Dedication

I *dedicate mythesis to my mother's spirit andto my father who are the reason of being a responsible person,and being with me in good and hard time. I also dedicate this to my wonderful family, I will always appreciate all they have done.*

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All praise and thanks be to Allah alone, the lord of the world.*First, itismy pleasure to express my gratitude to a lot of people who have given me support and help throughout the entiredoctorate program.*

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English abstract

Rift Valley fever (RVF) is a seriouslife-threatening diseasewith severe clinical manifestations and health consequences for humans anda wide range of domesticated animals. Human can be infected either by mosquito bites or through the exposure to blood, body fluids, or tissues of RVF-infected animals.In September 2000, a RVF outbreak was reported in Saudi Arabia, particularly in the Jazan region south-west Saudi Arabia with 886 human cases including 124 deaths.This outbreak has raised concerns about the potential spreading of the disease in new geographical areas including Europe, Asia and Americas as a consequence of climate change and globalization of trade in animals and animal products.Since the early recognition of RVF in Saudi Arabia, a comprehensive control program has been launched to contain the outbreak, albeit, the existing preventive measures are inadequate.However,these control measures are obviously lacking the geographical perspective besides the absence of spatial aspects. Furthermore, the geographical distribution of mosquitoes according to coordinates has not yet been adequately addressed.From these perspectives, the aim of thisstudywas (1) to examine the abundance and the distribution of RVF vectors according to geographical coordinates especially of the genus Aedes (2) toinvestigate the existence of RVFV in mosquitoes by molecular techniques.(3) to develop a new risk model to predictthe potential epizootic areas for RVF and the boundaries of intervention activities.4- to identify locations where people are potentially exposed to RVFand tocalculate the total population who are potentially exposed toRVF.However, various innovative approaches and novel bio-technological tools including, but not limited to, PCR, GIS (Geographical Information System) technology, GPS (Global Positioning System), satellite images,and field observation techniques were used in the current study. The results of thisresearch indicated that the very high risk zones were located in Sabia district, while both of Sabia and Balgazi districts were predicted as having high vulnerability to RVF occurrence. There are about 16.13 Km 2,of land under very high risk, 475.47Km

^{2} under high risk, and 3577.60 Km 2 under medium risk. Interestingly, at least 54315 persons in the cities of Samtah, Alardah, Alshigairy and Alaydabi are located nearby mosquito breeding sites and much more likely to have mosquito-borne diseases.Regarding mosquito surveillance data, Culex species was consistently the predominant mosquito, ranged from 98.13% to 99.26% in Sabia and Abuareesh respectively. While, phlebotomus sandflies, were found sporadically distributed in all districts with high relative abundance in Bulgazi (5.6%). Moreover, all mosquito samples tested by RT-PCR for the presence of RVFV were reported as negative.

The outcome of this study could enhance the existing RVF surveillance and preventive measureseffectively over the long time as well asenable decision makers to focus limited resources on areas at high risk of the disease.

