Exploring the sex and gender dimensions of climate change in East Africa

by

Crystal Gong

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

in

Epidemiology

School of Public Health

University of Alberta

Abstract

The unprecedented impacts from climate change have been documented and are projected to continue to dramatically effect human health and wellbeing. East Africa is projected to experience an increase in average surface temperatures and decrease in precipitation levels, impacting ecosystems, food systems, and human systems. Vulnerable groups, including women and children, are projected to experience increased vulnerability to climate change. These climate-health impacts are not sex or gender neutral; understanding the sex and/ or gender dimensions of climate-health in East Africa will inform more equitable climate programming, planning, and policy. Therefore, the aim of this research was to examine the sex and gender dimensions of climate change as it relates to health in East Africa.

First, a scoping methodology was utilized to systematically search three databases. Primary research articles that focused on climatic variables and human health research in East Africa, and published between 2009 to 2018 were included in the review. Relevance screening was carried out by two independent reviewers for title and abstract screening, followed by full-text review. We summarized the nature and extent to which sex and/ or gender was or was not included in the broader climate-health literature. We found that the number of articles considering sex and/ or gender was increasing over time; however, the level of high gender engagement in these articles remained low over time in East Africa. Furthermore, we found that a high proportion of quantitative studies were incorrectly using “sex” and “gender” terms, and when sex and/or gender was considered in the study, it was typically treated as a confounder and controlled for within the statistical analysis, without examining how sex and/or gender might modify or mediate the impact of climate change on health outcomes. This represented a concerning gap in the climate-health literature since climate change is expected to perpetuate existing sex and gender-based health disparities in East Africa. Therefore, Chapter 3 aimed to begin filling this research gap, and focused on exploring how sex quantitatively matters in the context of climate change and health, by examining how the effect of weather on health outcomes varies by sex in Southwestern Uganda. A retrospective analysis was conducted using de-identified health data (2011-2014) from Bwindi Community Hospital matched to meteorological data from Kanungu District. Multivariable time-series negative binomial regression models were built and fitted to the data to explore associations between weather and hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular disease outcomes, and then separate sex models were built. Three multivariable models were built for each health outcome to descriptively compare differences in associations for models that did not consider sex, models that only examined females, and models that only examined males. Overall, the significance and magnitude of associations varied between the female and male models, and models that did not consider sex. This finding suggests that the effect of meteorological parameters on the incidence of hospital visits varies by sex across health outcomes (ie. acute gastrointestinal illness, pneumonia, and cardiovascular disease). These findings underscore the importance of considering sex and/ or gender in future climate-health research. Understanding how sex and gender impact health will be critical in informing meaningful responses to climate change.

Preface

This thesis is a compilation of an original work by Crystal Gong, under the supervision of Drs. Sherilee Harper, Shelby Yamamoto, and Yan Yuan. The research presented in this thesis is part of a larger international collaborative project called the Indigenous Health Adaptation to Climate Change (IHACC) project (www.ihacc.ca). The IHACC project is centered on long-standing collaboration and partnerships with healthcare providers, government stakeholders, non-governmental organizations, universities, and communities in Southwestern Uganda, Amazonian Peru, and Arctic Canada.

The research project of which this thesis is a part, received research approval from the Bwindi Community Hospital, and the Research Ethics Boards at the University of Guelph, McGill University, University of Leeds, and the University of Alberta (Project Name “BCH Health Data – Indigenous Health Adaptation to Climate Change”, Pro. 00090179).

No part of this thesis has been previously published.

Dedication

Written in dedication to my family and friends for weathering this storm. In loving memory of Natasha Headley (1996-2015), wherever you are I hope that sunflowers bloom.

Acknowledgements

As a Chinese Canadian settler and immigrant, I acknowledge that I was situated within, and worked towards this MSc on Treaty 6 Territory, a traditional gathering place for diverse Indigenous Peoples including the Cree, Blackfoot, Métis, Nakota Sioux, Iroquois, Dené, Ojibway/ Saulteaux/Anishinaabe, and Inuit.

Thank you to the Bwindi Community Hospital and the beautiful communities within the Kanungu District in Southwestern, Uganda. This research would not be possible without you.

My sincerest thanks to my all-female committee, Dr. Yan Yuan and Dr. Shelby Yamamoto, for your support in navigating the murky waters of my master's thesis. Your guidance and feedback have been invaluable and greatly added to my experience in academia.

A special and sincerest thank you to my supervisor, Sheri. It was a pleasure working with you starting out as an undergraduate research student at the University of Guelph! I am so incredibly lucky, grateful, and thankful that I had the chance to work with one of the most knowledgeable, supportive, and caring supervisors. I cannot thank you enough for your support these past few years, I have learned and grown so much under your mentorship.

Thank you to everyone in the Harper Lab, previous and current: Steven Lam, Laura Jane Brubacher, Kate Landry, Jacqueline Middleton, Carlee Wright, Paola Torres Slimming, Vivienne Steele, Alex Sawatzky, Jen Jones, Jamie Snook, David Borish, Amy Caughey, Matthew Pike, Danielle Julien-Wright, Sharon Edmunds-Potvin, Nia King, Julia Bryson, Andrea Valdivia, Etienne De Jongh, and Alex Nunns. Thank you to the staff, previous and current, in the Climate Change and Global Health lab: Amy Kipp, Katharine Neale, Amreen Babujee, Shaugn Coggins, Tianna Rusnak, and Breanne Aylward. To my undergraduate volunteers Maesha Elahi and Sarah Demedeiros, it was a pleasure working with you both. A special thank you to Tianna for working alongside my volunteers to screen through thousands of articles for my review.

To my mentors, Helly Goez, Jim Uniacke, and Sarah Felske, I cannot thank you enough for all the lessons that you have imparted onto me. Thank you for listening. Thank you for being interested. Thank you for continuing to believe in me.

To my friends from home, thank you for over a decade of laughter and friendship. To Ruhi Kokal, Natasha Gandhi, Jessie Liu, Anindita Marwa, Yallenni Illamvaluthy, Opeyemi Kolade, and Husna Zekria thank you for doing life with me over the past decade, and supporting me through my master's program with visits to Edmonton, the Rocky Mountains, and lengthy Facetime calls. To Ruhi and Opey, thank you for being my go-to people for journeying through the crests and troughs of life. Thank you to my dear pals from Guelph, Natalie Arnold and Kim Poung. Nat, you have been my rock since the first day of university! How the turntables with life, who would've thought that we'd both end up in Alberta at the same time? I look forward to when you are a practicing ophthalmologist, transforming the field of medicine with your passion for eyeballs! Kimmy, thank you for being the best metaphorical big sister. Thank you for making yourself available. Thank you for your consistent encouragement and support for all these years!

Thank you to my Edmontonian pals, Tiffany and the boys, for putting the "life" back into work-life balance. Thank you to my classmates at the School of Public Health, you have added to my life in so many ways, in graduate school and beyond, it has been a pleasure working and learning alongside all of you! Special shoutouts to Kai Kao, Claire Benny, Naiomi Lu, Ly Nguyen, Farideh Bagherzadeh,

Elizabeth Wishart, Sapir Fellus, and Lisa Armstrong for tolerating me in our shared classes. Thank you for showing me incredible kindness when you didn't have to.

To mom, dad, Grace, and furry friends, thank you for your continued encouragement, love, and support! You all inspire me so much, in your own, unique ways. The journey getting here was not easy and I'm incredibly grateful to have had you by my side every step of the way.

To the city of Edmonton, thank you for welcoming me with open arms. I'm so appreciative of my time spent running the trails along the River Valley, of watching the stars and Northern Lights on Elk Island, and of admiring the beautiful "squirrel-like" magpies.

The journey through this master's program was not a singular one. I am incredibly grateful and thankful to everyone that has been a part of my life in some form these past two years, thank you for adding and sharing your colour, wisdom, and strength.

This project was funded through scholarship support from the Queen Elizabeth II Scholarship at the University of Alberta, and by Prof. Sherilee Harper via grants from the Canadian Institutes of Health Research.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

THE CLIMATE CRISIS

The climate crisis will continue to have an unprecedented impact on populations worldwide (Hoegh-Guldberg et al., 2018; Watts et al., 2019). The average surface temperature has increased approximately 1^{o}C above pre-industrial levels, and at current emission rates is projected to increase 1.5^{o}C by 2030-2052 (Hoegh-Guldberg et al., 2018). At a global warming of 1.5^{o}C, the Intergovernmental Panel on Climate Change (IPCC) projects there will be unprecedented changes to natural geophysical systems including: sea level rise, increased frequency of disaster events like floods and droughts, rising water scarcity, and losses to wetland and terrestrial ecosystems (Bindoff et al., 2019; Hoegh-Guldberg et al., 2018; Oppenheimer et al., 2019). Consequences of even incremental increases in temperature and precipitation have been found to have direct and indirect impacts on human health and mental wellbeing (Cunsolo Willox et al., 2015; Harper, Edge, & Cunsolo Willox, 2012; Hoegh-Guldberg et al., 2018; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020; Watts et al., 2019). As the impacts of climate change continue to worsen, it will become increasingly important to identify and characterize the health risks posed by climate change to inform responses (Bunce & Ford, 2015; Smith et al., 2014).

OVERVIEW OF THE IMPACTS OF CLIMATE CHANGE ON HEALTH

With increasing global temperatures and unpredictable weather events, the burden of climate-sensitive health outcomes has risen and is projected to continue rising (Niang et al., 2014; Watts et al., 2019). Climate variability, weather parameters, and high impact weather events act as direct and indirect drivers of vulnerability and health risks, as visualised in **Figure 1.1** (Smith et al., 2014; Watts et al., 2015). The pathways through which climate and weather impact human health and wellbeing are interacting, complex, and mediated by the socioecological determinants of health (Smith et al., 2014).

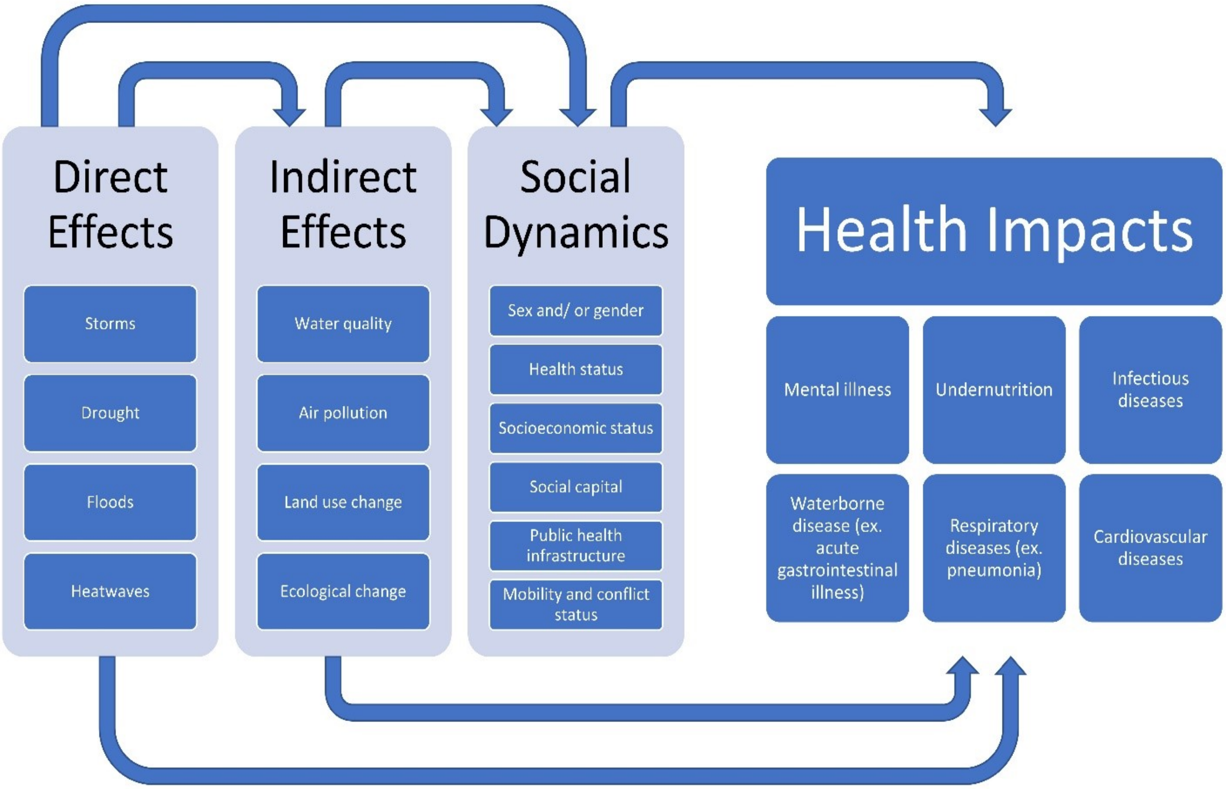


Figure 1.1 Adapted from the Lancet Commissions on Health and Climate Change (Watts et al., 2015).

Recent literature have documented links between the changing climate and the increasing burden of ill-health from vector-borne diseases, water-borne diseases, food-borne diseases, acute respiratory infections, and heat-related events (Niang et al., 2014; Takaro, Knowlton, Balmes, & Francisco, 2013; Watts et al., 2019). For example, heavy and unpredictable precipitation events, warming temperatures, and drought have been associated with increasing risk for acute gastrointestinal illness (Ghazani, Fitzgerald, Hu, Toloo, & Xu, 2018; McIver et al., 2016). Increasing air pollution, climate variability and warming have been associated with increased risk for acute respiratory infections and pneumonia (Huang et al., 2018; Sun et al., 2019; Takaro et al., 2013). Extreme temperatures and warming climates have also been shown to increase the risk of cardiovascular disease events and mortality (De Blois et al., 2015; Huang et al., 2018; Vasconcelos, Freire, Almendra, & Silva, 2013; Zhang et al., 2017). The public health impacts and effects of and by climate change have been shown to vary depending on geographical, biological, economic, social, and political factors (Hoegh-Guldberg et al., 2018; Watts et al., 2015, 2019).

VULNERABILITY AND CLIMATE CHANGE

Vulnerability within the climate-health literature is conceptualized as a function of climatic exposure-sensitivity (inherent properties of a health system and dependent on the interactions between the climatic driver and health system), and adaptive capacity (which is the ability of health systems and individuals to cope with climatic impacts) (Ford & Smit, 2004; Smit & Wandel, 2006). Climate change is a known multiplier of existing vulnerabilities, posing direct and indirect threats to health and wellbeing (Hoegh-Guldberg et al., 2018; Smith et al., 2014). Vulnerable groups – including Indigenous Peoples, women and girls, children, seniors, and socioeconomically marginalized populations – are often most at risk for negative health outcomes, and are disproportionately impacted by the negative effects of climate change (Anderson et al., 2016; Fazey et al., 2016; Kirmayer & Brass, 2016; Li & Ford, 2019; Martinez Garcia & Sheehan, 2016; Sheffield & Landrigan, 2011; Smith et al., 2014; Wang et al., 2016; Zhang et al., 2017). Many vulnerable groups already experience a high propensity for disease burden due to underlying factors related to geography, education, socioeconomic status, and health status; when combined with climatic hazards, these negative health risks and impacts are often magnified (Smith et al., 2014) (**Figure 1.2**).

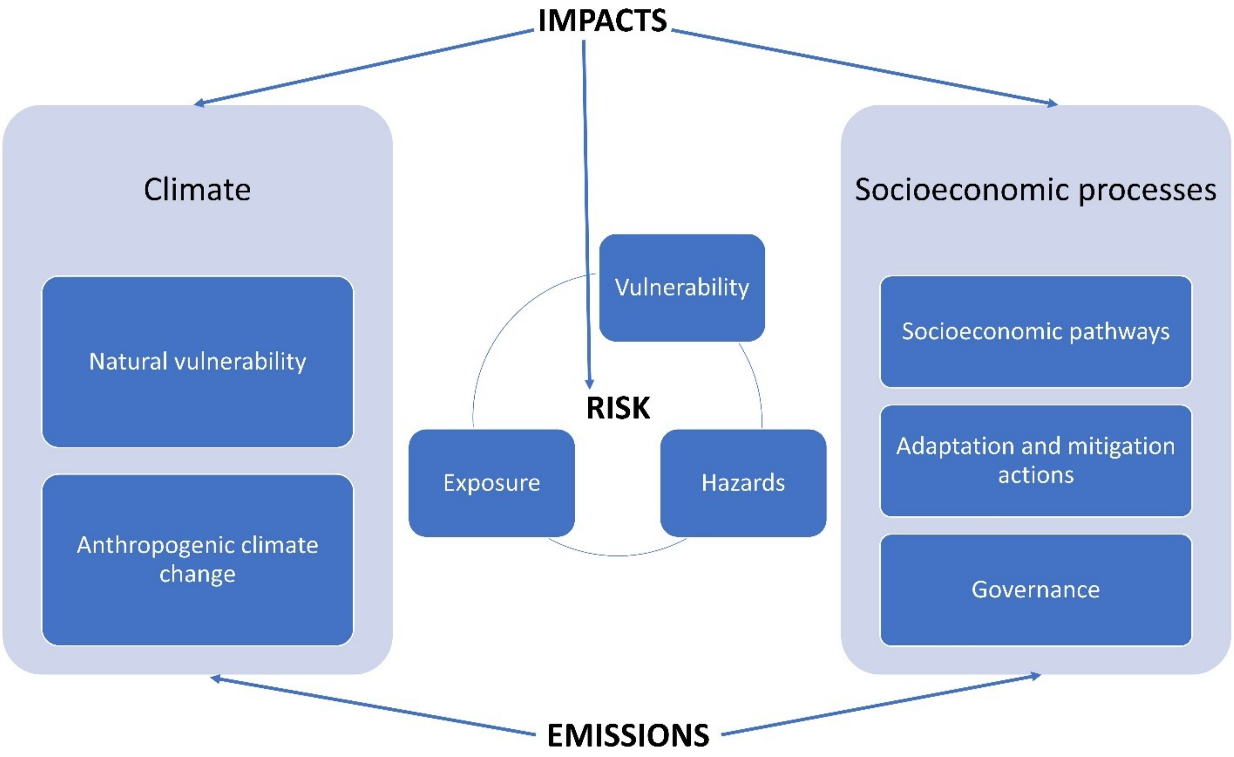


Figure 1.2 Visualization of vulnerability and climate change risks, adapted from the IPCC fifth assessment report (Smith et al., 2014).

Without considering existing and underlying vulnerability, climate change threatens to widen existing health inequities (Hoegh-Guldberg et al., 2018; Smith et al., 2014; Sorensen, Murray, Lemery, & Balbus, 2018). The direct and indirect pathways between weather and health do not occur in isolation, indeed the socioecological determinants of health intersect and interact to influence climatic impacts on health (Smith et al., 2014; Watts et al., 2015, 2019). In particular, sex and gender have emerged as key determinants within the climatic dimensions on health (Bunce & Ford, 2015; Sorensen et al., 2018; Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014a).

THE SEX AND GENDER DIMENSIONS OF CLIMATE CHANGE

1. *Sex and gender in climate change*

Within the context of climate change, sex and gender have emerged as key determinants with differing impacts on health due to underlying differences in biological vulnerability and socio-ecological vulnerability (Arora-Jonsson, 2011; Denton, 2002; Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014b). Contextualizing health vis-à-vis sex brings insights into the biological or physiological differences between women and men, while the gendered dimensions bring insights into the impacts of sociocultural roles, structures of power, social inequities, and social norms (Canadian Institutes of Health Research, 2019; Dębiak et al., 2019). The climate change literature has shown that the climatic impacts on health are not mutually exclusive to sex and/ or gender (Bee, Biermann, & Tshakhert, 2012; Bunce & Ford, 2015; Sorensen et al., 2018; van Daalen, Jung, Dhatt, & Phelan, 2020).

2. *Dimensions of sex and health in climate change*

Physiologically, climate change affects females and males through differential exposure-sensitivity pathways contributing to differing health experiences (Dębiak et al., 2019; Sorensen et al., 2018). For instance, the climate-health impacts from heatwaves demonstrate differentiating sex influences. Women are more physiologically vulnerable to the heat impacts of climate change on health due to reduced sweating dissipation capacity and higher metabolic rates, compared to males in dry heat environments who have more efficient sweating capacity and lower core body temperatures (Druyan et al., 2012; Yanovich, Ketko, & Charkoudian, 2020). Understanding the complex interplay between environmental drivers and health brings insights into the differentiating impacts due to biological vulnerabilities, and can help researchers, government stakeholders, policymakers, and communities develop more well-informed responses, policy, and programming to mitigate gaps in health equity within larger climate adaptation strategy (Smith et al., 2014; Sorensen et al., 2018).

3. *Dimensions of gender and health in climate change*

The United Nations Framework Convention on Climate Change identified gender as a key component to meaningful climate adaptation and response (United Nations Framework Convention for Climate Change, n.d.). Gender engagement within policy development has been identified as a key component to fair and equitable climate change adaptation (Bee et al., 2012). Women's gendered experiences have been the focus of discussions on the gendered dimensions of climate change; women tend to have access to less economic resources, are less likely to access healthcare services, have more caregiving responsibilities, and lack social power (Bee et al., 2012; Sorensen et al., 2018; Vincent et al., 2014b). The climate change discourse has been noted to lack discussion on the health experiences of males (Bunce & Ford, 2015), who have also been noted to experience gendered vulnerabilities, such as experiencing more exposure to occupational hazards and carcinogens (Landrigan et al., 2017). While gender has emerged as a key component to climate-response and adaptation, the application of gender-engagement within policy remains low (Preet, Nilsson, Schumann, & Evengård, 2010); marginalized voices, including women's voices, are not represented during climate negotiations for mitigation and adaptation (van Daalen et al., 2020).

