.
Ngwa et al. (2019)	SEIRS–SEI malaria transmission model with intervention strategies	Not specified	Analyzes malaria transmission under vector control interventions.	Limited incorporation of environmental variability.	Evaluates thresholds required for malaria elimination.	Transmission modelling	Best suited for studying intervention thresholds in malaria control.
Rezapour et al. (2023)	Fractal–fractional SIR–SI human–vector malaria transmission model with Mittag-Leffler memory effects	Not specified	Introduces fractal–fractional calculus and evaluates treatment and spraying interventions.	Lacks empirical validation with epidemiological data.	Captures memory effects in disease transmission dynamics.	Advanced transmission modelling	Best suited for theoretical modelling of malaria dynamics with memory effects.
Tchuenche et al. (2011)	SEITR–SEI human–vector malaria transmission model with multi-level drug resistance	Not specified	Includes drug resistance dynamics in humans and mosquitoes.	Omits vector control measures such as ITNs or spraying.	Highlights how treatment pressure can select resistant parasite strains.	Drug resistance modelling	Best suited for studying the evolution of drug-resistant malaria strains.
Tchoumi et al. (2018)	General SEIR-type human–vector model with questing–resting mosquito behavior	Not specified	Introduces generalized framework incorporating mosquito behavioural phases.	Does not include specific interventions or demographic structures.	Flexible framework applicable to multiple vector-borne diseases.	General vector-borne modelling	Best suited for studying mosquito behavioural effects in disease transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Tumwiine et al. (2007a)	SIRS–SI human–vector malaria transmission model with temporary immunity	Not specified	Explains oscillatory malaria dynamics due to temporary immunity loss.	Does not include immigration or intervention strategies.	Demonstrates how reinfection cycles produce oscillatory malaria dynamics.	Transmission modelling	Best suited for studying malaria persistence driven by temporary immunity loss.
Tumwiine et al. (2007b)	SIRS–SI human–vector malaria transmission model with immigration dynamics	Not specified	Incorporates infective immigrants sustaining malaria transmission.	Does not include intervention strategies.	Demonstrates how immigration can eliminate the disease-free equilibrium.	Transmission modelling	Best suited for studying malaria persistence in populations with continuous migration.

