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The Effect of Climate Variation on Infectious Diseases in Humans in New Zealand

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August 2011
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A thesis presented in partial fulfilment of the requirements for the degree of Masters in Veterinary Studies in Epidemiology at Massey University, Palmerston North, New Zealand under the supervision of Dr. Jackie Benschop & Dr. Geoffrey Jones.

This work was sponsored by the Institute of Environmental Science and Research Limited as part of a Foundation for Research, Science and Technology funded project (contract C03X0801).

Aleisha Brock
Submitted August 2011
Jeremiah 29:11-13

11 “For I know the plans I have for you,” declares the Lord, “plans to prosper you and not to harm you, plans to give you hope and a future.

12 Then you will call on me and come and pray to me, and I will listen to you.

13 You will seek me and find me when you seek me with all your heart.”
Abstract

The emergence and spread of infectious disease are a major issue associated with environmental change. Contributing to this is the effect climate variability and change may play in altering disease risk. The aims of this study were to investigate the association between climate and infectious diseases in humans throughout New Zealand from 1997 - 2007, then use the identified associations to project the burden of disease in 2015, 2040 and 2090 with respect to future climate change scenarios.

The four infectious diseases selected and investigated were campylobacteriosis, cryptosporidiosis, influenza hospitalisations and meningococcal disease. The association of weather variables and other confounders with the incidence risk (IR) of disease were explored using a quasi-Poisson generalized linear model, indicating that weather variables were significantly associated with disease risk. These results, along with expert opinion on epidemiological plausibility, were used to select confounders for the past association models.

Climate variation was associated with the IR of campylobacteriosis and cryptosporidiosis in New Zealand from 1997 - 2007. Campylobacteriosis notifications were found to be positively associated with the weekly absolute humidity. Additionally, campylobacteriosis notification risk factors were increasing beef and dairy density, intermediate and poor drinking water quality, being over 65 years of age and identifying with Pacific Island or Asian ethnicity. Protective factors were being less than 4 years of age and identifying with Maori ethnicity. Cryptosporidiosis notifications were found to be positively associated with the weekly average temperature and negatively associated with the weekly average rainfall. Risk factors for cryptosporidiosis notifications were poor drinking water quality, being less than 4 years of age and living in rural areas. Protective factors were identifying with Maori ethnicity and unknown drinking water quality.

Influenza hospitalisations and meningococcal disease notifications were not significantly associated with past climate variation. Identifying with Maori ethnicity was found to be a risk factor for influenza hospitalisations, with no protective factors identified. Risk factors for meningococcal disease notifications were an increasing social deprivation index (SDI) score,
being less than 4 years of age and identifying with Maori ethnicity. Identifying with Asian ethnicity was a protective factor for meningococcal disease.

The projection calculations of the change in disease incidence from the study period to 2015, 2040 and 2090 were carried out under a combination of 3 Intergovernmental Panel of Climate Change (IPCC) climate scenarios (A2, B1 and A1B) and 12 downscaled global climate models. The projected change in campylobacteriosis and cryptosporidiosis suggested increases in the rate of notifications, and a small to no decrease in influenza hospitalisation and meningococcal disease notifications.
Climate and infectious diseases

Acknowledgements

It is a pleasure to thank those who helped make this thesis possible.

To my supervisors, Dr. Jackie Benschop and Dr. Geoff Jones, I sincerely thank you for your help, guidance and encouragement in getting this work completed. With differing strengths and specialities, together you created a healthy work environment in which I increased in both knowledge and skills that I will continue to draw upon in the future. For this I am thankful.

With gratitude I thank my project leader, Dr. Dave Slaney of ESR for your guidance and encouragement. It has been a great honour to work with you and the FRST team.

During this thesis I have collaborated with many colleagues who I have great regard for, and I wish to thank all of those who have helped me with my work at both the EpiCentre and Statistics Department at Massey University, and those on the FRST project.

A special mention to Dr. Jonathan Marshall of Massey University, whose incredible computer coding skills helped make a seemingly impossible task less daunting. I’d also like to thank Professor Nigel French of Massey University for your help and guidance and Dr. Simon Spencer of Warwick University for the use of your Knorr-Held Richardson R-code. To Simon Verschaffelt of Massey University, thank you for always being willing to help with computer and programming dilemmas. To Dr. Andrew Tait of NIWA, thank you for your hard work producing the weather data and projections used in this thesis and for your guidance in using them. Thank you to all who helped with data sourcing and GIS coding.

A special thanks to Kate Holland for her contribution during her summer studentship and ongoing friendship. You helped fill our office with laughter and fun, and I wish you all the best with your future endeavours!

I sincerely appreciate the financial support from the Institute of Environmental Science and Research Limited (ESR) as part of a Foundation for Research, Science and Technology funded project (contract C03X0801).

I would like to thank the Bebarfald, Meade and Brock families for their unlimited support, love and encouragement. To Grandpa & Gran, thank you for your encouragement, prayers
and foresight with financial provisions. To Nana & Grandad, thank you for your prayers and support. To Tom & Kate Brock, thank you for your love, support and numerous dinners. To my siblings, Jessica, Aimee, Joshua & Caleb, thank you for your support, laughs, prayers and help in procrastination - there has never been a dull moment! Lastly, and most importantly, I wish to thank my husband Ian Brock, and my parents Steven & Susan Meade for their love, support and prayers throughout the past two years. To them I dedicate this thesis.

"Men go abroad to wonder at the heights of mountains, at the huge waves of the sea, at the long courses of the rivers, at the vast compass of the ocean, at the circular motions of the stars, and they pass by themselves without wondering." (Saint Augustine, 354 – 430 AD)
Abbreviations

AH Absolute humidity
AU Area unit
AR Autoregressive term
ARIMA Autoregressive integrated moving-average model
ARMA Autoregressive moving-average model
CAR Conditional autoregressive models
C.I. Credible Interval
CSF Cerebrospinal fluid
DHB District health board
ESR Institute of Environmental Sciences and Research Ltd.
FRST Foundation for Research, Science and Technology
GLM Generalised linear model
HAIFA The Health Analysis and Information for Action project
MeNZB Meningococcal B strain vaccination for New Zealand
i.i.d Identically and independently distributed
IPCC Intergovernmental Panel on Climate Change
IR Incidence risk
MA Moving-average term
MAF Ministry of Agriculture and Forestry
MCMC Markov chain Monte Carlo
NIWA National Institute of Water and Atmospheric Research Ltd.
NZCCC The New Zealand Climate Change Centre
NZHIS The New Zealand Health Information Service
OR Odds ratio
PAR Population at risk
PCA Principle component analysis
PCR Polymerase chain reaction
sARIMA Seasonal autoregressive integrated moving-average model
SDI Social deprivation index
VCS Virtual climate station
VTEC Verotoxin producing *Escherichia coli*
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