4. *Why should we consider sex and gender?*

Understanding and considering sex and/ or gender within health research has lead to novel discoveries and therapeutic interventions, and contributes to more rigorous science (Day, Mason, Lagosky, & Rochon, 2016; Johnson, Sharman, Vissandje, & Stewart, 2014; Ristvedt, 2014; Schiebinger & Stefanick, 2016). Not considering sex and/ or gender creates notable gaps in knowledge, and within the context of climate change contributes to widening gaps in health and gender equity (Bee et al., 2012; Day et al., 2016; Vincent et al., 2014b). Exploring, investigating, and understanding how climate-health impacts are differentiated by sex and gender will bridge gaps in gender and health equity, and allow for the development of more focused and effective mitigation and adaptation responses to climate change ("Gender in conservation and climate policy," 2019; van Daalen et al., 2020). The move towards a sustainable future via climate-resilient development pathways includes forming mitigation and adaptation strategies that recognize the relationships between weather, human, and socio-ecological systems, and considers the central tenets of equity, health, and well-being (Denton et al., 2014).

FOCUSING ON HEALTH IN EAST AFRICA AND UGANDA

Examining the sex and gender dimensions of climate-health are particularly important in regions experiencing intersecting and multiplied effects of climate change vulnerability. Specifically low income regions, including the Eastern Africa regions of Sub-Saharan Africa, are particularly vulnerable due to existing higher burdens of disease, disproportionate exposure to climate change, low-resource settings, and limited health infrastructure (Niang et al., 2014; Wang et al., 2016).

Over the next century, the average temperature in Africa is projected to increase at a faster rate than the global average (James, Washington, Rowell, & James, 2013; Sanderson et al., 2011). Average surface temperatures in Sub-Saharan Africa are projected to exceed 2°C by the end of this century, amplifying existing stresses on ecosystems, water systems, and food systems (Niang et al., 2014). Equatorial and southern regions of East Africa have already experienced significant increases in average temperature, with decreasing levels of precipitation since the 1980s (Anyah & Qiu, 2012; Gebrechorkos, Hülsmann, & Bernhofer, 2019; Souverijns, Thiery, Demuzere, & Lipzig, 2016). The Southwestern region of Uganda was identified as one of the fastest warming regions within Uganda, with an increase of 0.3°C per decade since the 1980s (Chris, Jim, Gary, & Libby, 2012; Magrath, 2008), and future projections indicate continued increases in average surface temperatures over this century (Egeru et al., 2019; Funk et al., 2018; Niang et al., 2014).

Recognizing that climate change is a multiplier of existing intersecting vulnerabilities, regions within Africa have begun incorporating gender-mainstreaming within climate response to develop more equitable approaches to climate change adaptation (Niang et al., 2014). For instance, Uganda has identified gender mainstreaming as an important consideration for natural resource policy within the context of climate change (Ampaire et al., 2017; Kisauzi, Mangheni, Sseguya, & Bashaasha, 2012). Notably, climate change research and policies emerging from Uganda have identified connections between climate, natural resources, and food systems on sex, gender, and health (Ampaire et al., 2017; Balikoowa, Nabanoga, Tumusiime, & Mbogga, 2019; Kisauzi et al., 2012). While sex and gender have received interest in the climate literature, few studies have summarized the scope of the sex and gendered dimensions of the current climate-health literature in East Africa or quantitatively explored the associations between sex, weather, and health in Uganda.

THESIS RESEARCH GOAL AND OBJECTIVES

This thesis is part of a larger collaborative research program in partnership with community partners, government stakeholders, researchers, and healthcare professionals, called the Indigenous Health Adaptation to Climate Change (IHACC) project. Partners and members of the IHACC team are located in Peru, Inuit Nunangat, and Uganda. Within the contextual background of Uganda, the research described in this thesis was collected in partnership with the Bwindi Community Hospital located in Southwestern Uganda. Bwindi Community Hospital is located in the Kanungu District in Southwestern Uganda. Kanungu District borders the Democratic Republic of Congo and Rwanda. The majority of the population are Bakiga, while a minority are Indigenous Batwa. Those living in Bwindi in Kanungu District are served by the Bwindi Community Hospital, serving a population of 100,000 people (Bwindi Community Hospital, 2014).

This thesis research is situated at the intersection of sex, gender, weather, and health, to explore the sex and gendered dimensions of climate change in East Africa and Uganda. The aim of my research project was to summarize and examine the sex and gendered dimensions of climate change as it related to health in East Africa. Specifically, the objectives of this research were to:

1. Summarize the nature and extent of current climate-health published research in East Africa using a sex and gender-based analysis (Chapter 2); and
2. Quantitatively explore the relationship between sex, meteorological variables, and hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular disease in Bwindi Community Hospital in Bwindi, Uganda (Chapter 3).

References

Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L., & van Asten, P. (2017). Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science and Policy*, *75*(October 2016), 81–90. https://doi.org/10.1016/j.envsci.2017.05.013

Anderson, I., Robson, B., Connolly, M., Al-Yaman, F., Bjertness, E., King, A., … Yap, L. (2016). Indigenous and tribal peoples' health (The Lancet-Lowitja Institute Global Collaboration): a population study. *The Lancet*, *388*(10040), 131–157. https://doi.org/10.1016/S0140-6736(16)00345-7

Anyah, R. O., & Qiu, W. (2012). Characteristic 20th and 21st century precipitation and temperature patterns and changes over the Greater Horn of Africa. *International Journal of Climatology*, *363*(January 2011), 347–363. https://doi.org/10.1002/joc.2270

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. https://doi.org/10.1016/j.gloenvcha.2011.01.005

Balikoowa, K., Nabanoga, G., Tumusiime, D. M., & Mbogga, M. S. (2019). Gender differentiated vulnerability to climate change in Eastern Uganda. *Climate and Development*, *11*(10), 839–849. https://doi.org/10.1080/17565529.2019.1580555

Bee, B., Biermann, M., & Tshakhert, P. (2012). Gender, Development, and Rights-Based Approaches: Lessons for Climate Change Adaptation and Adaptive Social Protection. In M. Alston & K. Whittenbury (Eds.), *Research, Action and Policy: Addressing the Gendered Impacts of Climate Change* (pp. 95–108). Dordrecht: Springer.

Bindoff, N. L., Cheung, W. W. L., Kairo, J. G., Arístegui, J., Guinder, V. A., Hallberg, R., … Williamson, P. (2019). Changing Ocean, Marine Ecosystems, and Dependent Communities. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, … N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*.

Bunce, A., & Ford, J. (2015). How is adaptation , resilience , and vulnerability research engaging with gender ? *Environmental Research Letters*, *10*(12). https://doi.org/10.1088/1748-9326/10/12/123003

Bwindi Community Hospital. (2014). Bwindi Community Hospital & Uganda Nursing School Bwindi: UCU affiliate annual report 2013/2014. Retrieved from http://www.bwindihospital.com/pdf/Annual report 2013-2014.pdf

Canadian Institutes of Health Research. (2019). How to integrate sex and gender into research. Retrieved May 1, 2020, from https://cihr-irsc.gc.ca/e/50836.html

Chris, F., Jim, R., Gary, E., & Libby, W. (2012). *Famine Early Warning Systems Network—Informing Climate Change Adaptation Series A Climate Trend Analysis of Uganda*.

Cunsolo Willox, A., Stephenson, E., Allen, J., Bourque, F. F., Drossos, A., Elgarøy, S., … Wexler, L. (2015). Examining relationships between climate change and mental health in the Circumpolar North. *REGIONAL ENVIRONMENTAL CHANGE*, *15*(1), 169–182. https://doi.org/10.1007/s10113-014-0630-z

Day, S., Mason, R., Lagosky, S., & Rochon, P. A. (2016). Integrating and evaluating sex and gender in health research. *Health Research Policy and Systems*, *14*(1), 1–5. https://doi.org/10.1186/s12961-016-0147-7

De Blois, J., Kjellstrom, T., Agewall, S., Ezekowitz, J. A., Armstrong, P. W., & Atar, D. (2015). The Effects of Climate Change on Cardiac Health. *Cardiology*, *131*(4), 209–217. https://doi.org/10.1159/000398787

Dębiak, M., Groth, K., Kolossa-Gehring, M., Sauer, A., Tobollik, M., & Wintermeyer, D. (2019). Sex and gender approaches in environmental health research: two exemplary case studies of the German environment agency. *Interdisciplinary Science Reviews*, *44*(2), 114–130. https://doi.org/10.1080/03080188.2019.1603860

Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gender and Development*, *10*(2), 10–20. https://doi.org/10.1080/13552070215903

Denton, F., Wilbanks, T. J., Abeysinghe, A. C., Burton, I., Gao, Q., Lemos, M. C., … Warner, K. (2014). Climate-resilient pathways: Adaptation, mitigation, and sustainable development. In C. B. Field, V. R. Barros, D. . J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L.White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1101–1131). https://doi.org/10.1017/CBO9781107415379.025

Druyan, A., Makranz, C., Moran, D., Yanovich, R., Epstein, Y., & Heled, Y. (2012). Heat tolerance in women-Reconsidering the criteria. *Aviation Space and Environmental Medicine*, *83*(1), 58–60. https://doi.org/10.3357/ASEM.3130.2012

Egeru, A., Barasa, B., Nampijja, J., Siya, A., Makooma, M. T., & Majaliwa, M. G. J. (2019). Past, present and future climate trends under varied representative concentration pathways for a sub-humid region in Uganda. *Climate*, *7*(3). https://doi.org/10.3390/cli7030035

Fazey, I., Wise, R. M., Lyon, C., Câmpeanu, C., Moug, P., & Davies, T. E. (2016). Past and future adaptation pathways. *Climate and Development*, *8*(1), 26–44. https://doi.org/10.1080/17565529.2014.989192

Ford, J. D., & Smit, B. (2004). A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. *Arctic*, *57*(4), 389–400. https://doi.org/10.14430/arctic516

Funk, C., Harrison, L., Shukla, S., Pomposi, C., Galu, G., Korecha, D., … Verdin, J. (2018). Examining the role of unusually warm Indo-Pacific sea-surface temperatures in recent African droughts. *QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY*, *144*(1), 360–383. https://doi.org/10.1002/qj.3266

Gebrechorkos, S. H., Hülsmann, S., & Bernhofer, C. (2019). Long-term trends in rainfall and temperature using high-resolution climate datasets in East Africa. *Scientific Reports*, *9*(11376), 1–9. https://doi.org/10.1038/s41598-019-47933-8

Gender in conservation and climate policy. (2019). *Nature Climate Change*, *9*(4), 255. https://doi.org/10.1038/s41558-019-0448-2

Ghazani, M., Fitzgerald, G., Hu, W., Toloo, G. S., & Xu, Z. (2018). Temperature variability and gastrointestinal infections: A review of impacts and future perspectives. *International Journal of Environmental Research and Public Health*, *15*(4). https://doi.org/10.3390/ijerph15040766

Harper, S. L., Edge, V. L., & Cunsolo Willox, A. (2012). “Changing climate, changing health, changing stories” profile: Using an EcoHealth approach to explore impacts of climate change on inuit health. *EcoHealth*, *9*(1), 89–101. https://doi.org/10.1007/s10393-012-0762-x

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., … Zhou, G. (2018). Impacts of 1.5^{o}C Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, … T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*.

Huang, C., Cheng, J., Phung, D., Tawatsupa, B., Hu, W., & Xu, Z. (2018). Mortality burden attributable to heatwaves in Thailand: A systematic assessment incorporating evidence-based lag structure. *Environment International*, *121*, 41–50. https://doi.org/10.1016/j.envint.2018.08.058

James, R., Washington, R., Rowell, D. P., & James, R. (2013). Implications of global warming for the climate of African rainforests. *Philosophical Transactions of the Royal Society B*, *368*.

Johnson, J., Sharman, Z., Vissandje, B., & Stewart, D. E. (2014). Does a Change in Health Research Funding Policy Related to the Integration of Sex and Gender Have an Impact? *PloS One*, *9*(6). https://doi.org/10.1371/journal.pone.0099900

Kirmayer, L. J., & Brass, G. (2016). Addressing global health disparities among Indigenous peoples. *The Lancet*, *388*(10040), 105–106. https://doi.org/10.1016/S0140-6736(16)30194-5

Kisauzi, T., Mangheni, M. N., Sseguya, H., & Bashaasha, B. (2012). Gender dimensions of farmer's perceptions and knowledge on climate change in Teso sub-region, Eastern Uganda. *African Crop Science Journal*, *20*(2), 443–451. https://doi.org/10.4314/acsj.v20i2

Landrigan, P. J., Fuller, R., Acosta, N. J. R., Adeyi, O., Arnold, R., Basu, N. (Nil), … Zhong, M. (2017). The Lancet Commission on pollution and health. *The Lancet*, *391*(10119), 462–512. https://doi.org/10.1016/S0140-6736(17)32345-0

Li, A., & Ford, J. (2019). Understanding Socio-Ecological Vulnerability to Climatic Change through a Trajectories of Change Approach : A Case Study from an Indigenous Community in Panama. *Weather Climate and Society*, *11*, 577–593. https://doi.org/10.1175/WCAS-D-18-0093.1

Magrath, J. (2008). Turning up the Heat: Climate Change and Poverty in Uganda. *Oxfam Policy and Practice: Agriculture, Food and Land*, *8*, 96–125.

Martinez Garcia, D., & Sheehan, M. C. (2016). Extreme weather-driven disasters and children's health. *International Journal of Health Services*, *46*(1), 79–105. https://doi.org/10.1177/0020731415625254

McIver, L., Kim, R., Woodward, A., Hales, S., Spickett, J., Katscherian, D., … Ebi, K. L. (2016). Health impacts of climate change in pacific island countries: A regional assessment of vulnerabilities and adaptation priorities. *Environmental Health Perspectives*, *124*(11), 1707–1714. https://doi.org/10.1289/ehp.1509756

Middleton, J., Cunsolo, A., Jones-Bitton, A., Wright, C. J., & Harper, S. L. (2020). Indigenous mental health in a changing climate: A systematic scoping review of the global literature. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/ab68a9

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). IPCC fifth assessment report. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 1199–1266). Cambridge University Press. https://doi.org/10.1017/CBO9781107415386.002

Oppenheimer, M., Glavovic, B. C., Hinkel, J., Wal, R. van de, Magnan, A. K., Abd-Elgawad, A., … Sebesvari, Z. (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, … N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*.

Preet, R., Nilsson, M., Schumann, B., & Evengård, B. (2010). The gender perspective in climate change and global health. *Global Health Action*, *3*(1), 5720. https://doi.org/10.3402/gha.v3i0.5720

Ristvedt, S. L. (2014). The evolution of gender. *JAMA Psychiatry*, *71*(1), 13–14. https://doi.org/10.1001/jamapsychiatry.2013.3199

Sanderson, B. M., Neill, B. C. O., Kiehl, J. T., Meehl, G. A., Knutti, R., & Washington, W. M. (2011). The response of the climate system to very high greenhouse gas emission scenarios. *Environmental Research Letters*, *6*(034005). https://doi.org/10.1088/1748-9326/6/3/034005

Schiebinger, L., & Stefanick, M. L. (2016). Gender Matters in Biological Research and Medical Practice. *Journal of the American College of Cardiology*, *67*(2), 2–4.

https://doi.org/10.1016/j.jacc.2015.11.029

Sheffield, P. E., & Landrigan, P. J. (2011). Global climate change and children’s health: Threats and strategies for prevention. *Environmental Health Perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Smith, K. R., Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., … Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 709–754). Cambridge, UK and New York City, USA: Cambridge University Press.

Sorensen, C., Murray, V., Lemery, J., & Balbus, J. (2018). Climate change and women’s health: Impacts and policy directions. *PLoS Medicine*, *15*(7), 1–10. https://doi.org/10.1371/journal.pmed.1002603

Souverijns, N., Thiery, W., Demuzere, M., & Lipzig, N. P. M. Van. (2016). Drivers of future changes in East African precipitation Drivers of future changes in East African precipitation. *Environmental Research Letters*, *11*(11).

Sun, S., Tian, L., Cao, W., Lai, P. C., Wong, P. P. Y., Lee, R. S. yin, … Wong, C. M. (2019). Urban climate modified short-term association of air pollution with pneumonia mortality in Hong Kong. *Science of the Total Environment*, *646*, 618–624. https://doi.org/10.1016/j.scitotenv.2018.07.311

Takaro, T. K., Knowlton, K., Balmes, J., & Francisco, S. (2013). Climate change and respiratory health : current evidence and knowledge gaps. *Expert Review of Respiratory Medicine*, *7*(4), 349–361. https://doi.org/10.1586/17476348.2013.814367

United Nations Framework Convention for Climate Change. (n.d.). Introduction to gender and climate change. Retrieved June 19, 2020, from https://unfccc.int/gender

van Daalen, K., Jung, L., Dhatt, R., & Phelan, A. L. (2020). Climate change and gender-based health disparities. *The Lancet Planetary Health*, *4*(2), e44–e45. https://doi.org/10.1016/S2542-5196(20)30001-2

Vasconcelos, J., Freire, E., Almendra, R., & Silva, G. L. (2013). The impact of winter cold weather on acute myocardial infarctions in Portugal. *Environmental Pollution*, *183*, 14–18. https://doi.org/10.1016/j.envpol.2013.01.037

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014a). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *IPCC Fifth Assessment Report* (Vol. 1999, pp. 101–103).

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014b). Cross-chapter box on gender and climate change. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 105–107).

Wang, H., Naghavi, M., Allen, C., Barber, R. M., Carter, A., Casey, D. C., … Zuhlke, L. J. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., … Costello, A. (2015). Health and climate change: policy responses to protect public health. *The Lancet*, *386*(10006), 1861–1914. https://doi.org/https://dx.doi.org/10.1016/S0140-6736(15)60854-6

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., … Montgomery, H. (2019). The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, *394*(10211), 1836–1878. https://doi.org/10.1016/S0140-6736(19)32596-6

Yanovich, R., Ketko, I., & Charkoudian, N. (2020). Sex differences in human thermoregulation: Relevance for 2020 and beyond. *Physiology*, *35*(3), 177–184. https://doi.org/10.1152/physiol.00035.2019

Zhang, Y., Feng, R., Wu, R., Zhong, P., Tan, X., Wu, K., & Ma, L. (2017). Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. *Global Health Research and Policy*, *2*(1), 1–9. https://doi.org/10.1186/s41256-017-0030-2

Chapter 2: How are sex and gender considered in climate change and health research in East Africa? A systematic scoping review

Crystal Gong[1], Shelby S. Yamamoto[1], Yan Yuan[1], Lea Berrang-Ford[2,3] Shuaib Lwasa[3,4], Didacus Namanya[3,5], IHACC Research Team[3], Sherilee L. Harper[1,3]

1. School of Public Health, University of Alberta, Edmonton, Canada
2. Priestley International Centre for Climate, University of Leeds, Leeds, United Kingdom
3. Indigenous Health Adaptation to Climate Change Research Group: James Ford, Cesar Carcamo, Patricia Garcia, Victoria Edge
4. Department of Geography Geo-Informatics and Climatic Sciences, School of Forestry, Environmental and Geographical Sciences, College of Agricultural and Environmental Sciences, Makerere University, Kampala, Uganda
5. Ministry of Health, Kampala, Uganda

Abstract

Background: Sex and gender are often considered to be prominent determinants of health in the context of climate change. However, the extent to which sex and gender are considered in climate change and health research is unclear, particularly in regions with heightened exposure and vulnerability to climate change, such as East Africa. This review asks: What is the extent and nature of sex and gender considerations in the climate change and health literature in East Africa? The objective of this review was to identify, describe, and summarize the extent that published climate-health research considered sex and/ or gender within East Africa.

Methods: Using a systematic scoping review approach, we searched PubMed MEDLINE®, Web of Science™, and EMBASE® to identify articles that examined human health and climatic variables in East African countries published from 2009-2018. We first summarized the extent to which sex and/ or gender was or was not included in the broader climate-health literature. Then, a sub-analysis was conducted on articles that did consider sex and/ or gender, characterizing the nature of sex and/or gender considerations.

Results: A total of 248 articles met the inclusion criteria and were included in the review. Of these articles, 167 articles considered sex and/ or gender. Climate-health articles were increasingly considering sex and/ or gender over time. Many articles used the terms “sex” and “gender” incorrectly and interchangeably (n=75; 44.9%). Most articles were categorized as engaging with gender at low levels (n=132; 86.8%), with very few articles engaging with gender at high levels (n=6 articles; 3.6%); articles scored higher in gender engagement provided recommendations to reduce health inequities while articles that scored low merely stated associations between gender and climate-health. Over time there was an increase in the frequency of articles that scored low and moderate in gender engagement, and a decrease in articles that scored high in gender engagement.

Conclusions: Improving the low levels of gender engagement in climate change and health research should become a top priority for research, given the urgent need for this evidence to inform more relevant and equitable climate change policy and practice.