الملخص العربي

مرض حمى الوادي المتصدع مرض خطير من الامراض المهددة لحياة الانسان ويتسبب في حدوث كثير من الاعراض والمضاعفات الوخيمة للإنسان والحيوان. يصاب الانسان بالمرض اما عن طريق تعرضه لسعات البعوض الناقل للمرض او نتيجة لتعرضه لدم أوإفرازات أوسوائل أو انسجة الحيوان المصاب.في عام 2000 تعرضت المملكة العربية السعودية لوباء مرض حمى الوادي المتصدع ولاسيما منطقة جازان في الجزء الجنوبي الغربي من المملكة حيث بلغ عدد المصابين من البشر آنذاك 886شخص توفي من بينهم 124شخص. ظهور هذا الوباء في المملكة أثار المخاوف من احتمال انتقال المرض الى مناطق جغرافية جديدة الى آسيا و أوربا و الأمريكتين بسبب التغير المناخي و ازدهار التجارة العالميةللحيوانات والمنتجات الحيوانية.منذ ظهور المرض في المملكة تم انشاء برنامج متكامل للسيطرة وكذلك تم تطبيق العديد من الاجراءات الوقائية لاحتواء المرض وان لم تكن كافية. حيث تفتقر الاجراءات الوقائية الحالية الى المنظور الجغرافي والجانب المكاني، ايضاً لم تتم دراسة التوزيع الجغرافي (بناء على الاحداثيات الجغرافية) للبعوض الناقل للمرض وخاصة من نوع الايدس. من هذا المنظور تهدف هذه الدراسة الى : 1/ دراسة الكثافة والتوزيع الجغرافي للبعوض الناقل للمرض وخصوصاً البعوض من نوع ايدس وذلك بناء على الاحداثيات الجغرافية. 2/ دراسة وجود فيروس حمى الوادي المتصدع في البعوض عن طريق تقنية البيولوجيا الجزيئية.3/ انشاء نموذج لتحديد المواقع الخطرة والأكثر تعرضاً للإصابة بالمرض ورسم حدود جغرافية لمناطق المكافحة. 4/ تحديد المواقع التي ربما يتعرض فيها السكان للمرض وتقدير عدد السكان المعرضين للإصابة في تلك المواقع. في هذا البحث تم استخدام العديد من الطرق والتقنيات الحديثة على سبيل المثال لا الحصرتقنية البيولوجيا الجزيئية، نظم المعلومات الجغرافية و نظام تحديد المواقع الجغرافية، صور الاقمار الاصطناعية،اضافة الى الزيارات الميدانية. حيث خلصت الدراسة الى ان المناطق الأكثر عرضة للإصابة بالمرض تتركز في محافظة صبيا بينما تتركز المناطق الخطرة في محافظتي صبيا وبلغازي. و تقدر مساحة المناطق الأكثر عرضة للإصابة بالمرض بـ (16,13 كلم مربع)، ومساحة المناطق الخطرة بـ (475,47كلم مربع)، بينما تبلغ مساحة المناطق المتوسطة الخطورة (3577,60كلم مربع).الجدير بالذكر ان هنالك عدد 54315 شخص يقطنون في مدن صامطة الشقيري، العيدابي، العارضة، و يسكنون بالقرب من بؤر توالد البعوض الناقل للأمراض مما يجعلهم أكثر عرضة للإصابة بالأمراض المنقولة بالبعوض. فيما يختص بنتائج المسح الحشري، اثبتت الدراسة ان البعوض من جنس الكيولكس من اكثر الانواع السائدة بنسبة تتراوح ما بين 98,13 % في محافظة صبيا و 99,26 % في ابوعريش،أيضاً تنتشر الذبابة الرملية في جميع المحافظة بشكل متقطع ولكن بشكل اكبر في محافظة بلغازي بنسبة (5,6%). علاوة على ذلك أوضحت نتائج الدراسة ان جميع عينات البعوض التي تم فحصها بتقنية الاحياء الجزيئية سلبية لفيروس حمى الوادي المتصدع.

من المتوقع ان تسهم نتائج هذه الدراسة بشكل كبير في تحسين الاستقصاء المرضي و الاجراءات الوقائية وتمكين صانعي القرار من إدارة و توجيه الموارد المتاحة الى المناطق الخطرة و المناطق الأكثر خطورة.

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List of Abbreviations

RVF: Rift Valley Fever

RVFV: Rift Valley Fever virus

GIS: Geographical Information System

GPS :Global Positioning System

OIE: World Organization for Animal Health

WHO : World Health Organization

FAO: Food and Agriculture Organization

NDVI: Normalized Difference Vegetation Index

ARIMA :Auto Regressive Integrated Moving Average

SARIMA: Seasonal Auto Regressive Integrated Moving Average

OBP: Onderestepoort Biological Products limited

KEVEVAPI :Kenya Veterinary Vaccine Producing Institute

EVSVRI:Egypt's Veterinary Serum and Vaccine Research Institute

ELISA :Enzyme linked Immune Absorbent Assay

DIVA: Differentiating infected fromvaccinated animals

VNT :Virus neutralization tests

DEM: Digital Elevation Model

IDW: Inverse Distance Weighted

RT- PCR :Reverse Transcription Polymerase Chain Reaction

cDNA: Complementary deoxyribonucleic acid

VERO: African green monkey kidney

BHK : Baby hamster kidney

GLCF :Global Land Cover Facility

RA%: The relative abundance

ITNs: Insecticide-treated bed nets Insecticide

ULV : Spraying at ultra-low volume

CPV : Recombinant Capripoxvirus

ESA : European Space Agency