2 Intervention Based Model

Table 2: Comparison of Intervention based Models

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Adeniyi et al. (2024)	SIZ–SI human–vector malaria transmission model with behavioral awareness and LLIN intervention	Not Specified	Integrates human behavioral responses through awareness campaigns affecting LLIN usage. Applies sensitivity analysis methods to determine key transmission parameters.	Focuses mainly on LLIN usage without considering other malaria interventions.	Includes behavioral changes driven by awareness campaigns. Uses Latin Hypercube Sampling (LHS) for robust sensitivity analysis of transmission parameters.	Transmission dynamics modelling	Best suited for evaluating the role of awareness campaigns and human behavioral responses in malaria control strategies.
Helikumi et al. (2024)	Fractional-order SEIRS–SEI human–vector malaria transmission model incorporating awareness and insecticide control	Zimbabwe	Incorporates fractional calculus to capture memory effects in malaria transmission dynamics.	More complex than classical integer-order models.	Captures long-term memory effects in malaria transmission dynamics.	Fractional-order transmission modelling	Best suited for modelling malaria systems with memory effects and combined control strategies.
Wang and Zhao (2018)	SI–LSI climate-driven human–vector malaria transmission model incorporating insecticide-treated bed nets (ITNs)	Port Harcourt, Nigeria	Integrates real-world climate data and explicitly models the effect of insecticide-treated bed nets.	Focuses mainly on climate-driven dynamics and does not include spatial effects or age-structured populations.	Provides thresholds for ITN coverage and demonstrates how climate factors influence malaria transmission.	Climate-driven transmission model	Best suited for modelling malaria transmission in regions where climate variability and bed-net interventions strongly influence disease dynamics.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Garba and Danbaba (2020)	Temperature-dependent vaccination-structured SEIR malaria transmission model with stage-structured vectors	KwaZulu-Natal Province, South Africa	Investigates how temperature variability affects malaria transmission dynamics and the effectiveness of interventions such as bed nets, vaccination, larvicides, and adulticides.	Does not incorporate human mobility or insecticide resistance dynamics in malaria transmission.	Demonstrates how environmental factors, particularly temperature, influence intervention effectiveness and malaria transmission patterns.	Climate-driven malaria intervention modelling	Evaluating the impact of temperature variability on malaria transmission and control strategies in regions with significant climatic variation.
Chiyaka et al. (2008)	Vaccination-structured SEIR–SEI malaria transmission model with treatment and personal protection	Not specified	Incorporates vaccination, treatment, and personal protection strategies while accounting for superinfection and resistance in malaria transmission dynamics.	Does not incorporate spatial heterogeneity or human mobility effects in malaria spread.	Demonstrates the existence of threshold vaccination and treatment levels required for malaria elimination and highlights backward bifurcation in malaria dynamics.	Intervention and vaccination modelling	Evaluating long-term impacts of vaccination, treatment, and personal protection strategies and identifying threshold levels required for malaria eradication.
Bakare (2015)	SEIRS–SEI malaria transmission model with multiple vector control interventions	Not specified	Incorporates multiple vector control strategies including insecticide-treated nets, indoor residual spraying, educational campaigns, and fungal bio-pesticides to evaluate their combined impact on malaria transmission.	Model complexity and multiple interacting parameters may limit accessibility for non-specialist users.	Demonstrates how combinations of vector control interventions can significantly reduce malaria transmission and highlights the importance of integrated control strategies.	Multi-intervention malaria modelling	Assessing the combined effects of multiple vector control strategies on malaria transmission dynamics.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Khiri et al. (2020)	Patch-based SEIRS–SEI malaria transmission model incorporating human mobility	Kedougou, Senegal	Integrates human mobility patterns derived from mobile network data into a spatial malaria transmission model to evaluate the role of movement in sustaining malaria outbreaks.	Requires detailed mobility data, which may not always be available, and assumes mosquito populations remain localized within spatial patches.	Demonstrates that human movement is a key driver of malaria persistence and identifies highly mobile individuals as potential transmission amplifiers.	Spatial mobility modelling	Evaluating the impact of human mobility on malaria persistence and identifying high-risk mobile populations for targeted interventions.
Garira and Mathebula (2019)	Coupled multiscale malaria transmission model linking within-host and population dynamics	Not specified	Integrates within-host parasite dynamics with population-level transmission processes and introduces novel metrics such as community gametocyte load and community sporozoite load.	Requires extensive biological and epidemiological data for calibration and parameter estimation.	Provides a multiscale framework for evaluating the combined effects of interventions such as LLINs and ACT across individual and community transmission levels.	Multiscale transmission modelling	Assessing intervention effectiveness and malaria elimination strategies across both within-host and population transmission scales.