Keywords

Sex, gender, climate change, health, vulnerability, equity, East Africa

Introduction

Climate change threatens to widen existing health gaps and multiply existing vulnerabilities (Hoegh-Guldberg et al., 2018; Sorensen, Murray, Lemery, & Balbus, 2018). Groups disproportionately burdened by the impacts of climate change – women and girls, children, seniors, Indigenous Peoples, and socioeconomically marginalized populations – are also often most at risk for adverse health outcomes (Anderson et al., 2016; Fazey et al., 2016; Kirmayer & Brass, 2016; Li & Ford, 2019; Martinez Garcia & Sheehan, 2016; Sheffield & Landrigan, 2011; Wang et al., 2016; Zhang et al., 2017). In particular, sex and gender have emerged as prominent determinants of health within the context of a changing climate (Bunce & Ford, 2015; Hoegh-Guldberg et al., 2018; Sorensen et al., 2018; Zhang et al., 2017).

The health impacts of climate change are not sex- or gender-neutral (Ampaire et al., 2020; Hoegh-Guldberg et al., 2018; Sorensen et al., 2018; Zhang et al., 2017). The direct and indirect pathways through which climate change impacts health often differ by sex and gender; indeed, climate change exposure, sensitivity, and adaptive capacities are often mediated by sociocultural, economic, and physiologic differences (Sorensen et al., 2018). For instance, differential impacts of climate change on health by sex and gender are often demonstrated during heatwaves. Biologically, men in dry heatwaves experience lower core temperatures and more effective sweating capacity versus women who experience a higher working metabolic rate and reduced sweat dissipation (Druyan et al., 2012; Yanovich, Ketko, & Charkoudian, 2020). Meanwhile gendered impacts of heatwaves include differential impacts on males often through increased outdoor occupational exposures compared to females with often poorer access to healthcare and cooling facilities (Sorensen et al., 2018; Watts et al., 2019). Therefore, understanding climate-sensitive health outcomes vis-a-vis sex brings insight into to biological and physiological differences (Dębiak et al., 2019), whereas understanding the gendered dimensions of climate change brings insight into how social roles, structural and social inequities, power dynamics, and sociocultural norms impact health (Dębiak et al., 2019). Climate-health research is increasingly calling for the consideration of sex and gender implications in order to understand underlying climate change vulnerability and develop focused and equitable climate change planning, decision-making, and policy (Bunce & Ford, 2015; Dębiak et al., 2019; Dymén, Andersson, & Langlais, 2013).

These sex and gender dimensions of climate change impacts on health are particularly important in regions with greater underlying vulnerability to climate change. For instance, climate change threatens to widen the existing gaps in health equity globally, but particularly in lower to middle income countries (Hutchins et al., 2018; Thomas & Twyman, 2005). Low-income regions, such as the East African region of Sub-Saharan Africa, are particularly vulnerable to and disproportionately impacted by the effects of climate change due to factors such as geography, conflict, low resource settings, existing high burdens of disease, and limited health infrastructure (Niang et al., 2014; Wang et al., 2016) – factors which are not sex- or gender-neutral.

Literature reviews have been conducted on the sex and/or gendered nature of climate change without considering health impacts (Bunce & Ford, 2015; Moosa & Tuana, 2014; Patel, Asia, & Mathew, 2020), as well as the gender and sex dimensions of health without considering climate change (Oksuzyan, Juel, Vaupel, & Christensen, 2008; Smith, Bessette, Weinberger, Sheffer, & Mckee, 2016). Less work, however, has examined where these topics intersect to review the climate change, sex, gender, and health nexus, and no reviews have been conducted on this nexus for East Africa, a region highly vulnerable to climate change. We fill this research gap by asking the research question: What is the extent and nature of sex and gender considerations in the literature on climatic variables and health in East Africa? This review advances our current understanding of the sex and gender dimensions of climate change and health in East Africa by summarizing and synthesizing the climate-health research landscape and identifying research gaps.

Methods

A scoping review approach was used to systematically and transparently map the published literature on climate-sensitive health outcomes in East Africa. The scoping review protocol was developed *a priori* for transparency and replicability. The review framework was guided by scoping methodology defined by Arksey & O'Malley (Arksey & O'Malley, 2005) and was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018).

SEARCH STRATEGY

An inclusive search string was developed in consultation with a research librarian to capture a multidisciplinary coverage of health, biomedical, and natural science literature in the following databases: PubMed MEDLINE®, Web of Science™, and EMBASE® (**Table 2.1**). Place terms were collated from a list of countries within East Africa identified by the United Nations based on Statistical Divisions ("Geographic Region," n.d.). Climatic and hazards terms were adapted from previously published climate-health literature reviews (Bryson et al., 2020; Lam et al., 2019; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020). Health terms were developed based on published literature on climate-sensitive health outcomes (Herlihy et al., 2016; Watts et al., 2018). Date restrictions were applied from all research databases for articles published online from January 1, 2009 – December 31, 2018 to capture recent articles published in the last ten years. Language restrictions were not placed on the searches; however, terms were entered in English. Due to limited resources publications that met inclusion criteria for full text screening, and not written in English or French were excluded. The databases were searched on June 21, 2019.

Table 2.1 Search string used in Medline® database and adapted to other databases to identify climate-health articles specific to East Africa published between 2009-2018.

Variable	Search String
Location	((East* Africa*) OR (British Indian Ocean) OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR (French Southern Territories) OR Kenya OR Madagascar OR Malawi OR

	Mauritius OR Mayotte OR Mozambique OR (Reunion island) OR Rwanda OR Seychelles OR Somalia OR (South Sudan) OR Tanzania OR Uganda OR Zambia OR Zimbabwe) **AND**
Climatic variable/ hazard	((climate chang*) OR (climatic chang*) OR (climate variability) OR (climatic variability) OR (weather variability) OR (climate extreme*) OR (global warming) OR weather* OR storm* OR temperature* OR flood* OR drought* OR (sea level rise) OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR (forest fire*) OR (wildfire*) OR humid* OR season* OR (el nino) OR (la nina)) **AND**
Health outcome	(health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR (well-being) OR (well being) OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*)

DATA MANAGEMENT AND SCREENING ELIGIBILITY

Citations were uploaded into Mendeley® (Version 1.19.4), which was utilized for citation management, as well as automatic and manual reference de-duplication. Next, de-duplicated references were uploaded into systematic review software DistillerSR© (Evidence Partners, Ottawa, Canada) for a two-staged screening process conducted by two independent reviewers. Independent reviewers screened titles and abstracts for Level 1 screening using a stacked screening form. In Level 1, the second reviewer confirmed exclusion of the article. Potentially relevant articles proceeded to Level 2 screening. In Level 2 screening, two independent reviewers screened the full text of each article. To be included, articles had to discuss health outcomes related to human health; focus on climate change and/or a climate hazard; focus on countries in East Africa; be a published primary research article; and be published online from 2009-2018. Health was defined as “a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity” (“WHO Constitution,” 1946). Climate change was defined as “a change in the state of the climate that can be identified by changes in the mean and/ or variability of its properties and that persists for an extended period" (Hoegh-Guldberg et al., 2018). Climate hazards were defined as the "potential occurrence of a natural…[or weather] event that may cause loss of life, injury, or other health impacts" (Hoegh-Guldberg et al., 2018). Countries within East Africa were classified based on the United Nations' Statistical Divisions ("Geographic Region," n.d.). Reviewers met throughout the screening process to resolve conflicts related to study selection.

DATA EXTRACTION AND ANALYSIS

Articles that met inclusion criteria were analysed and included in the scoping review. One independent reviewer manually extracted the following data from articles using DistillerSR©: year of online publication, study region(s), study methodology, climatic variable(s) and/ or hazard(s), health outcome(s), and whether sex and/ or gender was considered in the study.

We first examined the extent to which sex and/or gender was included in the broader climate-health literature in East Africa. This enabled us to calculate the proportion of climate-health articles that considered sex and/ or gender in the study (i.e. the count of climate-health articles that considered sex and/ or gender divided by the count of all climate-health articles), stratified by publication year, location of research, type of research, health outcome, and climatic focus of the article. Thus, articles did not have to consider sex and/or gender to be included in the review.

Then, a sub-analysis was conducted on articles that did consider sex and/ or gender, exploring the nature of sex and/or gender considerations. These articles were evaluated against the sex and gender equity in research (SAGER) guidelines (Heidari, Babor, De Castro, Tort, & Curno, 2016). This involved assessing whether articles used the terms "sex" and "gender" correctly, differentiated study participants by sex and/ or gender, and evaluated whether articles followed the SAGER reporting guidelines for each section of the article (i.e. title/ abstract, introduction, methods, results, and discussion sections). Additionally, we also coded articles using a gender assessment rubric developed by Bunce et al. (2015) to evaluate the extent to which gender engagement was considered in the article (**Table 2.2**). This involved calculating an engagement index, which was comprised of a nine-point scale that was equally weighted to identify whether the climate-health article had "high," "medium," or "low" levels of gender engagement (Bunce & Ford, 2015). Articles that were classified as "high level of engagement" had to score between seven to nine points; "medium level of engagement" scored between four to six points; and "low level of engagement" scored between zero and three points (Bunce & Ford, 2015). Descriptive statistics were conducted in STATA® (Version 15) and Microsoft Excel® (2016) to summarize the extracted information and examine trends in sex and/ or gender considerations in the climate-health literature.

Table 2.2 Summary of the gender engagement rubric used to grade climate-health articles that met the sex and/ or gender inclusion criteria adapted from Bunce & Ford (2015).

Attributes and components	**Question**	**Total Section Score**
1. Gender-mainstreaming: extent to which gender concepts are being applied to the health and climate literature in East Africa (Total 3 points)		
Gender-sensitive	• Is there explicit recognition of the different needs and experiences by gender? • Are there objectives, actions, and/ or indicators that aim to reduce gender disparities? • Is gender-sensitive language used?	Presence: score 1 Absence: score 0 *Articles had to have evidence of gender-sensitivity to receive a total score of 1.*
Gender-responsive	• Are the research findings presented in a gender-disaggregated manner? • Do progress indicators measure the different impacts experienced by each gender? • Are there recommendations or evidence of equal participation in decision making processes by all genders?	Presence: score 1 Absence: score 0 *Articles had to have evidence of gender-responsiveness to receive a total score of 1.*
Gender-transformative	• Does the research critically analyze social values, organizational practices, and goals? • Does the research promote the rethinking of social structures of power as they relate to gender?	Presence: score 1 Absence: score 0 *Articles had to have evidence of gender-transformativeness to receive a total score of 1.*
2. Experience of gender: extent to which the specific needs of different genders are acknowledged and addressed throughout the research processes (Total 3 points)		
Practical needs	• Does the research focus on improving the practical and differentiated needs each gender experiences within current gender norms?	Presence: score 1 Absence: score 0 *Articles had to have evidence of practical needs to receive a total score of 1.*

Strategic needs	- Does the research aim to reduce gender inequality through a re-evaluation of power distribution/ social roles and responsibilities/ legal rights?	Presence: score 2 Absence: score 0 *Articles had to have evidence of strategic needs to receive a total score of 2.*
3. Degree of action: extent of action being taken to reduce gender inequality in climate-health research processes (Total 3 points)		
Statements of recognition	- Does the paper acknowledge that a relationship exists between gender and climate-health research?	Presence: score 1 Absence: score 0 *Articles had to have evidence of statements of recognition to receive a total score of 1.*
Groundwork	- Are recommendations made that would reduce gender inequality in climate-health research? - Are recommendations made that aim to reduce gender inequality in climate-health research?	Presence: score 1 Absence: score 0 *Articles had to have evidence of groundwork to receive a total score of 1.*
Action	- Does the paper describe concrete actions that have been taken or are being taken to reduce gender inequality in climate-health research?	Presence: score 1 Absence: score 0 *Articles had to have evidence of action to receive a total score of 1.*
Total Gender Engagement Score: 9 points		

Results

A total of 13,704 citations were retrieved from the database searches (**Figure 2.1**). A total of 248 articles met the inclusion criteria and were included in the analysis.

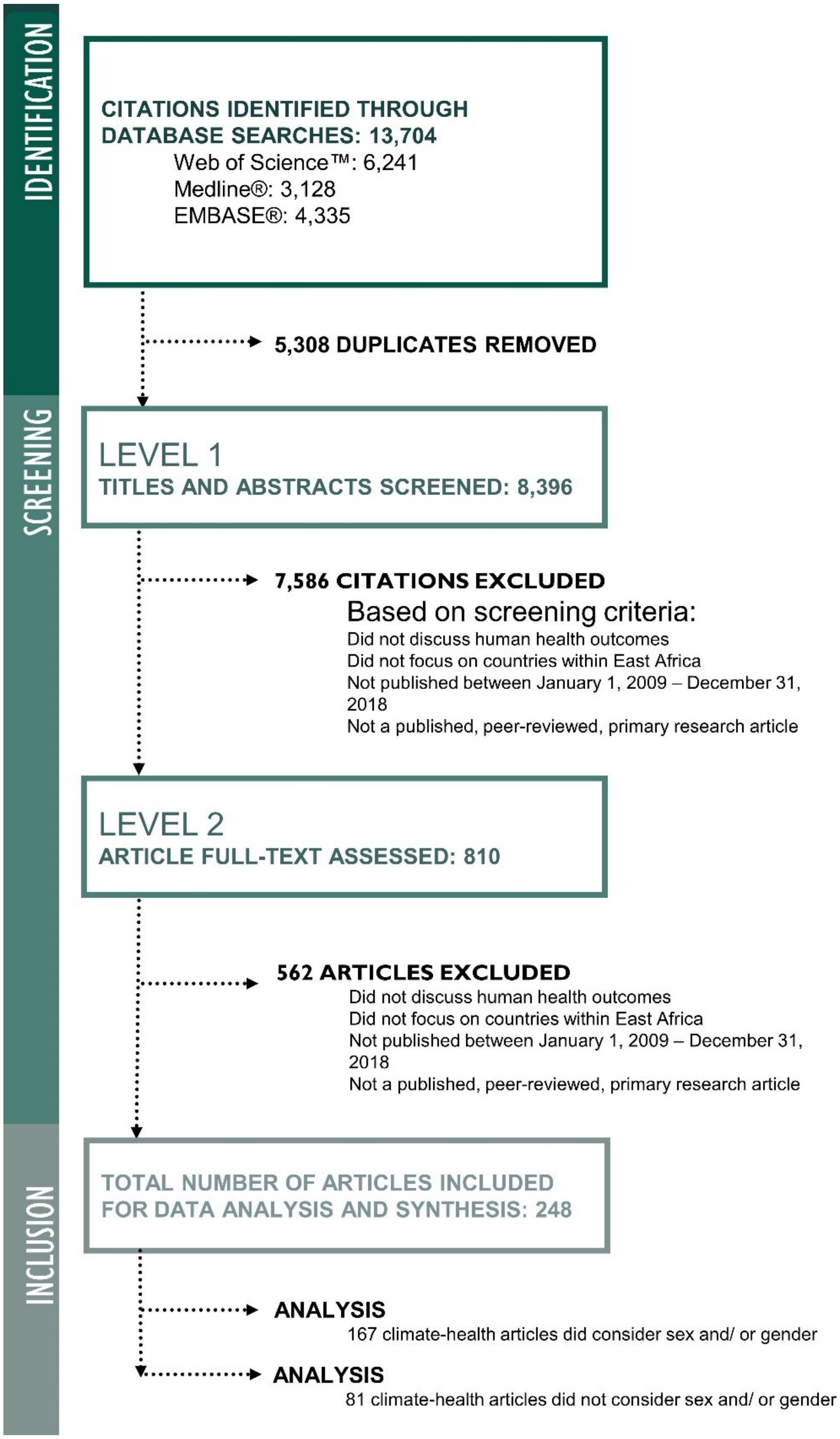


Figure 2.1 PRISMA flow diagram displaying the screening and review process used to identify and select articles about climatic variables and health outcomes in countries within East Africa published between 2009 and 2018.

CLIMATE-HEALTH ARTICLE CHARACTERISTICS AND TRENDS

Between 2009-2018, publication frequency increased from 2010 onwards. The majority of climate-health articles utilized quantitative research methods (n=229 articles; 92.3%); the remaining articles utilized mixed qualitative and quantitative methods (n=10 articles; 4.0%) and qualitative methods (n=9 articles; 3.6%).

The three most common topical themes in the climate-health articles included vector-borne diseases and zoonoses (n=109 articles; 44.0%), waterborne disease and all-cause acute gastrointestinal illness (n=50 articles; 20.2%), and nutritional health (n=39 articles; 15.7%). Articles that discussed vector-borne disease typically focused on investigating the relationship between climatic variables and malaria. Very few climate-health articles researched maternal health (n=2 articles; 0.8%), neurological disorders (n=1 article; 0.4%), effects of heat on health (n=1 article; 0.4%), and cardiovascular disease and stroke (n=1 article; 0.4%). The most frequently studied climatic variables included seasonality (n=127 articles; 51.2%), precipitation (n=126 articles; 50.8%), and temperature (n=103 articles; 41.5%). Climatic hazards were studied less frequently than climatic variables, and included the impacts of floods (n=19 articles; 7.7%), drought (n=9 articles; 3.6%), storms (n=2 articles; 0.8%), and wildfires (n=1 article; 0.4%).

Most articles described studies that took place in Kenya (n=48 articles; 19.4%), Uganda (n=45 articles; 18.1%), Ethiopia (n=43 articles; 17.3%), and Tanzania (n=30; 12.1%). A lower frequency of articles took place in Malawi (n=22; 8.8%), Mozambique (n=19; 7.7%), Zambia (n=16; 6.5%), Rwanda (n=12; 4.8%), Zimbabwe (n=10; 4.0%), Reunion Island (n=7; 2.8%), Somalia (n=7; 2.8%), Madagascar (n=4; 1.6%), Burundi (n=4; 1.6%), Mayotte (n=3; 1.2%), and South Sudan (n=3; 1.2%). Very few articles described research that took place in Djibouti (n=1 article; 0.4%), Eritrea (n=1 article; 0.4%), and Mauritius (n=1 article; 0.4%). No articles described research that took place in the British Indian Ocean Territory, Comoros, French Southern Territories, or Seychelles.

WHAT WAS THE EXTENT OF SEX AND/ OR GENDER CONSIDERATIONS WITHIN THE CLIMATE-HEALTH LITERATURE?

The majority of climate-health articles considered sex and/or gender (n=167/229 articles; 67.3%), and this frequency increased over time [Figure 2.2A]. Within articles, sex and/ or gender was mentioned in the title or abstract (n=65 articles; 38.9%), introduction (n=40 articles; 24.0%), study design (n=167 articles; 100%), results (n=159 articles; 95.2%), and discussion (n=76 articles; 45.5%). Climate-health articles that focused on vector-borne disease and zoonoses (n=65 articles; 38.9%), foodborne disease and nutrition (n=32 articles; 19.2%), and fever and infection (n=25 articles; 15.0%) most frequently considered sex and/or gender [Figure 2.2B]. Proportionately, qualitative studies (n=8 articles; 88.9%) tended to more often consider sex and/ or gender than quantitative studies (n=152 articles; 66.4%) or mixed methods studies (n=7 articles; 70%) (**Figure 2.2C**). The most frequent climate variables and hazards that considered sex and/ or gender were topics that focused on seasonality (n=102 articles; 61.1%), precipitation (n=67 articles; 40.1%), and temperature (n=49 articles; 29.3%). Articles that described research in Ethiopia (n=31 articles; 18.6%), Kenya (n=29 articles; 17.4%), and Uganda (n=28 articles; 16.8%) most frequently considered sex and/ or gender (**Figure 2.3**).

