SEIRS Malaria Model with Seasonal Variations

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Introduction

This simulation models the spread of malaria using a SEIRS model that includes **seasonal variation** in transmission. Parameters are based on estimated data and some literature from **Benin and West Africa**.

Full R Code

```r
# Load necessary packages
library(deSolve)
library(tidyverse)
library(reshape2)

# Define the SEIRS model with seasonality
SEIRS_model <- function(t, state, parameters) {
  with(as.list(c(state, parameters)), {

    P <- S + E + I + R
    beta_t <- beta * (1 + A * sin(2 * pi * t / T))
    lam <- beta_t * E / P

    dS <- -lam * S + mu * R
    dE <- lam * S - alpha * E
    dI <- alpha * E - epsilon * I
    dR <- epsilon * I - mu * R

    list(c(dS, dE, dI, dR))
  })
}

# Initial population and states
initP <- 1000000
initE <- 1
initI <- 0
initR <- 0
initS <- initP - initE - initI - initR
istate <- c(S = initS, E = initE, I = initI, R = initR)
```

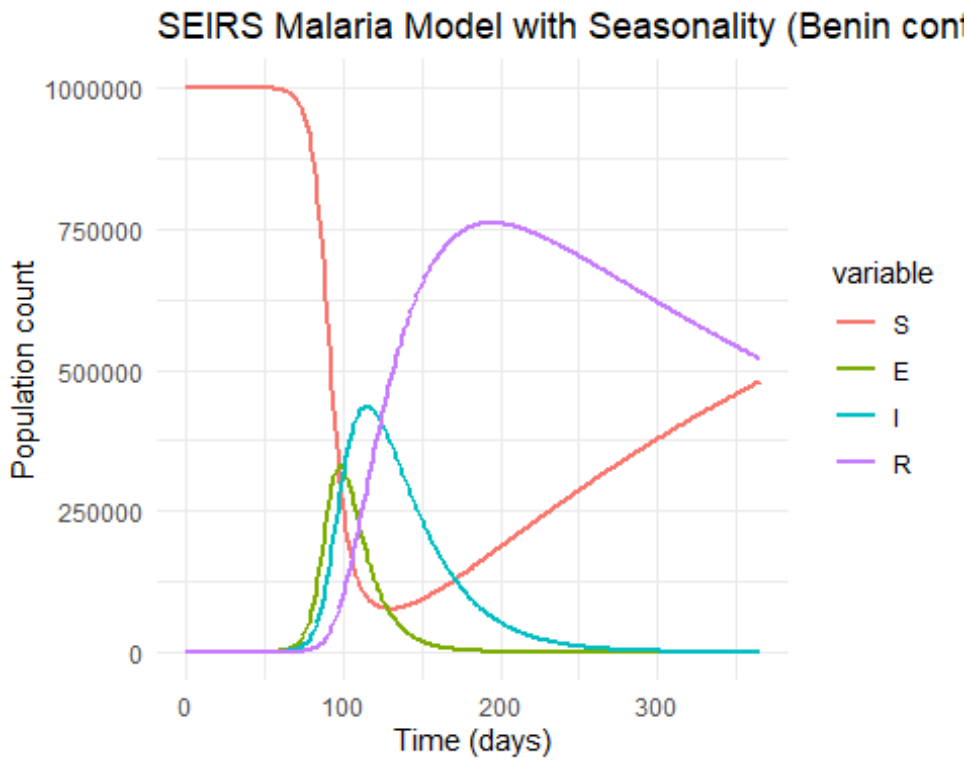
```r
# Parameters based on Benin context
parameters <- c(
  mu = 1/365,           # loss of immunity ~ 1 year
  beta = 0.16,          # transmission coefficient for R0 ~ 5
  A = 0.7,              # seasonal amplitude
  alpha = 1/12,         # incubation ~12 days
  T = 365,              # seasonal cycle (1 year)
  epsilon = 1/30        # infectious period ~30 days
)

# Time vector
t <- seq(0, 365, by = 1)

# Solve the ODEs
out <- ode(y = istate, times = t, func = SEIRS_model, parms = parameters)
out_df <- as.data.frame(out)

# Melt the dataframe and plot
out_long <- melt(out_df, id.vars = "time")

ggplot(out_long, aes(x = time, y = value, color = variable)) +
  geom_line(size = 1) +
  labs(title = "SEIRS Malaria Model with Seasonality (Benin context)",
       y = "Population count",
       x = "Time (days)") +
  theme_minimal()
```


SEIRS Malaria Model with Seasonality (Benin cont
1000000
750000
500000
250000
0
Population count
0
100
200
300
Time (days)
variable
S
E
I
R