Mukhtar et al. (2020)	SEIAR–SEI human–vector malaria transmission model with Bayesian inference	South Sudan	Uses Bayesian inference (MCMC) with surveillance data to assess the impact of long-lasting insecticidal net (LLIN) coverage on malaria transmission dynamics.	Focuses primarily on a single intervention (LLINs) and does not incorporate additional control measures such as IRS or treatment combinations.	Incorporates asymptomatic infections and Bayesian parameter estimation to evaluate optimal LLIN coverage for malaria control.	Intervention effectiveness modelling	Assessing optimal LLIN coverage levels and resource allocation strategies for malaria control in high-transmission settings.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Zhao et al. (2022)	Seasonal delay SEIRS–SI malaria transmission model with ivermectin intervention	Kenya	Incorporates seasonal variation and ivermectin-induced mosquito mortality to evaluate their combined impact on malaria transmission dynamics.	Does not include age structure, spatial dynamics, or cost-effectiveness analysis.	Highlights the potential of ivermectin as a mosquito-killing intervention and demonstrates how seasonal transmission patterns influence malaria control outcomes.	Seasonal malaria intervention modelling	Evaluating ivermectin-based malaria control strategies in regions with strong seasonal transmission patterns.
Witbooi et al. (2021)	SEIRS–SEI human–vector malaria model with migration dynamics	South Africa	Develops a malaria transmission model incorporating migration effects and evaluates the impact of infected migrants and indoor residual spraying on malaria transmission dynamics.	Does not consider age structure, spatial heterogeneity, or cost-effectiveness analysis and assumes homogeneous mixing between human and mosquito populations.	Highlights the role of infected migrant inflow in sustaining malaria transmission and demonstrates the importance of migration management alongside vector control interventions.	Migration-driven malaria transmission modelling	Evaluating the impact of migration and indoor residual spraying on malaria persistence in endemic regions.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Awine and Silal (2020)	Extended SEIR–SEI human–vector malaria intervention model with regional heterogeneity	Ghana	Develops a population-level malaria transmission model incorporating regional ecological variability and evaluates intervention strategies including LLINs, IRS, ACT, and IPTp using historical surveillance data.	Focused on Ghana and may have limited generalizability to other regions with different ecological and epidemiological conditions.	Integrates multiple malaria infection states, treatment compartments, and regional transmission variability to evaluate intervention effectiveness across ecological zones.	Regional intervention modelling	Assessing the impact of combined malaria interventions across different ecological regions and transmission settings.
Woldegerima et al. (2021)	SEIRS–SEI malaria transmission model with transmission-blocking drug intervention	Sub-Saharan Africa	Evaluates the impact of transmission-blocking drugs (TBDs) on malaria transmission dynamics and mortality using a compartmental model calibrated with real-world malaria burden data.	Does not incorporate age structure, spatial dynamics, or cost-effectiveness analysis and assumes homogeneous population mixing.	Highlights the importance of high drug efficacy and treatment coverage, showing that transmission-blocking drugs can substantially reduce malaria mortality and transmission.	Drug-based malaria intervention modelling	Assessing the effects of transmission-blocking drug efficacy and treatment coverage on malaria transmission and elimination thresholds.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Nwankwo and Okuonghae (2022)	Temperature-dependent SEIRS–SEI malaria transmission model with stage-structured vectors	Not specified	Incorporates temperature-dependent mosquito survival and insecticide-treated net (ITN) efficacy to analyze the impact of climate variability on malaria transmission dynamics.	Requires detailed temperature-dependent mosquito and intervention efficacy data and does not incorporate spatial structure or human mobility.	Demonstrates how temperature fluctuations influence malaria transmission and modify the effectiveness of ITN-based interventions.	Climate-driven malaria transmission modelling	Studying the impact of climate variability on malaria transmission dynamics and intervention effectiveness.
Mohammed-Awel and Gumel (2019)	Epidemiology–genetics SEIRS–SEI malaria transmission model incorporating insecticide resistance	Not specified	Integrates epidemiological malaria transmission dynamics with genetic evolution of insecticide resistance to evaluate the effectiveness of ITNs and IRS.	Model complexity and genetic structure increase analytical difficulty and may limit straightforward interpretation.	Provides insights into how insecticide resistance evolution influences malaria control effectiveness and highlights the need for resistance management strategies.	Genetic resistance malaria modelling	Assessing the impact of insecticide resistance on malaria transmission and evaluating vector control strategies under resistance scenarios.