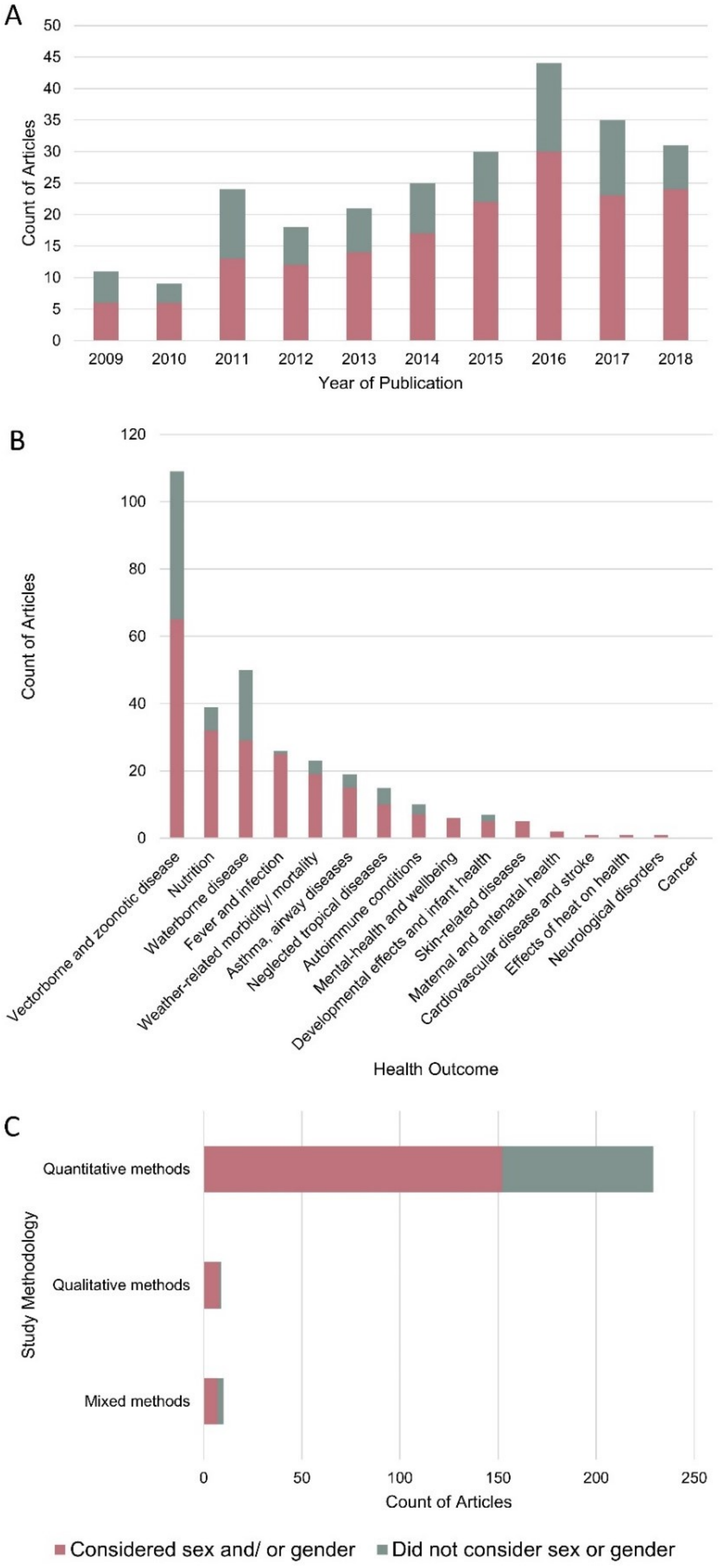


Figure 2.2 Trends in the frequency of publications for climate-health articles that considered sex and/ or gender within East Africa (2009-2018), by (**A**) year of publication, (**B**) health outcome, and (**C**) study methodology.

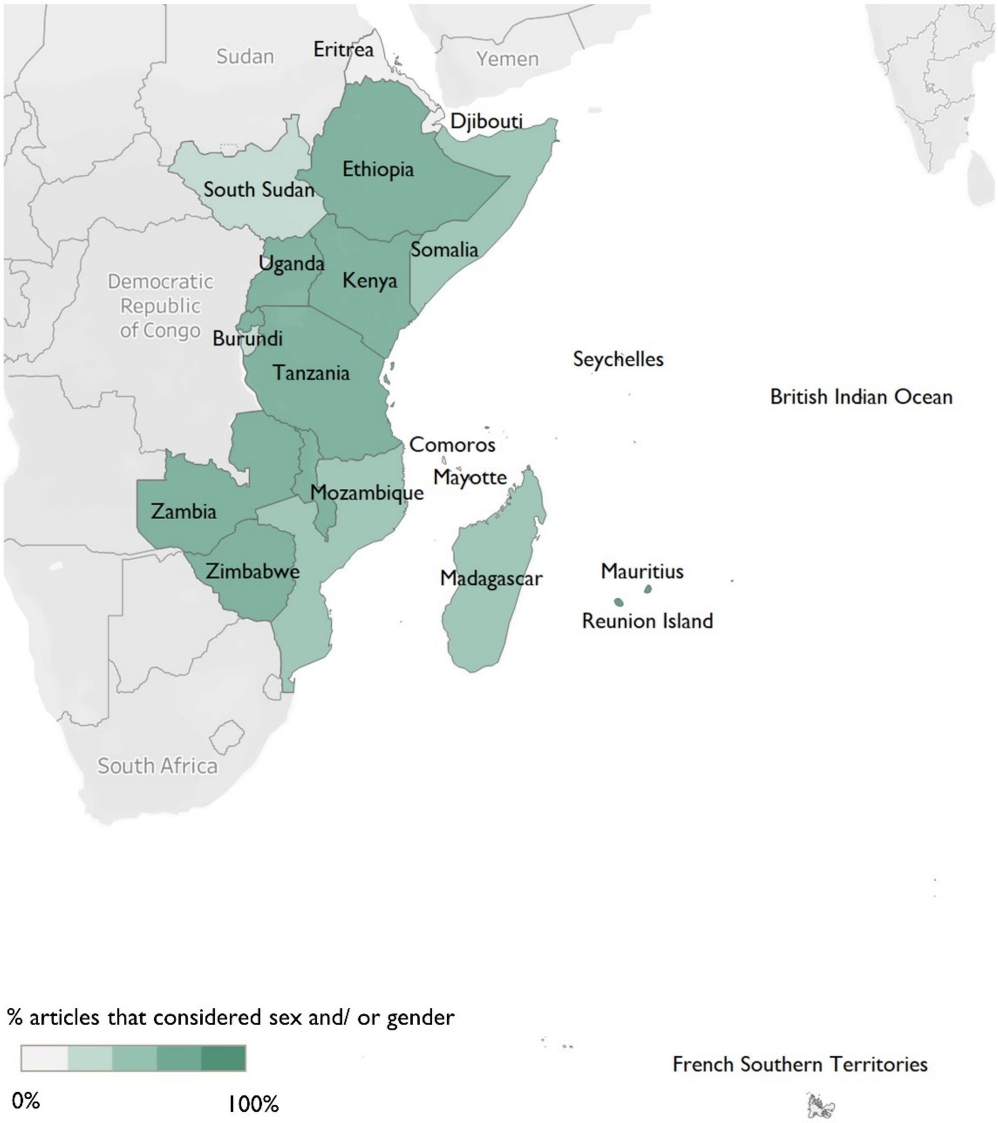


Figure 2.3 Illustrating the percentage of climate-health articles that considered sex and/ or gender from the different countries within East Africa.

What was the nature of sex and/or gender considerations in the climate-health literature?

Many articles used the terms "sex" and "gender" incorrectly

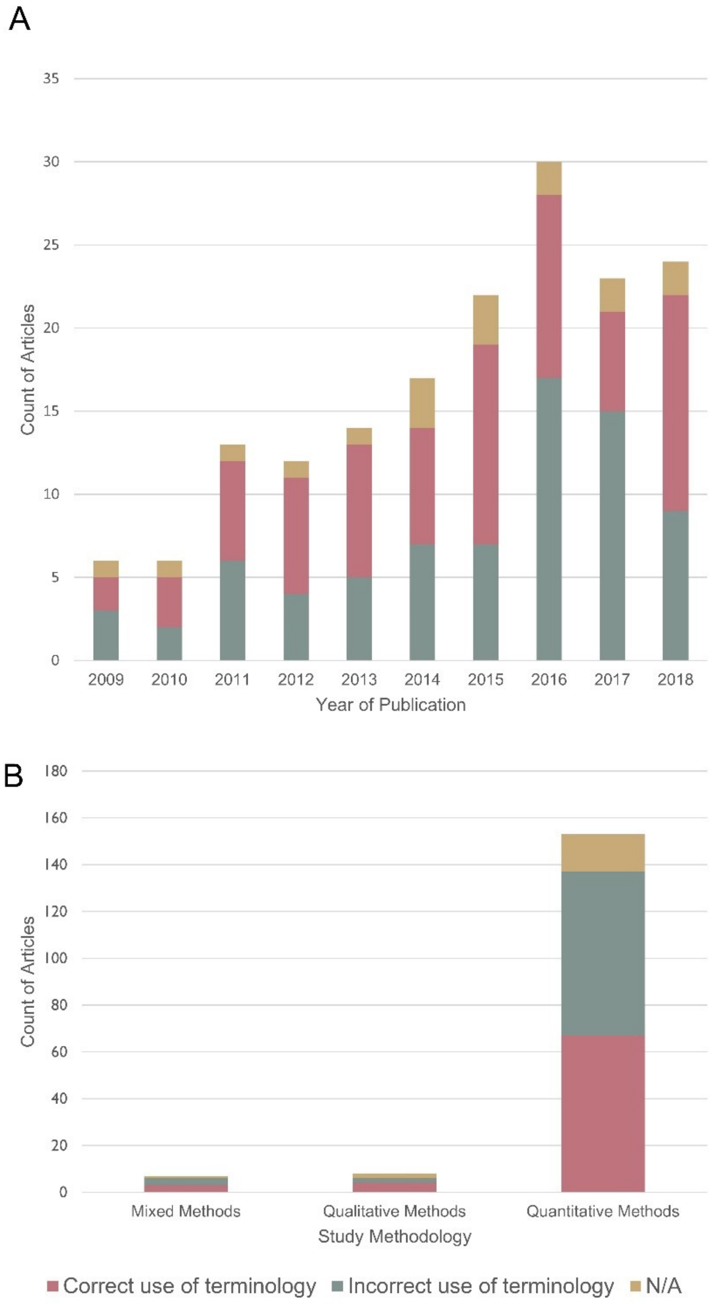
Of the articles that considered sex and/or gender, many did not use the terms "sex" and/or "gender" correctly (n=75 articles; 44.9%), and often used the terms "sex" and "gender" interchangeably. Over time, however, articles increasingly used "sex" and "gender" terms correctly; beginning from 33%

correct in 2009 to 54% correct in 2018; while articles that not include the terms “sex” or “gender” were classified as not available or “N/A” (**Figure 2.4A**). Some articles did not use the terms “sex” or “gender” at all within quantitative studies (n=16/153 articles; 10.5%), mixed methods studies (n=1/7 articles; 14.3%), and qualitative studies (n=2/8 articles; 25%); articles only descriptively compared females and males. A high proportion of quantitative studies (n=70/153 articles; 45.8%) and mixed methods studies (n=3/7 articles; 42.9%) incorrectly used “sex” and “gender” terms within the articles that considered sex and/ or gender (**Figure 2.4B**). “Sex” and “gender” terms were most commonly used correctly in articles describing research in Uganda (n=18/28 articles; 64.3%), Ethiopia (n=16/31 articles; 51.6%), and Tanzania (n=13/23 articles; 56.5%); however, while the proportion of articles describing sex and/ or gender research in Kenya was high, few of these articles used correct “sex” and “gender” terminology (n=9/29 articles; 31.0%) (**Figure 2.4C**). Articles that focused on vector-borne disease and zoonoses (n=28/65 articles; 43.0%), nutrition (n=15/32 articles; 46.9%), and fever and infection (n=14/25 articles; 56.0%) most frequently used correct terminology (**Figure 2.4D**). Climatic variables and/ or hazards articles that most frequently used correct terminology focused on seasonality (n=49/102 articles; 48.0%), temperature (n=22/49 articles; 44.9%), and precipitation (n=26/67 articles; 38.8%).

Few articles that considered sex and/ or gender solely focused on one sex/gender group

All articles examined sex and gender using binary categories, and most articles (n=157/167; 94.0%) studied mixed female and male populations. No articles (n=0/167; 0%) solely studied the effects of climate-health impacts on male populations. Very few articles (n=9; 5.4%) examined climate-health impacts on female-only populations. Climate-health studies that focused on female study populations tended to focus on nutrition, antenatal care, or maternal health as health outcomes and more often discussed the underlying the relationship between power dynamics and social norms on the gendered climate-health impacts (e.g. Balehey, Tesfay, & Balehegn, 2018; Roba, O’Connor, Belachew, & O’Brien, 2015; Wilunda et al., 2017).

Studies that found males disproportionately impacted by certain climate-sensitive health outcomes were often descriptive, and lacked an exploration into the determinants of health (e.g. Bekele et al., 2017; Bwire et al., 2017; Golassa et al., 2015; Kirstein et al., 2018a; Oketcho, Karimuribo, & Nyaruhucha, 2012). Some studies reported that males were associated with a higher prevalence of gastrointestinal conditions, malaria, leishmaniasis, cholera, and scabies (e.g. Bekele et al., 2017; Bwire et al., 2013; Enbiale & Ayalew, 2018; Golassa & White, 2017; Kirstein et al., 2018b; Oketcho et al., 2012). Some studies mentioned that occupational hazards and spending more time outdoors were potential contributors to the gendered differences in these climate-sensitive health outcomes, but potential pathways or analyses were not further explored in these articles (e.g. Bwire et al., 2013; Golassa & White, 2017; Oketcho et al., 2012).


A
35
30
25
20
15
10
5
0
Count of Articles
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year of Publication
B
180
160
140
120
100
80
60
40
20
0
Count of Articles
Mixed Methods
Qualitative Methods
Quantitative Methods
Study Methodology
Correct use of terminology
Incorrect use of terminology
N/A

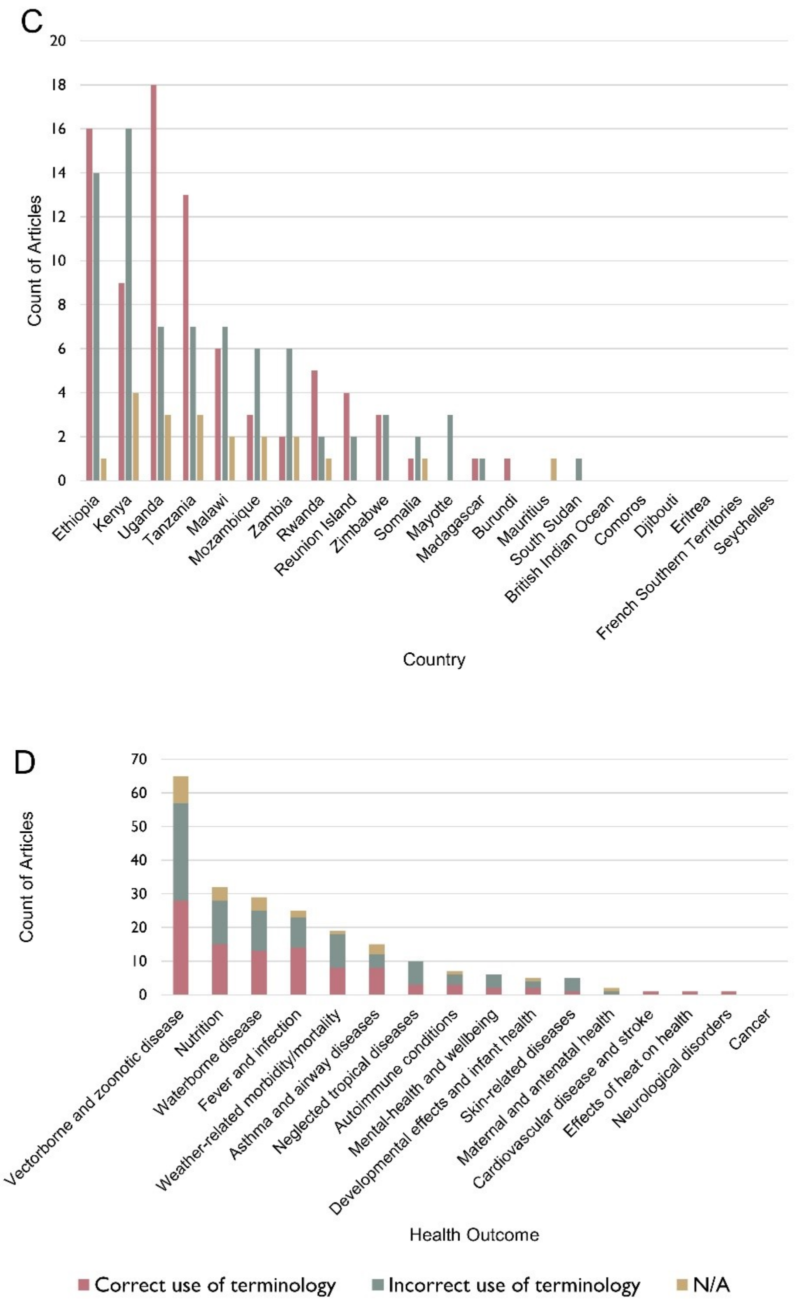


Figure 2.4 Trends in the frequency of publications relating to the correct and incorrect use of the terms “sex” and “gender” from climate-sensitive health articles that considered sex and/ or gender in East Africa (2009-2018), by (**A**) year, (**B**) study methodology, (**C**) country, and (**D**) health outcome.

Qualitative and mixed methods studies tended to better integrate sex and/or gender considerations

Quantitative research articles tended to consider sex and/ or gender more descriptively; for instance, some articles described the characteristics of the study sample or mentioned that sex data were captured in hospital records (Bett et al., 2017; Brottet et al., 2016; Mayala et al., 2015; Pinchoff et al., 2015; Sasaki, Suzuki, Fujino, Kimura, & Cheelo, 2009). Generally, quantitative studies included sex as a confounder within statistical models, or study participants were matched on sex to account for sex within the study design; however, few studies commented on how sex and/or gender would modify or mediate the impact of climate change on health outcomes (e.g. Kiser, Samuel, Mclean, Muyco, & Cairns, 2012; Olive et al., 2016).

The depth of gender engagement varied by health outcome, climatic variable, methodology, and engagement component

Most climate-health articles had a low gender engagement score

Of the articles that considered sex and/or gender, the average score for gender engagement was 1.75 out of a possible 9.0 points. Seven articles (4.2%) met the inclusion criteria for classification as having high engagement, scoring between 7-9 points; twenty-six articles (15.6%) had moderate engagement where articles scored between 4-6 points; and one hundred thirty-four articles (80.2%) had low engagement where articles scored between 0-3 points. Quantitative study methodologies tended to score low in total gender engagement (n=132; 86.8%) (**Figure 2.5A**). Countries that had at least one article that scored high in gender engagement included Tanzania (n=2; 1.2%), South Sudan (n=1; 0.6%), Mozambique (n=1; 0.6%), Kenya (n=1; 0.6%), Ethiopia (n=1; 0.6%), and Uganda (n=1; 0.6%). Climatic variables and/ or hazards that scored high in gender engagement focused on seasonality (n=4; 2.4%), precipitation (n=3; 1.8%), temperature (n=1;0.6%), and floods (n=1; 0.6%). Studies that scored high in gender engagement focused on nutritional health (n=2; 1.2%), mental health and wellbeing (n=2; 1.2%), maternal health (n=1; 0.6%), and vector-borne disease and zoonoses (n=1; 0.6%). Over time there was an increase in the frequency of articles that scored low and moderate in gender engagement, while the frequency of studies that scored high stagnated (**Figure 2.5B**).

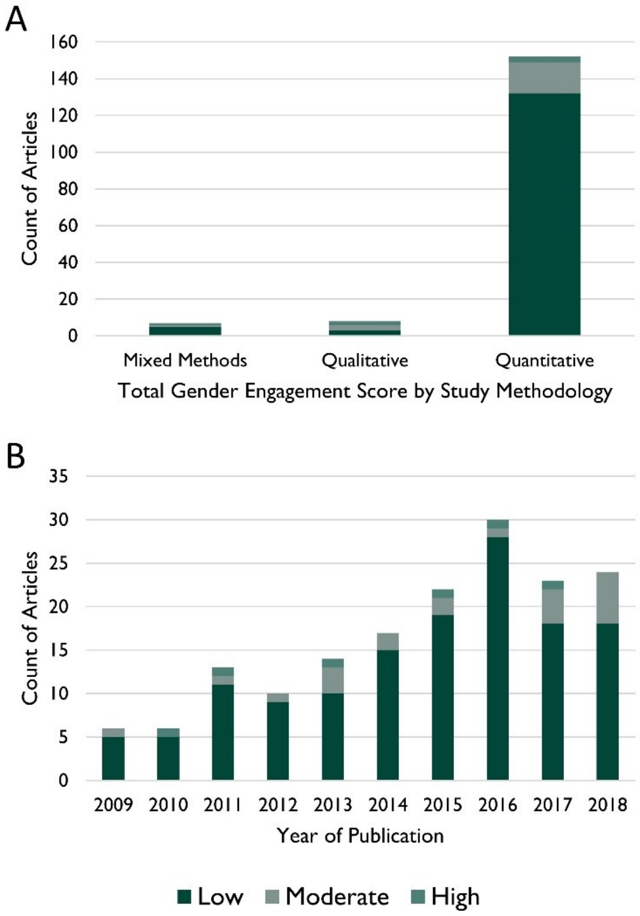
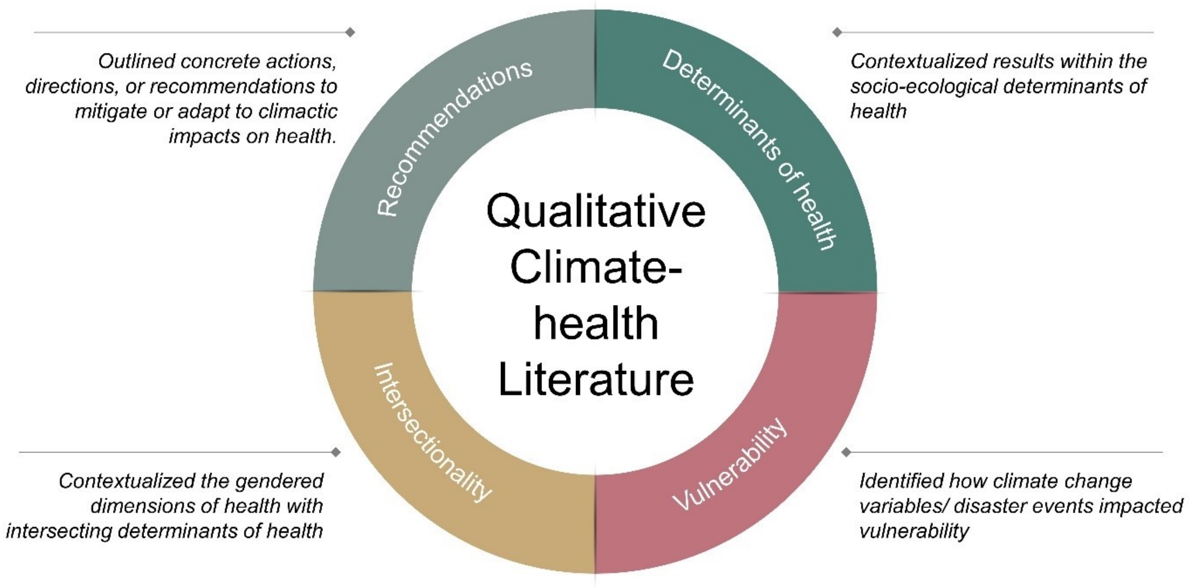


Figure 2.5 Total gender engagement scores of climate-health articles (2009-2018) stratified by (**A**) study methodology, and (**B**) publication year.

