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Population dynamics of the malaria vector *Anopheles arabiensis* from northern KwaZulu Natal, South Africa (2014-2019)

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Epidemiology (Infectious Disease Epidemiology).

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Abstract

Background

Over the years, South Africa has reported a significant decrease in indigenous cases but malaria cases have remained stagnant despite continued efforts to eliminate the disease. The failure to completely eliminate malaria transmission has been ascribed to several factors, including a limited understanding of the intricate bionomics of vectors driving the ongoing residual malaria transmission. *Anopheles arabiensis* (the primary malaria vector in South Africa) and several potential secondary vectors have been implicated in malaria transmission. However, the population dynamics of these vectors and their individual roles in the ongoing residual malaria transmission are not well described. Several factors affect mosquito population dynamics, these include population density and environmental and ecological factors. This study aims to describe and determine the factors that influence the population dynamics of the *Anopheles arabiensis* population from Jozini, KwaZulu Natal, in South Africa.

Methods

The data used in this study were collected from sections 2, 8, and 9 in Mamfene (KwaZulu-Natal) and stored in the SIT database housed at the National Institute for Communicable Diseases (NICD). For purposes of this work, data collected between 2014 and 2019 were retrieved from the SIT database and summarised using descriptive statistics. Furthermore, multiple linear and logistic regression models were used to determine factors that influenced or were associated with two distinct outcomes. The outcomes were *An. arabiensis* density for the multiple linear regression model and the occurrence of *An. arabiensis* for the multiple logistic regression model. For both regression models, these factors included the section, season, and year of collection; the average temperature, humidity, and wind speed observed during the collection period; and the distance between households and traps. To model the effect of sex, the multiple linear regression model used the number of females in the *An. Arabiensis* population, while the logistic regression model used both sexes and the males served as a reference group.

Results

Out of 7838 mosquitoes collected, 4234 (53.0%) were members of the *Anopheles gambiae* complex, and 1198 (15.3%) were members of the *Anopheles funestus* group. *Anopheles arabiensis* was the most abundant species from the *An. Gambiae* complex contributing 49.0%

of the total collection, while *An. Parensis* dominated the *An*. *Funes*tus group contributing 8.4% of the total collection. The *An*. *Arabiensis* population density peaked during autumn and was at its lowest in winter. The multiple linear model showed that factors that influenced *An. arabiensis* density were section, year, and season of collection; the temperature and humidity observed during the collection period; and the number of *An*. *arabiensis* female mosquitoes collected. Multiple logistic regression modeling showed an association between the occurrence of *An*. *arabiensis* and section and season of the collection, the sex collected, and the temperature and humidity observed during collection. The logistic regression model also showed that the was an interaction between average rainfall and season of collection which positively influenced the occurrence of *An*. *Arabiensis*.

Conclusion

This study showed that *Anopheles arabiensis* occur in sympatry with various other anophelines. Most of the other anophelines sampled were previously implicated as potential malaria vectors in South Africa. These findings confirm that Mamfene is receptive to malaria transmission, with more than one vector probably driving the ongoing residual malaria transmission. This presents challenges to current vector control strategies that are mainly focused on the primary malaria vector, *An*. *arabiensis*. Overall, it can be concluded that the most efficient time to conduct supplementary vector control activities is during winter when conditions are least favourable for the primary vector, *An*. *arabiensis*. It is recommended that malaria control programmes should enhance winter larviciding as a supplementary vector control strategy.