Drabo et al. (2024)	Stochastic Markov-chain malaria transmission model with immunity-structured populations	Burkina Faso	Incorporates stochastic transmission dynamics using Markov chain modelling to evaluate the effectiveness of IRS and LLINs in malaria control.	Model assumptions and stochastic structure may limit applicability in high-transmission settings.	Captures random fluctuations in malaria transmission and highlights the role of semi-immune individuals in disease persistence.	Stochastic malaria transmission modelling	Evaluating intervention effectiveness and malaria dynamics in low-transmission settings using stochastic analysis.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Ndam and Azike (2024)	SCEIR–SCEI human–vector malaria containment model with intervention controls	Not specified	Develops a malaria transmission model incorporating human-protection strategies (LLINs, IRS, IPTp, treatment) and vector-control strategies (larviciding, fumigation, genetic control).	Does not incorporate age structure, spatial heterogeneity, or cost-effectiveness analysis.	Introduces controlled compartments for both humans and mosquitoes, allowing direct evaluation of containment strategies.	Containment and vector-control modelling	Assessing the long-term effectiveness of combined human-protection and vector-control strategies for malaria eradication.
Ojo and Goufo (2021)	SEIRS–SEI human–vector malaria model with awareness-driven interventions	Not specified	Develops a malaria transmission model incorporating awareness campaigns alongside ITNs, indoor residual spraying, and treatment.	Assumes perfect adherence to interventions and does not incorporate spatial heterogeneity or cost-effectiveness analysis.	Introduces behavioural awareness effects into malaria transmission modelling.	Awareness-driven malaria intervention modelling	Evaluating the combined effects of awareness campaigns and vector control interventions for malaria control.
Ochieng (2024)	Seasonal awareness-structured SEIRS malaria transmission model	Not specified	Incorporates seasonal variation and awareness campaigns using social media and other public health communication strategies.	The model may not fully capture the complexity of real-world intervention implementation and behavioural responses.	Integrates behavioural awareness and environmental seasonality into malaria transmission modelling.	Awareness and seasonal malaria modelling	Evaluating the impact of awareness campaigns and seasonal transmission dynamics in malaria control.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Okell et al. (2008)	Age-structured SEIR–SEI malaria transmission model with treatment and prophylactic protection	Tanzania	Evaluates the impact of Artemisinin Combination Therapy (ACT) and alternative antimalarial regimens on malaria transmission dynamics across different transmission intensities.	Assumes uniform drug coverage and efficacy and does not incorporate vector control interventions or spatial transmission dynamics.	Provides insights into how ACT reduces infectiousness and malaria transmission.	Drug-based malaria intervention modelling	Assessing the impact of ACT and long-acting antimalarial treatments on malaria transmission across regions with varying transmission intensities.
Adegbite et al. (2023)	SEIRVT human–vector malaria transmission model incorporating human mobility and vigilance to control strategies	Covenant University, Ota, Ogun State, Nigeria	Develops a malaria transmission model incorporating human mobility, vigilance to control measures, and multiple prevention strategies including LLINs, IRS, air conditioners, protective clothing, house nets, and lotions. Combines epidemiological data from student surveys, hospital malaria cases, and literature sources to calibrate the model.	Focuses on a controlled university population of undergraduate students, which may limit generalizability to broader community transmission settings.	Integrates conventional and traditional malaria control tools with human mobility dynamics and evaluates malaria importation effects in a low-transmission environment.	Intervention-based malaria transmission modelling	Evaluating the role of human mobility and vigilant use of malaria prevention tools in reducing malaria transmission in low-endemic environments such as university campuses.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Adom-Konadu et al. (2022)	Deterministic SEIRS–SEI human–vector malaria transmission model evaluating prevention strategies	Not specified	Develops a deterministic SEIRS malaria transmission model incorporating multiple prevention strategies including insecticide-treated nets, intermittent prophylactic treatment, mosquito repellents, indoor residual spraying, and larviciding. Performs sensitivity analysis and numerical simulations to evaluate intervention effectiveness.	Does not include spatial modelling, stochastic dynamics, or Bayesian parameter estimation, which could improve model realism and predictive accuracy.	Identifies the optimal proportion of individuals adhering to preventive measures and seeking treatment required to achieve malaria eradication.	Intervention transmission modelling	Assessing the combined impact of preventive measures and treatment coverage on malaria elimination and identifying optimal intervention thresholds for malaria control.