A high proportion of quantitative research articles had low gender engagement scores

Of the articles that scored high in gender engagement, three used quantitative methods, two used qualitative methods, and one article described a mixed methods design. A very low proportion of articles using quantitative methods (n=3; 2.0%), compared to a higher proportion of articles using qualitative methods (n=2; 25.0%) and mixed methods (n=1; 14.3%) scored high in gender engagement. The three quantitative articles that scored high for gender engagement contextualized the results by recognizing existing vulnerabilities across gender groups, recognizing that climate impacts have gendered health outcomes, and making recommendations that aimed to reduce gender inequity (Mboera et al., 2010; Roba et al., 2016; Schramm et al., 2016).

Articles that used qualitative methods, on the other hand, tended to more often explore and score high in gender engagement. For example, many articles that used qualitative methods situated their results within the socio-ecological determinants of health, recognizing intersectionality and interacting proximal and distal factors including social status, environment, education, income, sociocultural norms, and gender which influence climate change impacts on health (e.g. Githinji & Crane, 2014; Shaffer & Naiene, 2011; Wilunda et al., 2017). Shaffer and Naiene (2011), for instance, discussed how climate change stressed health systems by impacting the interactions between the environment and food security, water security, gender, and mental health and wellbeing. Central themes from the qualitative studies that scored high in gender engagement were summarized in **Figure 2.6**.



Outlined concrete actions, directions, or recommendations to mitigate or adapt to climactic impacts on health.

Contextualized results within the socio-ecological determinants of health

Contextualized the gendered dimensions of health with intersecting determinants of health

Identified how climate change variables/ disaster events impacted vulnerability

Figure 2.6 Key descriptive findings relating to the gendered climate-health considerations in qualitative articles that scored moderate and high, and published between 2009-2018 in East Africa.

Gender engagement scores varied between different engagement components

Articles that integrated experiences of gender scored highest on gender mainstreaming. These climate-health articles recognized different gender needs and experiences, presented results in a gender disaggregated manner, and critically analyzed social values, goals, and organizational practices. When considering gender mainstreaming, articles were increasingly becoming more gender-sensitive, gender-responsive, and gender-transformative over time (**Figure 2.7**). Articles were also increasingly recognizing health needs and experiences that differed by gender, though overall few articles scored high in gender mainstreaming. For example, some articles that focused on malaria used gender-sensitive language and recognized women and children as vulnerable groups (Bizimana, Twarabamenye, Kienberger, J.-P., & E., 2015; Rulisa et al., 2009). An article that examined access to antenatal care in South Sudan found that flooding and poor road conditions during the wet season impacted women's access and utilization of antenatal care services (Wilunda et al., 2017).

Articles on average scored lower on experiences of gender (averaging 0.23 out of 3 points) and degrees of action (averaging 0.49 out of 3 points). Few climate-health articles (n=25; 15%) examined how experiences of gender could be contextualized and applied within existing gender norms. Fewer articles (n=7; 4.2%) examined strategic needs to reduce gender inequity by re-evaluating the distribution of power, responsibilities, and social roles as it related to the gendered impacts of climate change on health. Some articles that examined experiences of gender explored how climate change differentially impacted the health and vulnerability of female groups (e.g. Balehey et al., 2018; Shaffer & Naiene, 2011; Wilunda et al., 2017). Very few articles (n=3; 1.8%) made recommendations on tangible actions that could take place to reduce sex and gender inequity to mitigate or adapt to the health impacts of climate change.

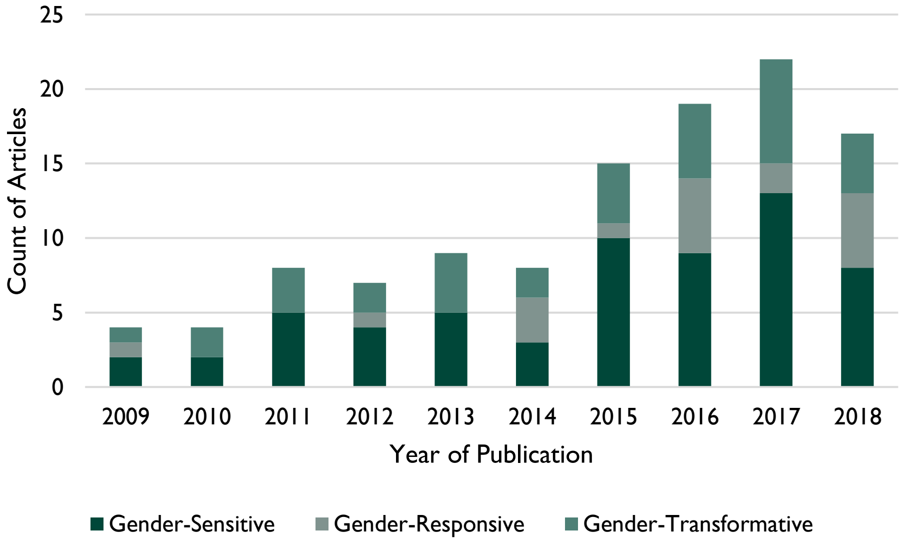


Figure 2.7 Comparing the count of articles by year of publication in considering gender-sensitivity, gender-responsiveness, and gender-transformativeness.

Discussion

We describe topical, temporal, and geographical trends in relation to sex and/or gender considerations in the climate change and health literature for East Africa. Temporal trends showed a gradual increase in climate-health publications. Climate-health research that considered sex and/or gender were geographically concentrated on the East African regions of Uganda, Ethiopia, Kenya, and Tanzania, while there was a dearth of research in East African regions of British Indian Ocean territory, Comoros, French Southern Territory, and Seychelles. This geographical gap in climate-health research may contribute to a lack of understanding in the region-specific contexts of how sex and gender are differentially impacted by physiological, temporal, geographical, social, cultural, and political factors, as well as climate change exposure, risks, and vulnerability, limiting the evidence available to inform sustainable and effective climate change adaptation strategies and initiatives.

Climate-health articles increasingly considered and incorporated sex and gender-based analyses over time; however, the total gender engagement scores remained marginal. Furthermore, it was concerning to identify a decline in articles with high levels of gender engagement over time. These findings are interesting as a previous review from Bunce et al. (2015) found that Sub-Saharan Africa was a hotpot for gender research in the climate adaptation, resilience, and vulnerability literature. Our findings suggest, however, that this trend may not be as pervasive in the climate-health literature for East Africa. Indeed, many studies that integrated experiences of gender failed to examine how potential sociocultural, political, and economic pathways intersect and interact to influence the root causes of vulnerability and impact health outcomes. Many of the articles that integrated sex-based analyses merely presented data disaggregated by sex and descriptively summarized health impacts and outcomes, with a clear gap in examining and understanding potential physiological pathways through which climate change impacts health vis-a-vis sex. This reductionist approach to sex- and gender-based analyses that was dominant in the climate-health literature has also been noted in the broader human dimensions of climate change literature (Bee, Biermann, & Tshakhert, 2012; Djoudi et al., 2016). This research gap has important implications as sex and gender considerations have been identified as critical in understanding the ways in which climate change impacts health outcomes, adaptation, and vulnerability (Arora-Jonsson, 2011; Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014), yet, based on our results, remains understudied in the climate-health literature. In this light, future climate-health articles should prioritize integrating sex and gender-based analyses by exploring the potential implications and pathways that intersect and interact with sex and gender on health outcomes, and outline future actions or recommendations to bridge the gap between sex and gender equity in climate health research (Arora-Jonsson, 2011).

Quantitative epidemiological research on climate-health was predominant in terms of frequency; however, of these quantitative articles, less than 50% of articles considered sex and/ or gender and had low total gender engagement scores. The few quantitative studies that did score high in gender engagement tended to disaggregate results by sex, discuss the sex and gender-based implications of results, critically analyze gender using a lens based on structures of power, and made recommendations for the mitigation or adaptation of climatic impacts on health. As a whole, there has been a challenge in collecting sex/ gender data, and examining sex and/or gender considerations in quantitative health studies aside from stratifying or using interaction terms in regression models, and linking results to solutions or recommendations (Mena & Bolte, 2019; Rich-Edwards, Kaiser, Chen, Manson, & Goldstein, 2018). Future quantitative climate-health research should respond to this research gap by collecting data on sex and gender, discussing the potential implications of sex and gender on the study results, and exploring causal mechanisms (Day, Mason, Lagosky, & Rochon, 2016; Heidari et al., 2016).

While there was a lower frequency of qualitative and mixed methods studies, proportionally more often qualitative and mixed methods studies meaningfully integrated experiences of sex and/or gender. The qualitative research approach often lends itself well to incorporating sex and gender-based analyses as it focuses on contextual exploration, allowing for the space to explore socio-ecological processes and the relationships between environmental and climatic conditions and human health (Sallee & Flood, 2012). Understanding how and in what contexts sex and gender impact health within a changing climate via diverse research methodologies can reveal the specific and unequal effects of climate change, and allow for the creation of specific climate-health policies, responses and adaptations (Arora-Jonsson, 2011). There was a gap in the research for quantitative research designs that meaningfully integrated and engaged with sex and/ or gender. We recommend that future quantitative studies further engage with sex and/ or gender within the study design, data collection, analysis, and reporting stages; to meaningfully investigate the impacts of sex and/ or gender on health and go beyond identifying relationships between sex and/ or gender and health.

Similar to the broader human dimensions of climate change literature, the gendered dimensions of climate-health research captured in this review were predominately rooted in the female experience (Bee et al., 2012; Bunce & Ford, 2015). This finding may reflect recent efforts in human health research in general to increase female representation in research data, motivated by a long and inequitable history of research focusing predominately on men’s health (Christianson, Alex, Wiklund, Hammarstrom, & Lundman, 2012). Our finding may also reflect the larger human dimensions of climate change discourse that often identifies women as a vulnerable population (Arora-Jonsson, 2011; Vincent et al., 2014), and often situates women as an understudied gender (Bunce & Ford, 2015), both of which can spur research efforts and shape research agendas. Indeed, we found that framing of the female experience and women’s health was centered on vulnerability and focused on the social and power inequities between males and females. This focus on gender-based health disparities tends to frame or portray women as passive victims, overlooking opportunities for empowerment, agency, autonomy, and capacity development (Bee et al., 2012; Bunce & Ford, 2015). As such, opportunities for future climate-health research should include examining the implications of sex and gender on health using a strength-based approach to accentuate strengths rather than deficits (Arora-Jonsson, 2011) to bridge the gap in sex and gender equity (Vincent et al., 2014), and foster meaningful climate change adaptation (Arora-Jonsson, 2011; Heidari et al., 2016).

Many articles often incorrectly used the terms “sex” and “gender” interchangeably. This finding was consistent with the broader health literature, noting that the inconsistent and interchangeable use of the terms creates confusion and obfuscates the underlying relationships between health and sex and/or gender (Christianson et al., 2012; King, 2010; Ristvedt, 2014). This is important in the context of climate change impacts on health because sex and gender present different causal pathways within the climate-health nexus, which require specific and distinct considerations for climate change understanding risk and vulnerability, as well as for developing effective mitigation and adaptation responses. This is not to say that the terms “sex” and “gender” are mutually exclusive; indeed, in reality, they are interconnected and interrelated, as gender characteristics often shape and influence biological factors to impact health, and vice versa (Day et al., 2016; Ristvedt, 2014).

Conclusion

This review systematically summarized, synthesized, and analyzed trends in the nature and extent of sex and gender considerations in the climate-health research in East Africa. We found that while the climate-health literature is increasingly integrating sex and gender considerations, it remains an emerging area of research. It was concerning that the depth of gender engagement in the climate-health literature decreased over time, underscoring significant gaps in our understanding of exposure, risks, and vulnerability, which compromise our ability to develop effective, just, and equitable climate change adaptation and mitigation strategies. Improving the integration of sex and gender into the climate-health literature presents opportunities for strengthening adaptive capacity, and developing more equitable, relevant, and meaningful climate-health policy, practice, and responses.

Acknowledgements

We would like to thank the University of Alberta health sciences librarian, Sandra Campbell, for her expertise in research databases and conducting literature searches. We would also like to thank Alexandra Nunns, Maesha Elahi, Sarah Demedeiros, and Tianna Rusnak for their time screening titles/ abstracts and full texts for relevance. This work was funded by the Canadian Institutes of Health Research (CIHR) and a Queen Elizabeth II scholarship.

References

Ampaire, E. L., Acosta, M., Huyer, S., Kigonya, R., Muchunguzi, P., Muna, R., & Jassogne, L. (2020). Gender in climate change, agriculture, and natural resource policies: insights from East Africa. *Climatic Change*, *158*(1), 43–60. https://doi.org/10.1007/s10584-019-02447-0

Anderson, I., Robson, B., Connolly, M., Al-Yaman, F., Bjertness, E., King, A., … Yap, L. (2016). Indigenous and tribal peoples' health (The Lancet-Lowitja Institute Global Collaboration): a population study. *The Lancet*, *388*(10040), 131–157. https://doi.org/10.1016/S0140-6736(16)00345-7

Arksey, H., & O'Malley, L. (2005). Scoping studies: toward a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32.

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. https://doi.org/10.1016/j.gloenvcha.2011.01.005

Balehey, S., Tesfay, G., & Balehegn, M. (2018). Traditional gender inequalities limit pastoral women's opportunities for adaptation to climate change: Evidence from the Afar pastoralists of Ethiopia. *PASTORALISM-RESEARCH POLICY AND PRACTICE*, *8*. https://doi.org/10.1186/s13570-018-0129-1

Bee, B., Biermann, M., & Tshakhert, P. (2012). Gender, Development, and Rights-Based Approaches: Lessons for Climate Change Adaptation and Adaptive Social Protection. In M. Alston & K. Whittenbury (Eds.), *Research, Action and Policy: Addressing the Gendered Impacts of Climate Change* (pp. 95–108). Dordrecht: Springer.

Bekele, A., Zemenfes, D., Kassa, S., Deneke, A., Taye, M., & Wondimu, S. (2017). Patterns and seasonal variations of perforated peptic ulcer disease: Experience from Ethiopia. *Annals of African Surgery*, *14*(2). Retrieved from http://www.annalsofafricansurgery.com/file_download/271/Article+6.pdf

Bett, B., Said, M. Y., Sang, R., Bukachi, S., Wanyoike, S., Kifugo, S. C., … Grace, D. (2017). Effects of flood irrigation on the risk of selected zoonotic pathogens in an arid and semi-arid area in the eastern Kenya. *PloS One*, *12*(5), e0172626. https://doi.org/https://dx.doi.org/10.1371/journal.pone.0172626

Bizimana, J.-P., Twarabamenye, E., Kienberger, S., J.-P., B., & E., T. (2015). Assessing the social vulnerability to malaria in Rwanda. *Malaria Journal*, *14*(1), 2. https://doi.org/http://dx.doi.org/10.1186/1475-2875-14-2

Brottet, E., Jaffar-Bandjee, M.-C., Li-Pat-Yuen, G., Filleul, L., E., B., M.-C., J.-B., & G., L.-P.-Y. (2016). Etiology of Influenza-Like Illnesses from Sentinel Network Practitioners in Reunion Island, 2011-2012. *PLoS ONE*, *11*(9), e0163377. https://doi.org/https://dx.doi.org/10.1371/journal.pone.0163377

Bryson, J. M., Bishop-Williams, K. E., Berrang-Ford, L., Nunez, E. C., Lwasa, S., Namanya, D. B., & Harper, S. L. (2020). Neglected Tropical Diseases in the Context of Climate Change in East Africa: A Systematic Scoping Review. *The American Journal of Tropical Medicine and Hygiene*, *00*(0), 1–12. https://doi.org/10.4269/ajtmh.19-0380

Bunce, A., & Ford, J. (2015). How is adaptation , resilience , and vulnerability research engaging with gender ? *Environmental Research Letters*, *10*(12). https://doi.org/10.1088/1748-9326/10/12/123003

Bwire, G., Malimbo, M., Makumbi, I., Kagirita, A., Wamala, J. F., Kalyebi, P., … Dahlke, M. (2013). Cholera surveillance in Uganda: an analysis of notifications for the years 2007-2011. *The Journal of Infectious Diseases*, *208 Suppl*, S78-85. https://doi.org/https://dx.doi.org/10.1093/infdis/jit203

Bwire, G., Munier, A., Ouedraogo, I., Heyerdahl, L., Komakech, H., Kagirita, A., … Mengel, M. A. (2017). Epidemiology of cholera outbreaks and socio-economic characteristics of the communities in the fishing villages of Uganda: 2011-2015. *PLoS Neglected Tropical Diseases*, *11*(3), e0005407. https://doi.org/http://dx.doi.org/10.1371/journal.pntd.0005407

Christianson, M., Alex, L., Wiklund, A. F., Hammarstrom, A., & Lundman, B. (2012). Sex and Gender Traps and Springboards : A Focus Group Study Among Gender Researchers in Medicine and Health Sciences. *Health Care for Women International*, *33*(8), 739–755. https://doi.org/10.1080/07399332.2011.645970

Day, S., Mason, R., Lagosky, S., & Rochon, P. A. (2016). Integrating and evaluating sex and gender in health research. *Health Research Policy and Systems*, *14*(1), 1–5. https://doi.org/10.1186/s12961-016-0147-7

Dębiak, M., Groth, K., Kolossa-Gehring, M., Sauer, A., Tobollik, M., & Wintermeyer, D. (2019). Sex and gender approaches in environmental health research: two exemplary case studies of the German environment agency. *Interdisciplinary Science Reviews*, *44*(2), 114–130. https://doi.org/10.1080/03080188.2019.1603860

Djoudi, H., Locatelli, B., Vaast, C., Asher, K., Brockhaus, M., & Basnett Sijapati, B. (2016). Beyond dichotomies: Gender and intersecting inequalities in climate change studies. *Ambio*, *45*(s3), 248–262. https://doi.org/10.1007/s13280-016-0825-2

Druyan, A., Makranz, C., Moran, D., Yanovich, R., Epstein, Y., & Heled, Y. (2012). Heat tolerance in women-Reconsidering the criteria. *Aviation Space and Environmental Medicine*, *83*(1), 58–60. https://doi.org/10.3357/ASEM.3130.2012

Dymén, C., Andersson, M., & Langlais, R. (2013). Gendered dimensions of climate change response in Swedish municipalities. *Local Environment*, *18*(9), 1066–1078. https://doi.org/10.1080/13549839.2012.752802

Enbiale, W., & Ayalew, A. (2018). Investigation of a Scabies Outbreak in Drought-Affected Areas in Ethiopia. *Tropical Medicine and Infectious Disease*, *3*(4). https://doi.org/https://dx.doi.org/10.3390/tropicalmed3040114

Fazey, I., Wise, R. M., Lyon, C., Câmpeanu, C., Moug, P., & Davies, T. E. (2016). Past and future adaptation pathways. *Climate and Development*, *8*(1), 26–44. https://doi.org/10.1080/17565529.2014.989192

Geographic Region. (n.d.). Retrieved June 13, 2019, from https://unstats.un.org/unsd/methodology/m49/

Githinji, V., & Crane, T. A. (2014). Compound Vulnerabilities: The Intersection of Climate Variability and HIV/AIDS in Northwestern Tanzania. *WEATHER CLIMATE AND SOCIETY*, *6*(1), 9–21. https://doi.org/10.1175/WCAS-D-12-00052.1

Golassa, L., Baliraine, F. N., Enweji, N., Erko, B., Swedberg, G., & Aseffa, A. (2015). Microscopic and molecular evidence of the presence of asymptomatic Plasmodium falciparum and Plasmodium vivax infections in an area with low, seasonal and unstable malaria transmission in Ethiopia. *BMC Infectious Diseases*, *15*, 310. https://doi.org/https://dx.doi.org/10.1186/s12879-015-1070-1

Golassa, L., & White, M. T. (2017). Population-level estimates of the proportion of Plasmodium vivax blood-stage infections attributable to relapses among febrile patients attending Adama Malaria Diagnostic Centre, East Shoa Zone, Oromia, Ethiopia. *Malaria Journal*, *16*(1), 301. https://doi.org/https://dx.doi.org/10.1186/s12936-017-1944-3

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, *1*(1), 1–9. https://doi.org/10.1186/s41073-016-0007-6

Herlihy, N., Bar-hen, A., Verner, G., Fischer, H., Sauerborn, R., Depoux, A., … Schütte, S. (2016). Climate change and human health: what are the research trends? A scoping review protocol. *BMJ Open*, *6*(e012022). https://doi.org/10.1136/bmjopen-2016-012022

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., … Zhou, G. (2018). Impacts of 1.5ºC Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, … T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*.

Hutchins, S. S., Bouye, K., Luber, G., Briseno, L., Hunter, C., & Corso, L. (2018). Public Health Agency Responses and Opportunities to Protect Against Health Impacts of Climate Change Among US Populations with Multiple Vulnerabilities. *Journal of Racial and Ethnic Health Disparities*, *5*(6), 1159–1170. https://doi.org/10.1007/s40615-017-0402-9

King, B. M. (2010). Point: A call for proper usage of “gender” and “sex” in biomedical publications. *American Journal of Physiology - Regulatory Integrative and Comparative Physiology*, *298*(6), 2009–2010. https://doi.org/10.1152/ajpregu.00694.2009

Kirmayer, L. J., & Brass, G. (2016). Addressing global health disparities among Indigenous peoples. *The Lancet*, *388*(10040), 105–106. https://doi.org/10.1016/S0140-6736(16)30194-5

Kirstein, O. D., Skrip, L., Abassi, I., Iungman, T., Horwitz, B. Z., Gebresilassie, A., … Warburg, A. (2018a). A fine scale eco-epidemiological study on endemic visceral leishmaniasis in north ethiopian villages. *Acta Tropica*, *183*, 64–77. https://doi.org/https://dx.doi.org/10.1016/j.actatropica.2018.04.005

Kirstein, O. D., Skrip, L., Abassi, I., Iungman, T., Horwitz, B. Z., Gebresilassie, A., … Warburg, A. (2018b). A fine scale eco-epidemiological study on endemic visceral leishmaniasis in north ethiopian villages. *Acta Tropica*, *183*, 64–77. https://doi.org/http://dx.doi.org/10.1016/j.actatropica.2018.04.005

Kiser, M. M., Samuel, J. C., Mclean, S. E., Muyco, A. P., & Cairns, B. A. (2012). Epidemiology of pediatric injury in Malawi: Burden of disease and implications for prevention. *International Journal of Surgery*, *10*(10), 611–617. https://doi.org/http://dx.doi.org/10.1016/j.ijsu.2012.10.004

Lam, S., Dodd, W., Skinner, K., Papadopoulos, A., Zivot, C., & Ford, J. (2019). Community-based monitoring of Indigenous food security in a changing climate : global trends and future directions. *Environmental Research Letters*, *14*(7).

Li, A., & Ford, J. (2019). Understanding Socio-Ecological Vulnerability to Climatic Change through a Trajectories of Change Approach : A Case Study from an Indigenous Community in Panama. *Weather Climate and Society*, *11*, 577–593. https://doi.org/10.1175/WCAS-D-18-0093.1

Martinez Garcia, D., & Sheehan, M. C. (2016). Extreme weather-driven disasters and children’s health. *International Journal of Health Services*, *46*(1), 79–105. https://doi.org/10.1177/0020731415625254

Mayala, B. K., Fahey, C. A., Wei, D., Zinga, M. M., Bwana, V. M., Mlacha, T., … Mboera, L. E. (2015). Knowledge, perception and practices about malaria, climate change, livelihoods and food security among rural communities of central Tanzania. *Infectious Diseases of Poverty*, *4*, 21. https://doi.org/https://dx.doi.org/10.1186/s40249-015-0052-2

Mboera, L. E. G., Senkoro, K. P., Mayala, B. K., Rumisha, S. F., Rwegoshora, R. T., Mlozi, M. R. S., & Shayo, E. H. (2010). Spatio-temporal variation in malaria transmission intensity in five agro-ecosystems in Mvomero district, Tanzania. *Geospatial Health*, *4*(2), 167–178. https://doi.org/http://dx.doi.org/10.4081/gh.2010.198

Mena, E., & Bolte, G. (2019). Intersectionality-based quantitative health research and sex/gender sensitivity: A scoping review. *International Journal for Equity in Health*, *18*(1), 1–12. https://doi.org/10.1186/s12939-019-1098-8

Middleton, J., Cunsolo, A., Jones-Bitton, A., Wright, C. J., & Harper, S. L. (2020). Indigenous mental health in a changing climate: A systematic scoping review of the global literature. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/ab68a9

Moosa, C. S., & Tuana, N. (2014). Mapping a Research Agenda Concerning Gender and Climate Change : A Review of the Literature. *Hypatia*, *29*(3).

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). IPCC fifth assessment report. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 1199–1266). Cambridge University Press. https://doi.org/10.1017/CBO9781107415386.002

Oketcho, R., Karimuribo, E. D., & Nyaruhucha, C. N. M. (2012). Epidemiological factors in admissions for diarrhoea in 6 - 60-month-old children admitted to Morogoro Regional Hospital, Tanzania. *South African Journal of Child Health*, *6*(3), 81–84. https://doi.org/http://dx.doi.org/10.7196/SAJCH.479

Oksuzyan, A., Juel, K., Vaupel, J. W., & Christensen, K. (2008). Men : good health and high mortality . Sex differences in health and aging *. *Aging Clinical and Experimental Research*, *20*(2), 25–28.

Olive, M.-M., Chevalier, V., Grosbois, V., Tran, A., Andriamandimby, S.-F., Durand, B., … C., R. (2016). Integrated Analysis of Environment, Cattle and Human Serological Data: Risks and Mechanisms of Transmission of Rift Valley Fever in Madagascar. *PLoS Neglected Tropical Diseases*, *10*(7), e0004827. https://doi.org/https://dx.doi.org/10.1371/journal.pntd.0004827

Patel, S. K., Asia, S., & Mathew, B. (2020). Climate change and women in South Asia : a review and future policy implications and women in. *World Journal of Science, Technology and Sustainable Development*, *17*(2), 145–166. https://doi.org/10.1108/WJSTSD-10-2018-0059

Pinchoff, J., Chipeta, J., Banda, G. C., Miti, S., Shields, T., F., C., … Moss, W. J. (2015). Spatial clustering of measles cases during endemic (1998-2002) and epidemic (2010) periods in Lusaka, Zambia. *BMC Infectious Diseases*, *15*(1), 121. https://doi.org/https://dx.doi.org/10.1186/s12879-015-0842-y

Rich-Edwards, J. W., Kaiser, U. B., Chen, G. L., Manson, J. E., & Goldstein, J. M. (2018). Sex and gender differences research design for basic, clinical, and population studies: Essentials for investigators. *Endocrinology Reviews*, *39*, 424–439. https://doi.org/10.1210/er.2017-00246

Ristvedt, S. L. (2014). The evolution of gender. *JAMA Psychiatry*, *71*(1), 13–14. https://doi.org/10.1001/jamapsychiatry.2013.3199

Roba, K. T., O'Connor, T. P., Belachew, T., & O'Brien, N. M. (2015). Seasonal variation in nutritional status and anemia among lactating mothers in two agro-ecological zones of rural Ethiopia: A longitudinal study. *Nutrition (Burbank, Los Angeles County, Calif.)*, *31*(10), 1213–1218. https://doi.org/https://dx.doi.org/10.1016/j.nut.2015.03.007

Roba, K. T., O'Connor, T. P., Belachew, T., O'Brien, N. M., K.T., R., T.P., O., & T., B. (2016). Variations between post- and pre-harvest seasons in stunting, wasting, and Infant and Young Child Feeding (IYCF) practices among children 6-23 months of age in lowland and midland agro-ecological zones of rural Ethiopia. *The Pan African Medical Journal*, *24*, 163. https://doi.org/http://dx.doi.org/10.11604/pamj.2016.24.163.9387

Rulisa, S., Mens, P. F., Karema, C., Schallig, H. D. F. H., Kaligirwa, N., Vyankandondera, J., & de Vries, P. J. (2009). Malaria has no effect on birth weight in Rwanda. *Malaria Journal*, *8*(1), 194. https://doi.org/http://dx.doi.org/10.1186/1475-2875-8-194

Sallee, M. W., & Flood, J. T. (2012). Using Qualitative Research to Bridge Research, Policy, and Practice. *Theory into Practice*, *51*(2), 137–144. https://doi.org/10.1080/00405841.2012.662873

Sasaki, S., Suzuki, H., Fujino, Y., Kimura, Y., & Cheelo, M. (2009). Impact of drainage networks on cholera outbreaks in Lusaka, Zambia. *American Journal of Public Health*, *99*(11), 1982–1987. https://doi.org/https://dx.doi.org/10.2105/AJPH.2008.151076

Schramm, S., Kaducu, F. O., Smedemark, S. A., Ovuga, E., & Sodemann, M. (2016). Gender and age disparities in adult undernutrition in northern Uganda: high-risk groups not targeted by food aid programmes. *Tropical Medicine & International Health : TM & IH*, *21*(6), 807–817. https://doi.org/http://dx.doi.org/10.1111/tmi.12708

Shaffer, L. J., & Naiene, L. (2011). Why Analyze Mental Models of Local Climate Change? A Case from Southern Mozambique. *WEATHER CLIMATE AND SOCIETY*, *3*(4), 223–237. https://doi.org/10.1175/WCAS-D-10-05004.1

Sheffield, P. E., & Landrigan, P. J. (2011). Global climate change and children's health: Threats and strategies for prevention. *Environmental Health Perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

Smith, P. H., Bessette, A. J., Weinberger, A. H., Sheffer, C. E., & Mckee, S. A. (2016). Sex / gender differences in smoking cessation : A review. *Preventive Medicine*, *92*, 135–140. https://doi.org/10.1016/j.ypmed.2016.07.013

Sorensen, C., Murray, V., Lemery, J., & Balbus, J. (2018). Climate change and women's health: Impacts and policy directions. *PLoS Medicine*, *15*(7), 1–10. https://doi.org/10.1371/journal.pmed.1002603

Thomas, D. S. G., & Twyman, C. (2005). Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change*, *15*(2), 115–124. https://doi.org/10.1016/j.gloenvcha.2004.10.001

Tricco, A. C., Lillie, E., Zarin, W., Brien, K. K. O., Colquhoun, H., Levac, D., … Garritty, C. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *IPCC Fifth Assessment Report* (Vol. 1999, pp. 101–103).

Wang, H., Naghavi, M., Allen, C., Barber, R. M., Carter, A., Casey, D. C., … Zuhlke, L. J. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Berry, H., … H., M. (2018). The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *The Lancet*, *392*(10163), 2479–2514. https://doi.org/http://dx.doi.org/10.1016/S0140-6736%2818%2932594-7

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., … Montgomery, H. (2019). The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, *394*(10211), 1836–1878. https://doi.org/10.1016/S0140-6736(19)32596-6

WHO Constitution. (1946). Retrieved May 1, 2020, from https://www.who.int/about/who-we-are/constitution

Wilunda, C., Scanagatta, C., Putoto, G., Montalbetti, F., Segafredo, G., Takahashi, R., … Betran, A. P. (2017). Barriers to utilisation of antenatal care services in South Sudan: a qualitative study in Rumbek North County. *Reproductive Health*, *14*(1), 65. https://doi.org/https://dx.doi.org/10.1186/s12978-017-0327-0

Yanovich, R., Ketko, I., & Charkoudian, N. (2020). Sex differences in human thermoregulation: Relevance for 2020 and beyond. *Physiology*, *35*(3), 177–184. https://doi.org/10.1152/physiol.00035.2019

Zhang, Y., Feng, R., Wu, R., Zhong, P., Tan, X., Wu, K., & Ma, L. (2017). Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. *Global Health Research and Policy*, *2*(1), 1–9. https://doi.org/10.1186/s41256-017-0030-2

Chapter 3: How does the association between weather and health vary by sex in Uganda?

Crystal Gong[1], Lea Berrang-Ford[2,3], Shelby S. Yamamoto[1], Yan Yuan[1], Shuaib Lwasa[3,4], Didacus Namanya[3,5], Katherine Bishop-Williams[6], Bwindi Community Hospital[7], Yi Huang[8], IHACC Research Team[3], Sherilee L. Harper[1,3]

1. School of Public Health, University of Alberta, Edmonton, Canada
2. Priestley International Centre for Climate, University of Leeds, Leeds, United Kingdom
3. Indigenous Health Adaptation to Climate Change Research Group: James Ford, Cesar Carcamo, Patricia Garcia, Victoria Edge
4. Department of Geography Geo-Informatics and Climatic Sciences, School of Forestry, Environmental and Geographical Sciences, College of Agricultural and Environmental Sciences, Makerere University, Kampala, Uganda
5. Ministry of Health, Kampala, Uganda
6. Department of Population Medicine, University of Guelph, Guelph, Canada
7. Bwindi Community Hospital, Buhoma, Uganda
8. Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada

Abstract

Background: Climate change poses increasing challenges for global health, multiplying existing vulnerabilities and perpetuating health inequities. These climate change challenges are not gender or sex neutral; however, little research has examined this quantitatively in East Africa. To explore these differential climate-health impacts, we examined how the associations between weather parameters and hospital visits differ by sex for acute gastrointestinal illness, pneumonia, and cardiovascular disease in Kanungu District, Southwestern Uganda.

Methods: A retrospective analysis was conducted on de-identified hospital records collected from the Bwindi Community Hospital and meteorological data collected from the region (2011-2014). Multivariable time-series negative binomial models were fitted to the data to explore associations between meteorological variables and climate-sensitive health outcomes, stratified by sex. For each health outcome, three models were built and descriptively compared: one model that did not consider sex; one model that examined only males; and one model that examined only females.

Results: The significance of meteorological variables and magnitude of association varied between the models that did not consider sex, the models that examined only males, and the models that examined only females; indeed, no two models for each health outcome were the same.

Discussion: Our results suggest that quantitative associations between weather and health differ by sex in Southwestern Uganda. This could be explained by sex, as well as gender roles in the region. These results underscore the importance of considering sex and gender in climate-health research and practice, which will be critical in informing sex and gender-sensitive climate change adaptation.

Keywords

weather, climate change, health, sex, gender, acute gastrointestinal illness, pneumonia, cardiovascular disease, Uganda, East Africa, Sub-Saharan Africa

Introduction

Climate change is a significant challenge to global health, threatening to widen health gaps and inequities (Hoegh-Guldberg et al., 2018; Watts et al., 2019). Climate change has already directly impacted health, and also indirectly impacted health via changes to food systems, water systems, and ecosystems (Smith et al., 2014; Watts et al., 2019, 2018). For example, warming temperatures, as well as increased heavy rainfall events, flooding, and droughts have been associated with increased foodborne and waterborne diseases, including diarrheal diseases (Levy, Woster, Goldstein, & Carlton, 2016; Smith et al., 2014); increasing incidence of respiratory disease has been associated with increased levels of air pollution and heat wave events (Takaro, Knowlton, Balmes, & Francisco, 2013); and changes in ambient temperatures have been associated with increased cardiovascular disease and mortality (Baaghideh & Mayvaneh, 2017; De Blois et al., 2015). These observed impacts are expected to continue to increase, with future climate change projected to increase waterborne and foodborne disease, respiratory disease, and cardiovascular disease globally (Baaghideh & Mayvaneh, 2017; Levy et al., 2016; Smith et al., 2014; Takaro et al., 2013).

Vulnerable groups – including low income countries, women and children, rural populations, and socioeconomically disadvantaged populations – are disproportionately impacted by the negative health effects of climate change (Anderson et al., 2016; Fazey et al., 2016; Hoegh-Guldberg et al., 2018; Kirmayer & Brass, 2016; Li & Ford, 2019; Martinez Garcia & Sheehan, 2016; Sheffield & Landrigan, 2011; Sorensen, Murray, Lemery, & Balbus, 2018; Wang et al., 2016; Zhang et al., 2017). For instance, women in the Eastern regions of Sub-Saharan Africa are particularly vulnerable to the effects of climate change due to rapid warming, existing high burdens of disease, limited health infrastructure, low-resource settings, social exclusion, and gender roles (Ampaire et al., 2020; Niang et al., 2014; Wang et al., 2016). In this region, the direct and indirect pathways through which climate change impacts health are often differentiated by sex and gender (Ampaire et al., 2020; Rao et al., 2019; Sorensen et al., 2018). For example, women are physiologically more susceptible to heat stress and have a higher associated risk for cardiovascular disease (De Blois et al., 2015; Druyan et al., 2012; Polk & Naqvi, 2005; Regitz-Zagrosek & Kararigas, 2017; Rosano, Vitale, Marazzi, & Volterrani, 2007). Furthermore, gender differences often result in men and women being differentially exposed to heat events, and women receiving unequal access to social goods and healthcare services (Maas & Appelman, 2010; Moosa & Tuana, 2014).

While climate change impacts on health are not sex or gender neutral, a recent systematic scoping review found that climate-health research had low levels of sex and/or gender engagement in East Africa (Chapter 2). Furthermore, this review found that a high proportion of quantitative studies were incorrectly using “sex” and “gender” terms, and when sex and/or gender was considered in the study, it was typically treated as a confounder and controlled for within the statistical analysis, without examining how sex and/or gender might modify or mediate the impact of climate change on health outcomes (Chapter 2). This represents a concerning gap in the climate-health literature since climate change is expected to perpetuate existing sex and gender-based health disparities in East Africa (Rao et al., 2019; Sorensen et al., 2018). Understanding how climate change differentially impacts health vis-a-vis sex and gender is critical to inform the development of sex- and gender-sensitive responses that ensure sex and gender inequities are not perpetuated within climate programming, planning, and policy development (Ampaire et al., 2020; Bunce & Ford, 2015; Dębiak et al., 2019; Rao et al., 2019).

The sex and gendered dimensions of climate change impacts on health are widely acknowledged (Denton, 2002; Sorensen et al., 2018; Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014); however, there is a striking gap in the literature investigating the quantitative intersection of climate change, health, and sex and gender in East Africa (Chapter 2). Herein, we explore how sex *quantitatively* matters in the context of climate change and health, by examining how the effect weather has on health varies by sex in Southwestern Uganda. Specifically, our study objective was to descriptively compare the associations between meteorological parameters and hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular disease by sex, in Kanungu District, Uganda.

Methods

KANUNGU DISTRICT, UGANDA

Kanungu District borders Rwanda and the Democratic of Congo, and has an approximate population of 252,000 people, with females representing approximately 52% of the population **(Figure 3.1**) (Uganda Bureau of Statistics, 2016). Most residents of Kanungu District primarily rely on agrarian livelihoods, though there are also some employment opportunities in tourism (Kabale District Council, 2011; Sauer et al., 2018). The majority of the population are Bakiga, who primarily rely on subsistence farming for cash and food crops (Bernard, Anthony, & Patrick, 2010; Berrang-Ford et al., 2012). The Indigenous Batwa are a minority group in Kanungu District, whose ancestral homelands are within the Bwindi Impenetrable National Park. Both Bakiga and Batwa are already experiencing climate-related health impacts and rank it as an important topic of research with local relevance and urgency (Berrang-Ford et al., 2012; Labbe et al., 2016). Batwa have had higher exposure and sensitivity to climate-health outcomes than Bakiga, including malaria (Berrang-Ford et al., 2012; Donnelly et al., 2016; Kulkarni et al., 2017; Labbe et al., 2016), acute gastrointestinal illness (Berrang-Ford et al., 2012; Busch et al., 2019; Labbe et al., 2016), and food insecurity (Berrang-Ford et al., 2012; Busch et al., 2019; Clark et al., 2015; Labbe et al., 2016; Patterson et al., 2017).

The climate within the Kanungu District contains two rainy seasons from September to December, and from March to May; as well as two dry seasons from December to February, and from June to July (McSweeney, New, Lizcano, & Lu, 2010). The climate is tropical and moderate, surrounded by mountainous regions and wetlands, including many small rivers and streams (Uganda Department of Relief Disaster Preparedness and Management, 2016). Average temperatures within the Kanungu District are cool and generally range from 15°C to 20°C (Uganda Department of Relief Disaster Preparedness and Management, 2016). Climate change models for Uganda have projected an increase in average temperatures and lower precipitation levels over the next century (Egeru et al., 2019; Funk et al., 2018; Patricola & Cook, 2011). The region of Southwestern Uganda has been identified as one of the fastest warming regions in Uganda with an increase of 0.3°C per decade since the 1980s (Chris, Jim, Gary, & Libby, 2012; Magrath, 2008).