3 Optimal Control Model

Table 3: Comparison of Optimal Control Transmission Models

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Witbooi et al. (2023)	SIRS–SI stochastic human–vector malaria transmission model with optimal control	General population	Integrates realistic features by incorporating stochastic uncertainties affecting malaria transmission dynamics.	Excludes age structure, spatial data, and cost-effectiveness analysis.	Captures randomness-based fluctuations in disease transmission and evaluates control strategies under uncertainty. Provides a systematic framework for optimal malaria control in stochastic environments.	Stochastic transmission model	Best suited for evaluating random effects in malaria transmission and assessing optimal control strategies under uncertainty.
Duve et al. (2024)	SVIR–SI human–vector	Sub-Saharan Africa (Ghana, Kenya, Malawi vaccination settings)	Incorporates RTS,S vaccination and influx of infected immigrants into malaria transmission dynamics; evaluates disease-free and endemic equilibria; uses sensitivity and optimal control analysis to identify effective intervention combinations.	Assumes homogeneous mixing between humans and mosquitoes; constant mosquito population; temporary immunity; no spatial movement except immigrant influx.	Integrates vaccination coverage with infected immigrant dynamics, highlighting how migration can sustain malaria transmission even under high vaccination coverage.	Vaccination and migration policy modelling	Assessing the combined impact of vaccination programs and infected immigrant influx on malaria elimination strategies.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Baba et al. (2019)	Two-strain SIR–SIR human–vector	Malaria endemic regions	Models transmission dynamics of drug-sensitive and drug-resistant malaria strains and evaluates optimal control strategies using ITNs and antimalarial treatment.	Does not incorporate additional vector control measures such as IRS or behavioural protection strategies and assumes homogeneous mixing between humans and mosquitoes.	Explicitly models drug resistance dynamics with separate sensitive and resistant strains within a host–vector transmission framework.	Drug resistance modelling	Evaluating treatment strategies and intervention policies in regions experiencing emerging antimalarial drug resistance.
Abioye et al. (2020a)	SEIR–SEI human–vector optimal control malaria model with sterile insect technique (SIT)	Malaria endemic regions	Develops an optimal control malaria transmission model incorporating insecticide-treated bed nets, treatment of infected individuals, sterile insect technique (SIT), and maternal–infant protection strategies to reduce malaria transmission.	Implementation of SIT requires substantial resources and precise data, making the model more difficult to apply in low-resource settings.	Extends classical malaria transmission models by incorporating sterile insect technique and targeted protection of vulnerable groups such as pregnant women and newborns.	Vector elimination and optimal control modelling	Designing long-term malaria elimination strategies using integrated interventions including SIT and protection of vulnerable populations.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Oke et al. (2020)	SIRS–ASI human–vector	Endemic malaria settings	Develops a compartmental human–vector model incorporating aquatic mosquito stages and three control strategies (ITNs, treatment, and insecticide spraying); uses Pontryagin's Maximum Principle to determine optimal intervention strategies.	Assumes homogeneous mixing between humans and mosquitoes and does not explicitly consider spatial movement or vaccination interventions.	Incorporates mosquito aquatic stages and evaluates combined intervention strategies within an optimal control framework.	Intervention optimisation	Assessing the long-term effectiveness of combined malaria control strategies such as ITNs, treatment, and insecticide spraying.
Otieno et al. (2016)	SEIRS–SEI human–vector	Kenya	Develops a human–vector malaria transmission model incorporating four intervention strategies (ITNs, treatment, IRS, and IPTp) and evaluates optimal control strategies across endemic, epidemic, and seasonal transmission settings.	Assumes homogeneous mixing and constant parameters and does not incorporate spatial heterogeneity or vaccination strategies.	Combines optimal control analysis with SEIRS–SEI transmission dynamics to evaluate intervention strategies tailored to different malaria transmission settings in Kenya.	Country-specific transmission modelling	Designing optimal malaria control strategies for endemic, epidemic-prone, and seasonal transmission settings in Kenya.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Danquah et al. (2023)	Age-structured SIUT–SI human–vector	Sub-Saharan Africa	Incorporates age structure (infants and adults) and explicitly models the use of counterfeit versus effective antimalarial drugs; evaluates intervention strategies including ITNs, IRS, and highly effective antimalarial drugs (HEAs); demonstrates backward bifurcation in malaria dynamics.	Assumes homogeneous mosquito population and simplified drug-use behaviour; limited representation of spatial or mobility dynamics.	One of the first malaria models explicitly incorporating counterfeit antimalarial drug use within an age-structured transmission framework.	Drug quality and resistance modelling	Evaluating the impact of counterfeit drugs and optimal intervention combinations (ITNs, IRS, HEAs) on malaria control.
Adeniyi et al. (2023)	SIRS–SI human–vector	Benue State, Nigeria	Integrates mosquito- and transfusion-transmitted malaria; computes R_0 (incl. transfusion component), stability and sensitivity; evaluates optimal combinations of screening, LLINs, treatment, IRS and larval control.	Homogeneous transfusion risk; limited immunity detail; simplifying assumptions on intervention effects.	Rarely models transfusion pathway explicitly; compares multi-intervention bundles and recommends feasible packages for resource-limited settings.	Intervention optimisation	Designing screening and bundled controls (LLINs+treatment+IR where transfusion contributes to transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Osman et al. (2019)	SEITRS human–vector compartmental malaria model with saturated incidence	Democratic Republic of Congo	Develops a simple malaria transmission model incorporating saturated incidence and human immunity; computes the basic reproduction number (R_0) using the next-generation matrix; performs equilibrium and sensitivity analyses; uses WHO malaria data (2007–2017) to simulate and predict malaria trends.	Does not incorporate environmental drivers such as seasonality or climate variability; assumes constant human and mosquito populations; no spatial heterogeneity or superinfection dynamics; assumes all infected individuals eventually receive treatment.	Integrates epidemiological modelling with real WHO surveillance data for DRC; highlights the influence of mosquito biting rate on transmission dynamics; provides practical policy insights on reducing malaria transmission through vector control and treatment.	Transmission dynamics modelling	Evaluating the impact of interventions such as treated bed nets, insecticide spraying, and improved treatment coverage on malaria transmission in endemic settings like the Democratic Republic of Congo.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Tchoumi et al. (2023a)	Age-structured SEIS/SEIRS–SEI human–vector vaccination	Sub-Saharan Africa	Develops an age-structured human–vector malaria transmission model incorporating vaccination for children under five years old alongside treatment and personal protection strategies; evaluates individual and combined intervention strategies using optimal control analysis.	Assumes homogeneous mixing between humans and mosquitoes and restricts vaccination to children under five; does not incorporate seasonality in mosquito dynamics.	Distinguishes transmission dynamics between children and adults and explicitly evaluates childhood vaccination within an optimal control framework.	Vaccination strategy modelling	Assessing the effectiveness of childhood malaria vaccination combined with treatment and personal protection interventions.