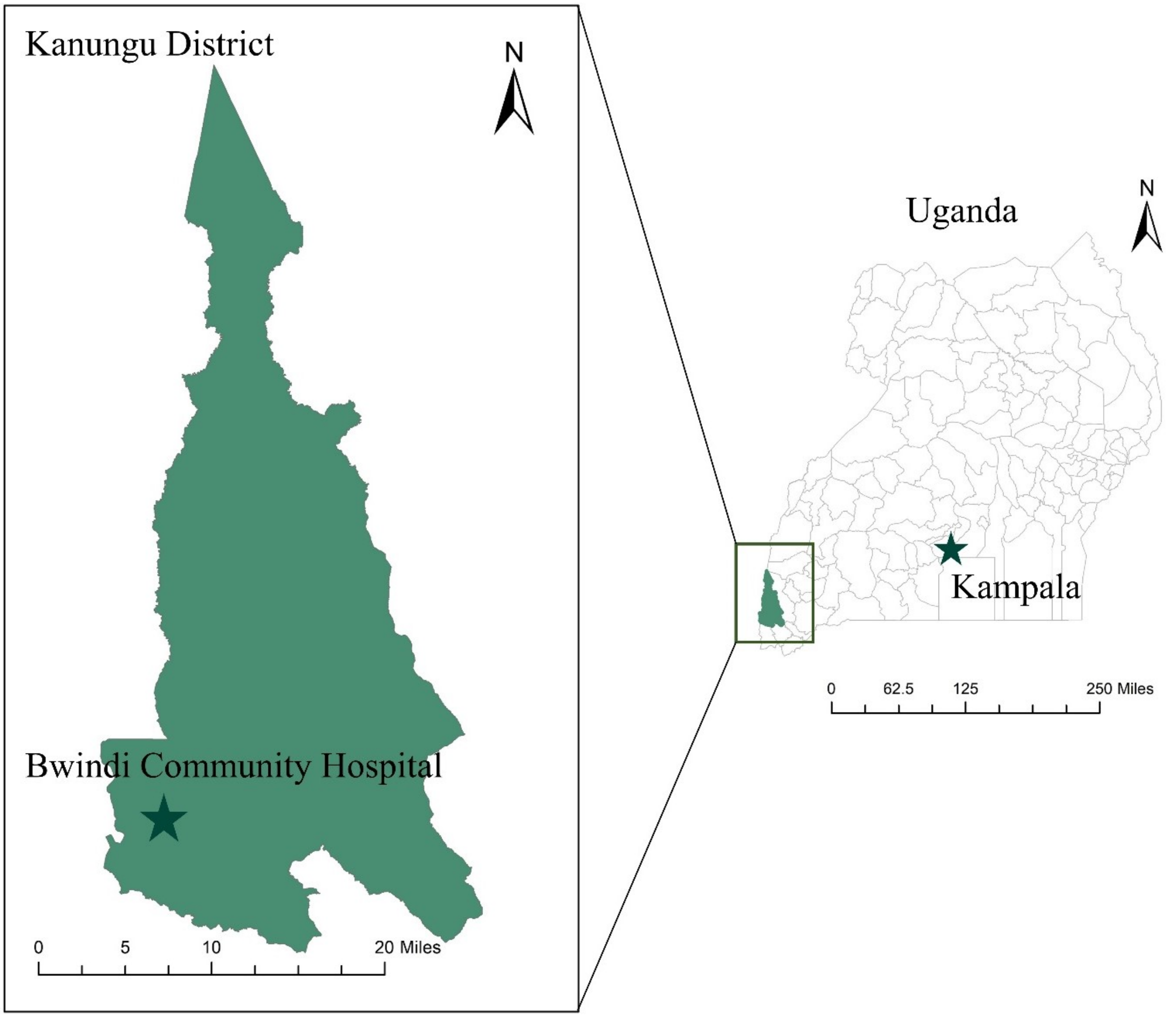


Figure 3.1 Map of Uganda, Kanungu District, and Bwindi Community Hospital.

Data collection

Health data

Health data were collected from the Bwindi Community Hospital (BCH) in Kanungu Distrinct.

Founded by philanthropists, BCH is a private hospital located in Buhoma and services a population of approximately 100,000 people in Kanungu District (Bwindi Community Hospital, 2014). There are 112 beds at BCH across six central hospital wards: pediatric in-patient (≤12 years of age), female and male adult in-patient (>12 years of age), surgery, maternity, and an out-patient ward (for individuals who did not require overnight hospital care). Healthcare services at BCH operate on a fee-for-service model, as well as private donations, with subsidies available for residents from a private insurance scheme, called eQuality.

An electronic database was developed from BCH records collected from the pediatric in-patient, adult in-patient, and outpatient wards for all hospital visits. Hospital visit entries from July 7, 2011 to December 31, 2014 were collected for out-patient records; December 1, 2011 to July 31, 2014 for adult in-patient records; January 1, 2011 to December 31, 2014 for pediatric in-patient records. Each record contained the date of hospital visit, patient's diagnoses including comorbidities, treatment ward, and individual identification number. Demographic data were extracted from patients within the eQuality insurance scheme, capturing sex and individual patient identification number. BCH health records were merged with eQuality records and matched (n=19,209/39,287; 48.9%) based on individual identification numbers (Bishop-Williams et al., 2018).

Case definitions for acute gastrointestinal illness, pneumonia, and cardiovascular diseases were classified according to the Uganda National Clinical Guidelines for Management of Common Conditions (Uganda Ministry of Health, 2012). Acute gastrointestinal illness cases were defined as the occurrence of three or more loose stools within a twenty-four hour period (Uganda Ministry of Health, 2012). Pneumonia cases were defined as inflammation and necrosis in lung tissue resulting in pus formation (Uganda Ministry of Health, 2012), confirmed by a staff physician at BCH (Bishop-Williams, 2020). Cardiovascular diseases included a variety of conditions confirmed by a staff physician, including deep vein thrombosis, ineffective endocarditis, congestive heart failure, hypertension, hypertensive emergencies (including acute target organ damage from encephalopathy, unstable angina, myocardial infarction, pulmonary edema, or stroke), coronary heart disease, pericarditis, pulmonary edema, and rheumatic heart disease (Uganda Ministry of Health, 2012).

Meteorological data

Meteorological data for precipitation (mm) and temperature (°C) were collected from the European Centre for Medium-Range Weather Forecasts Re-analysis (ERA)-Interim Climate Database via research partners at McGill University. The extracted data provided observations for average daily temperature (°C), maximum daily temperature (°C), minimum daily temperature (°C), and daily precipitation (mm), for the geographical cell where BCH was located with a spatial resolution of 0.75° by 0.75°. Meteorological data were extracted to match the dates of BCH visits from January 1, 2011 to December 31, 2014.

Temperature and precipitation variables were generated as independent variables for the regression analyses, including daily average temperature (°C), daily maximum temperature (°C), diurnal temperature range (ie. T_{max} - T_{min}; °C; DTR), and daily average precipitation (mm). Acute and distributed cumulative lag periods for the meteorological variables were created, where lag averages over 1 week prior, 2 weeks prior, 3 weeks prior, and 4 weeks prior to the date of hospital visits were generated for average temperature, max temperature, diurnal temperature range, and average precipitation, reflecting the epidemiology of each health outcome (Armstrong, 2006; Bhaskaran, Gasparrini, Hajat, Smeeth, & Armstrong, 2013) (**Table 3.1**).

Table 3.1 Summary of the weather parameters examined for each health outcome (i.e. acute gastrointestinal illness, pneumonia, and cardiovascular disease) in Kanungu District, Uganda (2011-2014).

Independent variables	**Description**
Acute gastrointestinal illness (dependent variable)	
Daily average temperature	Categories†: • Below 18.6°C℃ • 18.6 to 19.5°C • 19.5 to 20.4°C • Above 20.4°C Lag variables: • Lag day 0: Mean temperature on day of hospital visit • Lag day 0-3: Mean of the mean temperature for three days prior to hospital visit • Lag day 0-7: Mean of the mean temperature for the week prior to hospital visit • Lag day 8-14: Mean of the mean temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the mean temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the mean temperature four weeks prior to hospital visit
Daily maximum temperature	Categories‡: • Below 22°C • 22 to 24°C • 24 to 25.5°C • Over 25.5°C Lag variables: • Lag day 0: Mean maximum temperature on day of hospital visit • Lag day 0-3: Mean of the maximum temperature for three days prior to hospital visit • Lag day 0-7: Mean of the maximum temperature for the week prior to hospital visit • Lag day 8-14: Mean of the maximum temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the maximum temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the maximum temperature four weeks prior to hospital visit
Daily average precipitation	Continuous variable Lag variables: • Lag day 0: Mean precipitation on day of hospital visit • Lag day 0-3: Mean of the mean precipitation for three days prior to hospital visit • Lag day 0-7: Mean of the mean precipitation for the week prior to hospital visit • Lag day 8-14: Mean of the mean precipitation two weeks prior to hospital visit • Lag day 15-21: Mean of the mean precipitation three weeks prior to hospital visit • Lag day 22-28: Mean of the mean precipitation four weeks prior to hospital visit
Pneumonia (dependent variable)	
Daily average temperature	Categories†: • Below 18.6°C • 18.6 to 19.5°C • 19.5 to 20.4°C • Above 20.4°C Lag variables: • Lag day 0: Mean temperature on day of hospital visit • Lag day 0-7: Mean of the mean temperature for the week prior to hospital visit • Lag day 8-14: Mean of the mean temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the mean temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the mean temperature four weeks prior to hospital visit

Daily maximum temperature	Categories[‡]: • Below 22°C • 22 to 24°C • 24 to 25.5°C • Over 25.5°C Lag variables: • Lag day 0: Mean maximum temperature on day of hospital visit • Lag day 0-7: Mean of the maximum temperature for the week prior to hospital visit • Lag day 8-14: Mean of the maximum temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the maximum temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the maximum temperature four weeks prior to hospital visit
Daily diurnal temperature	Categories[*]: • Below 6.4°C • 6.4 to 8.0°C • 8.0 to 9.9°C • Above 9.9°C Lag variables: • Lag day 0: Mean diurnal temperature range on day of hospital visit • Lag day 0-7: Mean diurnal temperature range for the week prior to hospital visit • Lag day 8-14: Mean diurnal temperature range two weeks prior to hospital visit • Lag day 15-21: Mean diurnal temperature range three weeks prior to hospital visit • Lag day 22-28: Mean diurnal temperature range four weeks prior to hospital visit
Daily average precipitation	Continuous variable Lag variables: • Lag day 0: Mean precipitation on day of hospital visit • Lag day 0-7: Mean of the mean precipitation for the week prior to hospital visit • Lag day 8-14: Mean of the mean precipitation two weeks prior to hospital visit • Lag day 15-21: Mean of the mean precipitation three weeks prior to hospital visit • Lag day 22-28: Mean of the mean precipitation four weeks prior to hospital visit
Cardiovascular disease (dependent variable)	
Daily average temperature	Categories[†]: • Below 18.6°C • 18.6 to 19.5°C • 19.5 to 20.4°C • Above 20.4°C Lag variables: • Lag day 0: Mean temperature on day of hospital visit • Lag day 0-3: Mean of the mean temperature for three days prior to hospital visit • Lag day 0-7: Mean of the mean temperature for the week prior to hospital visit • Lag day 8-14: Mean of the mean temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the mean temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the mean temperature four weeks prior to hospital visit
Daily maximum temperature	Categories[‡]: • Below 22°C • 22 to 24°C • 24 to 25.5°C • Over 25.5°C

	Lag variables: • Lag day 0: Mean maximum temperature on day of hospital visit • Lag day 0-3: Mean of the maximum temperature for three days prior to hospital visit • Lag day 0-7: Mean of the maximum temperature for the week prior to hospital visit • Lag day 8-14: Mean of the maximum temperature two weeks prior to hospital visit • Lag day 15-21: Mean of the maximum temperature three weeks prior to hospital visit • Lag day 22-28: Mean of the maximum temperature four weeks prior to hospital visit
Daily average precipitation	Continuous variable Lag variables: • Lag day 0: Mean precipitation on day of hospital visit • Lag day 0-3: Mean of the mean precipitation for three days prior to hospital visit • Lag day 0-7: Mean of the mean precipitation for the week prior to hospital visit • Lag day 8-14: Mean of the mean precipitation two weeks prior to hospital visit • Lag day 15-21: Mean of the mean precipitation three weeks prior to hospital visit • Lag day 22-28: Mean of the mean precipitation four weeks prior to hospital visit
Control variable (confounding variable)	
Seasonality	Fit sine and cosine periodic functions to each health outcome.

†Categories were based on 25, 50, 75 percentile ranks;

‡Categories were based on 25, 50, 75 percentile ranks;

* Categories were based on 25, 50, 75 percentile ranks.

DATA ANALYSIS

Descriptive statistics were performed for health and weather data. Exploratory data analyses were conducted using two by two tables and scatter plots to visualize the data. Counts and proportions of hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular diseases were plotted across the study period (2011-2014) and stratified by sex. Graphical summaries of weather variables were also created.

A causal diagram was created prior to the timeseries regression analyses to identify potential confounders or interaction terms that could impact the association between the weather variables and counts of hospital visits (Appendix 3). Seasonality was identified as a potential confounder and controlled for as a fixed effect using the best fitting sine and cosine Fourier terms for each health outcome (Bhaskaran et al., 2013). The linearity of continuous independent variables with the natural log of each dependant variable was assessed using locally weighted scatterplot smoothing.

Continuous variables that did not meet the linearity assumption were then categorized based on percentile ranks within the data. Potential collinearity between independent variables was assessed using Spearman's rank correlation, with $|r_s|> 0.8$ indicating strong correlation, unless variables were related by design (ie. lag variables). If the correlation was above 0.8, the most biologically plausible variable was retained for model building. A purposeful model building approach was used to fit a timeseries multivariable Poisson model for each health outcome, this approach was repeated for building a female and male model; scientifically plausible variables were iteratively considered in the models until the most parsimonious and best fit model was built (Appendix 4). Unconditional and conditional associations (i.e. controlling for season) between the independent weather variables and dependent counts of hospital visits were explored for each health outcome using a liberal alpha value (α=0.20). The best fit model was built by comparing the fit between full and reduced models using likelihood ratio tests and Bayesian information criterion (BIC); if BIC and likelihood ratio tests gave different conclusions variables were removed based on the results from the likelihood ratio tests. After the best-fit multivariable Poisson models were built for each health outcome, negative binomial models were run to explore over-dispersion; significant likelihood ratio tests for the alpha parameter indicated over-dispersion and that the Poisson regression models did not fit the data. If data were over-dispersed, the purposeful model building approach was repeated using a negative binomial distribution. After the three final timeseries multivariable models were built for each health outcome (i.e. one acute gastrointestinal illness model; one pneumonia model; and one cardiovascular disease model), the model building approach was repeated for each sex. The purposeful model building approach was repeated for each health outcome for only males, and again for only females. The fit of the final models, model assumptions, outliers, and influential points were visually assessed using Pearson residuals, deviance residuals, leverage statistics, and normality using Anscombe residuals. We conducted a sensitivity analysis on potential outliers and influential points by removing them from the final model and examining changes in the magnitude, direction, and significance of each association. Finally, the three models (i.e. model without sex; model for males; model for females) for each health outcome were descriptively explored for differences in the variables included in the best fit models, as well as any differences in the magnitude and direction of associations. All statistical analyses were conducted in STATA/SE® (Version 15.0, Stata Corp, College Station, TX, USA). A p-value of less than 0.05 was considered statistically significant, unless otherwise specified.

ETHICS

This study received approval from the Bwindi Community Hospital, McGill University Research Ethics Board, University of Guelph Research Ethics Board, University of Leeds Research Ethics Office, and University of Alberta Research Ethics Board.

Results

SUMMARY OF HEALTH DATA

A total of 19,209 records were electronically collected over the study period between January 1, 2011 to December 31, 2014. Females (n=10,757/19,209) represented 56.0% of total hospital visits during the study period. Of the total hospital visits with demographic information, 11.31% were acute gastrointestinal illness visits (n=2,173/19,209; n_{female}=1,212/10,757 (11.27%); n_{male}=961/8,452 (11.37%)), 4.35% were pneumonia visits (n=835/19,209; n_{female}=415/10,757 (3.86%); n_{male}=420/8,452 (4.97%)), and 4.45% were cardiovascular disease visits (n=855/19,209; n_{female}=523/10,757 (4.86%); n_{male}=332/8,452 (3.93%)). A descriptive summary of the hospital visits by year, sex, and health outcome are described by **Figure 3.2**.

SUMMARY OF METEOROLOGICAL PARAMETERS

Over the study period, the daily average temperature was 19.53°C and ranged from 16.19°C-22.83°C, the daily minimum temperature ranged from 12.37°C-18.64°C, the daily maximum temperature ranged from 17.78°C-29.83°C. The average diurnal temperature range spanning the study period was 8.11°C, and ranged from 2.37°C-14.28°C. Daily average precipitation ranged from 0 mm-44.77 mm. A summary of the meteorological parameters in Bwindi from January 1, 2011 to December 31, 2014 is presented in **Figure 3.3**.

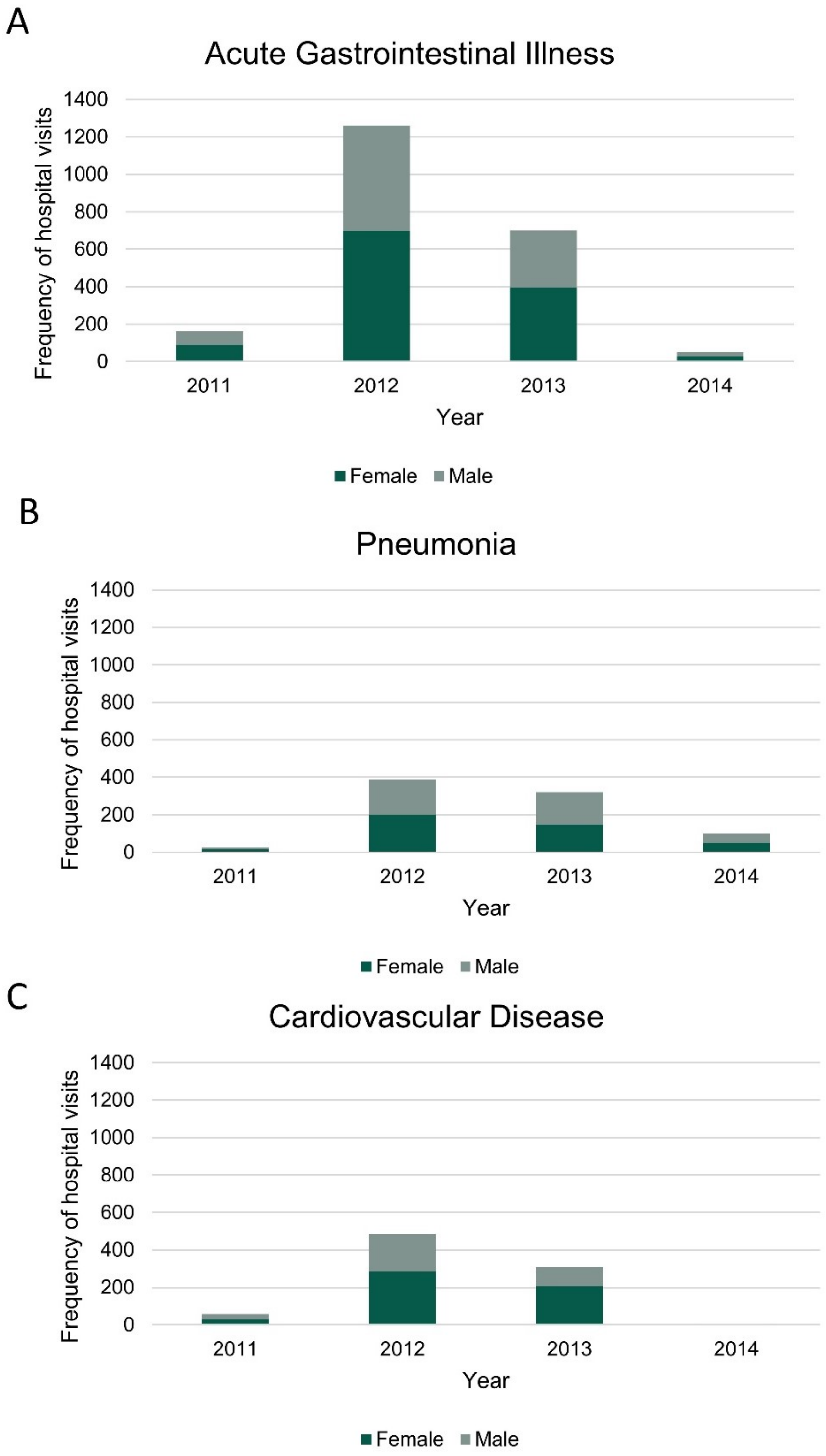


Figure 3.2 The frequency of visits for (**A**) acute gastrointestinal illness, (**B**) pneumonia, and (**C**) cardiovascular disease at Bwindi Community Hospital by year, stratified by sex in Bwindi, Uganda (2011-2014).