4 Cost Effective Model

Table 4: Comparison of Optimal Control Transmission Models

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Nana-Kyere et al. (2024)	Extended SEIR–SEI human–vector vaccination optimal control malaria model	Not Specified	Develops a human–vector malaria transmission model incorporating vaccination alongside traditional interventions such as bed nets and insecticide spraying; performs sensitivity and cost-effectiveness analyses to evaluate intervention impact.	Does not consider drug resistance or socioeconomic heterogeneity and requires high vaccination coverage to achieve significant disease reduction.	Integrates vaccination dynamics with asymptomatic and severe infection compartments and evaluates intervention cost-effectiveness within a stability analysis framework.	Vaccination and cost-effectiveness modelling	Planning vaccine-based malaria control strategies and evaluating the combined impact of vaccination and vector control interventions.
Keno et al. (2022c)	Climate-driven SEIRS–SEI human–vector optimal control malaria model	Not Specified	Incorporates temperature and rainfall variability into malaria transmission dynamics and evaluates optimal control strategies including treated bed nets, treatment, and indoor residual spraying.	Requires extensive climate data for accurate prediction and does not incorporate relapse or reinfection mechanisms.	Integrates climate variability into malaria transmission modelling, allowing improved analysis of seasonal malaria patterns and climate-sensitive outbreaks.	Climate-driven malaria transmission modelling	Planning malaria control strategies in regions with strong climate variability and assessing the impact of temperature and rainfall on malaria outbreaks.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Keno et al. (2022a)	Climate-driven SEIRS–SEI human–vector optimal control malaria model	Not Specified	Incorporates temperature variability into malaria transmission dynamics and applies optimal control and cost-effectiveness analysis to evaluate intervention strategies including treated bed nets, treatment, and indoor residual spraying.	Requires reliable temperature data for accurate modelling and does not incorporate drug resistance or socioeconomic factors influencing malaria transmission.	Integrates climate variability within a SEIRS–SEI malaria framework and evaluates cost-effective intervention strategies under seasonal malaria transmission conditions.	Climate-driven malaria transmission modelling	Planning malaria control strategies in regions where malaria transmission is strongly influenced by temperature fluctuations.
Keno et al. (2022b)	Climate-driven SEIRS–SEI human–vector optimal control malaria model	Not Specified	Incorporates climate variability (temperature and rainfall) into malaria transmission dynamics and applies optimal control theory and cost-effectiveness analysis to evaluate intervention strategies including treated bed nets, antimalarial drug treatment, and indoor residual spraying.	Assumes homogeneous mixing of human and mosquito populations and requires reliable climate data for accurate modelling; does not incorporate socioeconomic heterogeneity or drug resistance dynamics.	Integrates climate variability within a SEIRS–SEI malaria framework while combining optimal control and cost-effectiveness analysis to determine the most efficient malaria intervention strategies.	Climate-driven optimal control malaria modelling	Planning cost-effective malaria control strategies in regions where malaria transmission is strongly influenced by climatic variability such as temperature and rainfall.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Okosun and Makinde (2012)	Drug-resistant malaria transmission model incorporating access to basic amenities with optimal control analysis	Not Specified	Incorporates drug-resistant malaria strains and socioeconomic factors such as access to basic amenities; evaluates multiple intervention strategies using optimal control and cost-effectiveness analysis.	Assumes homogeneous mixing and simultaneous implementation of interventions; does not consider population migration or delays in intervention deployment.	Integrates socioeconomic determinants and drug resistance dynamics within a malaria transmission model and evaluates the cost-effectiveness of combined intervention strategies.	Drug-resistance and socioeconomic optimal control malaria modelling	Evaluating cost-effective malaria control strategies that combine infrastructure improvements, treatment, and treated bed nets in settings with limited access to basic amenities.
Olaniyi et al. (2022)	Social hierarchy–structured SIR–SI human–vector optimal control malaria model	Not Specified	Incorporates social class disparities in malaria transmission and evaluates intervention strategies including bed nets, treatment, vector control, and provision of social amenities; performs cost-effectiveness analysis of combined interventions.	Assumes homogeneous mixing within social classes and does not explicitly model biological transmission heterogeneity or spatial mobility.	Integrates socioeconomic structure into malaria transmission modelling and evaluates the cost-effectiveness of interventions across different social classes.	Socioeconomic intervention modelling	Policy planning for malaria control in socially stratified populations and assessing the impact of poverty and healthcare access on malaria transmission.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Olaniyi et al. (2020)	SEIRV–SEI human–vector optimal control malaria model with temporary immunity and protected travellers	Not Specified	Incorporates temporary immunity and protected travellers into malaria transmission dynamics and evaluates optimal control strategies including ITNs, prophylaxis, treatment, and IRS.	Does not explicitly consider drug resistance and may be less accurate in regions with high population mobility where immunity levels are difficult to estimate.	Integrates temporary immunity and traveller protection dynamics, which are rarely considered in malaria transmission models, and provides cost-effective intervention strategies.	Mobility and immunity modelling	Assessing malaria transmission dynamics in regions with human travel and temporary immunity.
Mwamtobe et al. (2014)	SEIRS–SEI human–vector optimal control malaria model	Malawi (Karonga District)	Develops a malaria transmission model using SEIRS human dynamics and SEI mosquito dynamics to evaluate the combined effects of indoor residual spraying, insecticide-treated nets, and treatment interventions.	Does not incorporate additional environmental drivers such as climate variability or drug resistance and assumes homogeneous mixing of human and mosquito populations.	Evaluates combined malaria interventions rather than isolated strategies, demonstrating that IRS, ITNs, and treatment together significantly reduce malaria prevalence.	Combined intervention modelling	Assessing optimal combinations of IRS, ITNs, and treatment strategies for malaria control in endemic regions.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Keno et al. (2021)	Climate-driven SIRS–SI human–vector optimal control malaria model	Not Specified	Develops an SIRS malaria transmission model incorporating temperature variability and evaluates optimal control strategies including insecticide-treated bed nets, treatment, and indoor residual spraying.	Requires reliable temperature data for accurate modelling and does not include other environmental drivers such as rainfall or humidity.	Establishes an explicit link between temperature variability and malaria transmission dynamics and evaluates cost-effective intervention strategies under climate variability.	Climate-driven malaria transmission modelling	Assessing malaria control strategies in regions where temperature variability influences malaria transmission.
Onifade et al. (2024)	Strain-structured SIRS–SEI malaria transmission model incorporating drug-resistance testing		Not Specified	Individual resistance testing alone cannot achieve malaria elimination and the model assumes homogeneous behaviour and immune responses across the population.	Incorporates drug-resistant and wild malaria strains with first- and second-line treatment strategies, and demonstrates backward bifurcation in malaria dynamics.	Best suited for evaluating the impact of resistance testing and treatment strategies on multidrug-resistant malaria prevalence.	
Li et al. (2023)	SVIR–SI human–vector optimal control malaria model with vector bias	Democratic Republic of Congo	Develops a malaria transmission model incorporating vector bias and time-dependent control interventions including RTS,S vaccination, insecticide-treated nets, treatment, and indoor residual spraying.	Requires accurate estimation of time-varying intervention effectiveness and assumes homogeneous mixing between human and mosquito populations.	Extends classical malaria transmission models by integrating vector bias and dynamic control strategies, enabling prediction of malaria trends under varying intervention coverage.	Intervention optimisation modelling	Evaluating long-term malaria control strategies and cost-effective intervention combinations in regions with varying intervention coverage.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Ghosh et al. (2020)	Relapse–reinfection SIR–SI human–vector optimal control malaria model	Not Specified	Incorporates relapse and reinfection dynamics into malaria transmission modelling and evaluates optimal control strategies including treatment, relapse prevention, vector control, and personal protection measures.	Does not account for climate variability or socioeconomic heterogeneity affecting malaria transmission.	Explicitly models relapse and reinfection processes, which are often overlooked in traditional malaria transmission models.	Relapse and reinfection modelling	Assessing the impact of repeated infections on malaria persistence and designing intervention strategies targeting relapse prevention and reinfection control.
Kalula et al. (2023)	Age-structured SEIAR/SEIRS–SEI human–vector climate-driven optimal control malaria model	Tanzania (Iringa region)	Develops an age-structured malaria transmission model incorporating asymptomatic carriers and temperature variability and evaluates time-dependent interventions including LLINs, treatment of symptomatic cases, screening of asymptomatic carriers, and insecticide spraying.	Requires reliable screening data for asymptomatic carriers and temperature effects may require location-specific calibration.	Extends classical malaria models by explicitly incorporating asymptomatic carriers and temperature-dependent transmission dynamics within an age-structured framework.	Asymptomatic carrier and climate modelling	Evaluating the role of asymptomatic carriers and temperature variability in malaria transmission and control strategies.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Ayalew et al. (2024)	SAIR–SI human–vector	Not Specified	Develops a human–vector malaria transmission model incorporating awareness campaigns alongside control measures such as treated bed nets, IRS, and treatment; evaluates disease dynamics using stability, bifurcation, and optimal control analyses.	Assumes homogeneous mixing between humans and mosquitoes and does not incorporate spatial heterogeneity or seasonal variation in mosquito populations.	Explicitly integrates human awareness dynamics into malaria transmission modelling within an optimal control framework.	Behavioural intervention modelling	Designing malaria control programs combining awareness campaigns with vector control and treatment strategies.
Edossa et al. (2023)	Drug-resistance SITRS–SI human–vector optimal control malaria model	Malaria endemic regions	Develops a deterministic malaria transmission model incorporating drug-sensitive and drug-resistant infections with optimal control and cost-effectiveness analysis to evaluate interventions such as ITNs, IRS, and treatment.	Requires accurate cost data for reliable cost-effectiveness evaluation and assumes homogeneous mixing of human and mosquito populations.	Explicitly incorporates drug-sensitive and drug-resistant malaria dynamics while evaluating cost-effective intervention combinations using optimal control theory.	Drug resistance and cost-effectiveness modelling	Evaluating optimal combinations of malaria interventions and cost-effective control strategies in endemic regions.

Study	Model Type	Country	Strengths	Limitations	Comparative Advantages	Application Category	Example Use Case
Okosun et al. (2013)	SEIRS–SEI human–vector optimal control malaria model with cost-effectiveness analysis	Malaria endemic regions	Develops a malaria transmission model incorporating optimal control and cost-effectiveness analysis to evaluate interventions including treated bed nets, insecticide spraying, and treatment of infected individuals.	Assumes perfect adherence to intervention strategies and does not include additional vector control techniques such as sterile insect techniques (SIT) or seasonal mosquito variations.	Provides important insights into cost-effective malaria control strategies and highlights backward bifurcation, showing that reducing R_0 below one is not always sufficient for malaria eradication.	Cost-effectiveness modelling of malaria interventions	Designing cost-effective malaria control strategies in resource-limited settings.

List of Acronyms

General Terms

ADM	Adomian Decomposition Method
ABC	Atangana–Baleanu–Caputo fractional operator
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
EIP	Extrinsic Incubation Period
GIS	Geographic Information System
HBR	Human Biting Rate
IRS	Indoor Residual Spraying
ITN	Insecticide-Treated Net
LLIN	Long-Lasting Insecticidal Net
LHS	Latin Hypercube Sampling
MCMC	Markov Chain Monte Carlo
ODE	Ordinary Differential Equation
PDE	Partial Differential Equation
SSA	Sub-Saharan Africa
WHO	World Health Organization
R_0	Basic Reproduction Number
R_v	Mosquito Reproduction Number

Epidemiological Compartments

S	Susceptible population
E	Exposed population (infected but not yet infectious)
I	Infectious population
R	Recovered population
A	Asymptomatic population
T	Treated population
V	Vaccinated or Vigilant population (depending on model context)
Z	Vigilant population adopting preventive behaviours
J	Juvenile mosquito stage
L	Larval mosquito stage

P	Pupae mosquito stage

Model Structure Acronyms

SIR	Susceptible–Infectious–Recovered model
SIRS	Susceptible–Infectious–Recovered–Susceptible model
SEIR	Susceptible–Exposed–Infectious–Recovered model
SEIRS	Susceptible–Exposed–Infectious–Recovered–Susceptible model
SEI	Susceptible–Exposed–Infectious mosquito model
SIR–SI	Susceptible–Infectious–Recovered human model coupled with Susceptible–Infectious mosquito model
SIRS–SI	Susceptible–Infectious–Recovered–Susceptible human model coupled with Susceptible–Infectious mosquito model
SEIR–SEI	Susceptible–Exposed–Infectious–Recovered human model coupled with Susceptible–Exposed–Infectious mosquito model
SEIRS–SEI	Susceptible–Exposed–Infectious–Recovered–Susceptible human model coupled with Susceptible–Exposed–Infectious mosquito model
SEIAR–SEI	Susceptible–Exposed–Infectious–Asymptomatic–Recovered human model coupled with Susceptible–Exposed–Infectious mosquito model
SIZ–SI	Susceptible–Infectious–Vigilant human population coupled with Susceptible–Infectious mosquito population
SEITR	Susceptible–Exposed–Infectious–Treated–Recovered model
SEITRS	Susceptible–Exposed–Infectious–Treated–Recovered–Susceptible model
SEITVR–SEI	Susceptible–Exposed–Infectious–Treated–Vaccinated–Recovered human model coupled with Susceptible–Exposed–Infectious mosquito model
SEIV–SEI	Susceptible–Exposed–Infectious–Vigilant human model coupled with Susceptible–Exposed–Infectious mosquito model
SEIRS–ELPSEI	Susceptible–Exposed–Infectious–Recovered–Susceptible human model with mosquito stages: Egg–Larva–Pupa–Susceptible–Exposed–Infectious
SEIRS–JSEI	Susceptible–Exposed–Infectious–Recovered–Susceptible human model coupled with Juvenile–Susceptible–Exposed–Infectious mosquito model
SI–LSI	Susceptible–Infectious human model with Larval–Susceptible–Infectious mosquito stages
SIRNRS–ELPAEI	Susceptible–Infectious–Recovered–Non-immune–Recovered–Susceptible human model with Egg–Larva–Pupa–Adult–Exposed–Infectious mosquito stages

Note: The interpretation of compartments (V representing vaccinated or vigilant individuals) may vary slightly depending on the modelling framework used in each study.

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