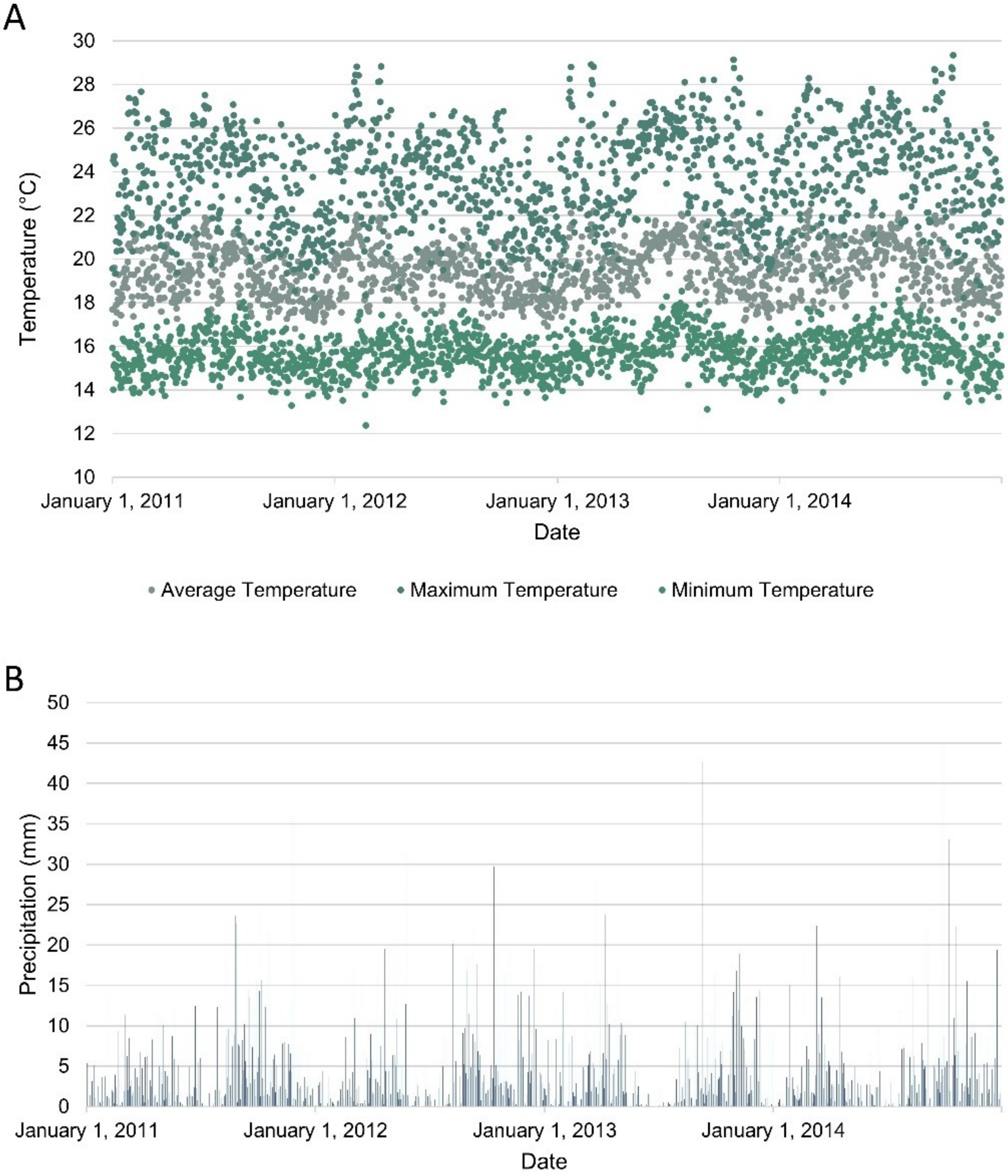


Figure 3.3 Graphical summary of the (**A**) daily average temperature (°C), maximum temperature (°C), minimum temperature (°C) and (**B**) precipitation (mm) from January 1, 2011 to December 31, 2014 in Kanungu District, Uganda.

MULTIVARIABLE TIMESERIES NEGATIVE BINOMIAL REGRESSIONS

The best fit models were multivariable timeseries negative binomial models that controlled for seasonality as a fixed effect using sine and cosine Fourier terms. The best fitting Fourier terms to control for seasonality were nine harmonics for acute gastrointestinal illness, and eleven harmonics for pneumonia and cardiovascular disease. The meteorological variables and magnitudes of association with daily counts of hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular disease differed substantially between the models that did not consider sex and the separately built female and male models; however, the direction of associations mostly remained the same (**Table 3.2-3.4**). There was some residual temporal autocorrelation within the final negative binomial models. A few influential points and outliers were identified; however, in our sensitivity analysis, removal of these observations resulted in marginal changes to the magnitude, direction, and significance of each variable, all observations were retained in the final best fit models.

Table 3.2 Summary of the final fitted time-series negative binomial models for Bwindi Community Hospital acute gastrointestinal illness visits associations with temperature and precipitation (controlling for seasonality), comparing sex-stratified models and models without sex considerations.

Variable		**IRR†**	**P-value**	**95% CI**	**Global P-value**
Acute Gastrointestinal Illness (no sex consideration)					
Average temperature 3 days prior	Below 18.6°C	ref	-	-	0.0059*
	18.6 to 19.5°C	0.830	0.151	0.644-1.070	
	19.5 to 20.4°C	0.749	0.061	0.554-1.014	
	Above 20.4°C	0.482	0.001	0.320-0.727	
Average temperature 3 weeks prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.577	<0.001*	0.447-0.745	
	19.5 to 20.4°C	0.409	<0.001*	0.305-0.549	
	Above 20.4°C	0.276	<0.001*	0.195-0.390	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.503	<0.001*	0.387-0.653	
	19.5 to 20.4°C	0.414	<0.001*	0.308-0.557	
	Above 20.4°C	0.219	<0.001*	0.152-0.314	
Maximum temperature 1 week prior	Below 22°C	ref	-	-	0.0017*
	22 to 24°C	0.554	<0.001*	0.405-0.757	
	24 to 25.5°C	0.491	<0.001*	0.334-0.723	
	Over 25.5°C	0.558	0.023*	0.338-0.921	
	Below 22°C	ref	-	-	<0.0001*
	22 to 24°C	0.687	0.005*	0.529-0.892	

Maximum temperature 2 weeks prior	24 to 25.5°C	0.340	<0.001*	0.351-0.643	
	Over 25.5°C	0.342	<0.001*	0.235-0.491	
Average precipitation 1 week prior	Continuous	1.059	0.019*	1.010-1.112	0.0189*
Acute Gastrointestinal Illness: Female Hospital Visits					
Average temperature 1 week prior	Below 18.6°C	ref	-	-	0.0060*
	18.6 to 19.5°C	1.046	0.804	0.731-1.497	
	19.5 to 20.4°C	1.192	0.455	0.752-1.887	
	Above 20.4°C	0.564	0.080	0.297-1.071	
Average temperature 3 weeks prior	Below 18.6°C	ref	-	-	0.0177*
	18.6 to 19.5°C	0.820	0.141	0.630-1.068	
	19.5 to 20.4°C	0.768	0.076	0.573-1.028	
	Above 20.4°C	0.529	0.002*	0.356-0.785	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.713	0.011*	0.549-0.925	
	19.5 to 20.4°C	0.618	0.001*	0.461-0.828	
	Above 20.4°C	0.386	<0.001*	0.267-0.559	
Maximum temperature 1 week prior	Below 22°C	ref	-	-	0.0022*
	22 to 24°C	0.604	0.004*	0.428-0.851	
	24 to 25.5°C	0.487	0.002*	0.308-0.769	
	Over 25.5°C	0.772	0.404	0.421-1.416	
Maximum temperature 2 weeks prior	Below 22°C	ref	-	-	0.0206*
	22 to 24°C	0.691	0.004*	0.537-0.889	
	24 to 25.5°C	0.721	0.033*	0.533-0.974	
	Over 25.5°C	0.602	0.011*	0.408-0.889	
Acute Gastrointestinal Illness: Males Hospital Visits					
Average temperature 3 days prior	Below 18.6°C	ref	-	-	0.0011*
	18.6 to 19.5°C	0.716	0.008*	0.559-0.917	
	19.5 to 20.4°C	0.668	0.004*	0.509-0.876	
	Above 20.4°C	0.521	<0.001*	0.375-0.724	
Average temperature 2 weeks prior	Below 18.6°C	ref	-	-	0.0417*
	18.6 to 19.5°C	0.840	0.188	0.649-1.088	
	19.5 to 20.4°C	0.665	0.008*	0.491-0.900	
	Above 20.4°C	0.636	0.025*	0.429-0.944	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.940	0.643	0.724-1.220	
	19.5 to 20.4°C	0.806	0.148	0.602-1.080	
	Above 20.4°C	0.432	<0.001*	0.297-0.628	
Max temperature 3 weeks prior	Below 22°C	ref	-	-	0.0367*
	22 to 24°C	0.714	0.007*	0.558-0.912	
	24 to 25.5°C	0.702	0.018*	0.524-0.940	

	Over 25.5°C	0.651	0.027*	0.445-0.952	
Average precipitation 2 weeks prior	Continuous	1.039	0.038*	1.002-1.078	0.0382*

*indicates p<0.05.

[†] Incidence rate ratio (IRR) values are exponentials of the coefficients.

Table 3.3 Summary of the final fitted time-series negative binomial models for Bwindi Community Hospital pneumonia visits associations with temperature and precipitation (controlling for seasonality), comparing sex-stratified models and models without sex considerations.

Variable		**IRR[†]**	**P-value**	**95% CI**	**Global P-value**
Pneumonia (no sex consideration)					
Average temperature 2 weeks prior	Below 18.6°C	ref	-	-	0.0095*
	18.6 to 19.5°C	0.625	0.002*	0.462-0.845	
	19.5 to 20.4°C	0.563	0.001*	0.399-0.794	
	Above 20.4°C	0.588	0.011*	0.392-0.884	
Average temperature 3 weeks prior	Below 18.6°C	ref	-	-	0.0001*
	18.6 to 19.5°C	0.747	0.060	0.552-1.012	
	19.5 to 20.4°C	0.616	0.004*	0.442-0.858	
	Above 20.4°C	0.414	<0.001*	0.277-0.617	
Maximum temperature 1 week prior	Below 22°C	ref	-	-	0.0223*
	22 to 24°C	0.667	0.017*	0.479-0.929	
	24 to 25.5°C	0.548	0.002*	0.374-0.804	
	Over 25.5°C	0.559	0.012*	0.354-0.882	
Maximum temperature 4 weeks prior	Below 22°C	ref	-	-	<0.0001*
	22 to 24°C	0.595	0.001*	0.441-0.803	
	24 to 25.5°C	0.508	<0.001*	0.363-0.710	
	Over 25.5°C	0.344	<0.001*	0.227-0.521	
Average precipitation 1 week prior	Continuous	1.059	0.044*	1.002-1.119	0.0438*
Average precipitation 2 weeks prior	Continuous	1.069	0.007*	1.018-1.122	0.0074*
Pneumonia (female)					
Average temperature 3 weeks prior	Below 18.6°C	ref	-	-	0.0008*
	18.6 to 19.5°C	0.515	<0.001*	0.370-0.716	
	19.5 to 20.4°C	0.557	0.001*	0.391-0.793	
	Above 20.4°C	0.536	0.004*	0.350-0.820	
	Below 22°C	ref	-	-	0.0028*

Same day maximum temperature	22 to 24°C	0.838	0.234	0.627-1.121	
	24 to 25.5°C	0.760	0.079	0.560-1.032	
	Over 25.5°C	0.511	<0.001*	0.357-0.730	
Maximum temperature 4 weeks prior	Below 22°C	ref	-	-	0.0225*
	22 to 24°C	0.699	0.025*	0.512-0.955	
	24 to 25.5°C	0.758	0.126	0.532-1.081	
	Over 25.5°C	0.519	0.005*	0.330-0.817	
Same day average precipitation	Continuous	0.968	0.033*	0.940-0.997	0.0326*
Pneumonia (males)					
Average temperature 2 weeks prior	Below 18.6°C	ref	-	-	0.0111*
	18.6 to 19.5°C	1.002	0.990	0.727-1.381	
	19.5 to 20.4°C	0.673	0.034*	0.467-0.970	
	Above 20.4°C	0.640	0.039*	0.419 -0.977	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	0.0009*
	18.6 to 19.5°C	0.670	0.027*	0.509-0.960	
	19.5 to 20.4°C	0.534	<0.001*	0.376-0.760	
	Above 20.4°C	0.465	<0.001*	0.308-0.701	

*indicates p<0.05.

†Incidence rate ratio (IRR) values are exponentials of the coefficients.

Table 3.4 Summary of the final fitted time-series negative binomial models for Bwindi Community Hospital cardiovascular disease visits associations with temperature and precipitation (controlling for seasonality), comparing sex-stratified models and models without sex considerations.

Variable		**IRR†**	**P-value**	**95% CI**	**Global P-value**
Cardiovascular disease (no sex consideration)					
Average temperature 1 week prior	Below 18.6°C	ref	-	-	0.0003*
	18.6 to 19.5°C	0.584	0.032*	0.356-0.956	
	19.5 to 20.4°C	0.315	<0.001*	0.179-0.556	
	Above 20.4°C	0.348	0.002*	0.177-0.685	
Average temperature 3 weeks prior	Below 18.6°C	ref	-	-	0.0067*
	18.6 to 19.5°C	0.614	0.027*	0.399-0.946	
	19.5 to 20.4°C	0.526	0.011*	0.322-0.862	
	Above 20.4°C	0.359	0.001*	0.201-0.641	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.526	0.007*	0.331-0.837	
	19.5 to 20.4°C	0.411	0.001*	0.245-0.690	
	Above 20.4°C	0.166	<0.001*	0.088-0.315	
Maximum temperature 2 weeks prior	Below 22°C	ref	-	-	0.0055*
	22 to 24°C	1.033	0.889	0.653-1.636	
	24 to 25.5°C	0.677	0.153	0.397-1.156	

	Over 25.5°C	0.430	0.013	0.221-0.837	
Average precipitation 1 week prior	Continuous	1.141	0.002*	1.051-1.238	0.0017*
Cardiovascular disease (female)					
Average temperature 1 week prior	Below 18.6°C	ref	-	-	<0.0001*
	18.6 to 19.5°C	0.508	0.006*	0.314-0.822	
	19.5 to 20.4°C	0.314	<0.001*	0.181-0.543	
	Above 20.4°C	0.144	<0.001*	0.074-0.281	
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	0.0286*
	18.6 to 19.5°C	0.730	0.205	0.449-1.188	
	19.5 to 20.4°C	0.530	0.022*	0.308-0.912	
	Above 20.4°C	0.408	0.006	0.216-0.769	
Cardiovascular disease (male)					
Average temperature 4 weeks prior	Below 18.6°C	ref	-	-	0.0002*
	18.6 to 19.5°C	0.939	0.777	0.606-1.455	
	19.5 to 20.4°C	0.650	0.098	0.391-1.083	
	Above 20.4°C	0.272	<0.001*	0.144-0.514	
Average precipitation 2 weeks prior	Continuous	1.088	0.005*	1.026-1.154	0.0048*

*indicates $p<0.05$.

[†] Incidence rate ratio (IRR) values are exponentials of the coefficients.

Discussion

Females had similar proportions of hospital visits for acute gastrointestinal illness, lower proportions of pneumonia, and higher proportions cardiovascular disease compared to males at Bwindi Community Hospital. We found that different meteorological parameters for temperature and precipitation were significantly associated with hospital visits for acute gastrointestinal illness, pneumonia, and cardiovascular disease. In comparing models that did not consider sex with those models that were separately built by sex, the coefficient magnitudes and significance of temperature and precipitation parameters differed suggesting the association between these health outcomes and meteorological parameters varies by sex.

For acute gastrointestinal illness, we observed similar sex distributions to that in the epidemiological literature, noting that females experience a higher frequency of self-reported cases for acute gastrointestinal illness in Canada (ex. Harper et al., 2015; Majowicz, Horrocks, & Bocking, 2007), China (ex. Zhou et al., 2013) and Southwestern Uganda (ex. Clark et al., 2015). The causal pathway for acute gastrointestinal illness hospital visits could partially be explained by biological differences (e.g., sex differences that exist within the gut microbiota impacting metabolism and digestion (Baars et al., 2018; Kim, Unno, Kim, & Park, 2020); menstruation that can worsen gastrointestinal symptoms, particularly in those who have irritable bowel syndrome and inflammatory bowel disease (Bharadwaj, Barber, Graff, & Shen, 2015; Lim et al., 2013)); however, the sex differences that we observed in visits might also be partially reflective of and a proxy for gendered experiences (e.g. gendered environmental exposure to risks (Vincent et al., 2014), access to sanitation and hygiene resources (Caruso et al., 2017; Kwiringira, Atekyereza, Niwagaba, & Günther, 2014), and access to healthcare services (Sorensen et al., 2018)). For instance, females are often the designated water collectors in Uganda and other parts of Sub-Saharan Africa (Graham, Hirai, & Kim, 2016; Mugumya, Asaba, & Kamya, 2017), resulting in a disproportionate exposure to waterborne diseases including diarrhea, cholera, and dysentery (Denton, 2002). Our results suggest that the specific exposure pathway from weather to acute gastrointestinal illness hospital visits might also differ for males and females in Kanungu District, as we found notable differences between the multivariable models: precipitation was only significant in the model without sex considerations and male-stratified model, while maximum temperature and average temperature was significant in all the multivariable models.

The proportion of pneumonia cases at BCH were slightly higher for males than females, which reflects other epidemiological studies where males were noted to have higher incident cases of pneumonia (Choi, Rho, & Lee, 2011; Falagas, Mourtzoukou, & Vardakas, 2007; Kaplan et al., 2002). This difference could reflect differences in biological causal pathways for males and females (e.g. biological differences in early life where males have disproportionately narrower peripheral pathways increasing the risk of lower respiratory tract infections like pneumonias (Falagas et al., 2007; Gupta, Helms, Jolliffe, & Douglas, 1996); and sex hormone differences in immune function in the lungs (Janele et al., 2006)), as well as gendered causal pathways (e.g. women are often exposed to higher levels of carbon monoxide, hydrocarbons, and particulate matter due to using traditional cooking stoves and spending more time in the home (Okello, Devereux, & Semple, 2018; Sorensen et al., 2018); men have disproportionate exposure to occupational hazards and lifestyle factors related to smoking (Falagas et al., 2007; Landrigan et al., 2017)). Our results suggest that sex and gender differences are also embedded within the weather-pneumonia transmission pathway, as we found notable differences between the multivariable models for the sex-stratified models and model without sex considerations, with differing significant associations between average temperature, max temperature, and precipitation.

The proportion of visits for cardiovascular disease was higher in females compared to males at BCH, which is supported by the epidemiological literature where a meta-analysis noted that females generally experience a higher prevalence of angina, as well as higher rates of myocardial infarction for those in Sub-Saharan Africa (Hemingway et al., 2008; Regitz-Zagrosek & Kararigas, 2017). Biologically, there are sex differences that exist in the mechanistic pathways for cardiovascular disease, due to differences at the cell, receptor, and gene level, which impact risk factors and clinical presentation of disease (Appelman, Rijn, Monique, Boersma, & Peters, 2015; Humphries et al., 2017; Regitz-Zagrosek & Kararigas, 2017). Across genders, while smoking behaviour tends to be higher in men, women who smoke are at a higher risk for cardiovascular disease; however, the direct and indirect causal pathways are not well understood (Humphries et al., 2017). Moreover, sociocultural and gendered factors have impacted the under-diagnosis and under-treatment of cardiovascular disease for women who present with cardiovascular disease (Humphries et al., 2017; Maas & Appelman, 2010). Our results suggest that these sex and gendered differences in cardiovascular disease are also reflected in the weather-cardiovascular disease pathway, as we found differences between the meteorological parameters for the multivariable sex-stratified models and models without sex considerations; there were differing significant associations between average temperature. Average precipitation was only significant variables within the model without sex considerations and male-stratified model. Maximum temperature was only significant in the model without sex considerations.

The direction of associations between weather variables and health outcomes in our study did not significantly vary by sex, and were similar to those reported elsewhere; while the direction of associations did change in the pneumonia male model and cardiovascular disease no sex model the categorical variables were not statistically significant. Though the direction of association did significant change in the pneumonia female model. Indeed, our study results reflect the general positive association between precipitation and acute gastrointestinal illness globally (Levy et al., 2016); however, there is substantial heterogeneity in the literature regarding the direction of the association between gastrointestinal illness and temperature, likely reflecting differences in local environments and populations (Levy et al., 2016), making comparisons to other locales challenging. We found a positive association for precipitation and pneumonia hospital visits and a negative association for temperature and pneumonia visits, perhaps indicating that lower temperatures were associated with an increased risk of pneumonia. Our results were reflective of the heterogeneous climate-health studies conducted in Sub-Saharan Africa (Omonijo & Matzarakis, 2014; Yang et al., 2018). There was a negative association for precipitation and pneumonia hospital visits in the female model, potentially reflecting sex as an independent non-modifiable risk factor in the transmission pathway. Finally, the negative association between temperature and cardiovascular disease hospital visits was surprising and did not reflect the heterogeneous, environmental health literature (De Blois et al., 2015; Ebi, Exuzides, Lau, Kelsh, & Barnston, 2004; Vasconcelos, Freire, Almendra, & Silva, 2013).

While the direction of associations between weather and health outcomes found in our study reflects other literature, we contribute new evidence of the important role that sex plays in these associations in Uganda. Our results suggest that the magnitude of effects and significance of associations between weather and health outcomes varies by sex; as such, given the low levels of sex and/or gender engagement in climate-health research East Africa (Chapter 2), our results highlights an important gap in understanding and we call for future research to move beyond solely treating sex and gender variables as confounders to be controlled for within the statistical analysis, and to also consider examining how sex and/or gender might differ or mediate the impact of climate change on health outcomes. Sex was considered not only as a potential confounder, but as well as an independent plausible risk factor within the transmission pathway between weather and health. Furthermore, we call for future health research that quantitatively examines the effect that other social determinants of health have on weather-health associations, as well as how these determinants of health intersect, allowing for an intersectional approach to data analysis (Cantor & Thorpe, 2018). Considering sex and gender implications on health will allow for the development of more gender-sensitive, relevant, and effective responses to climate change adaptation (Arora-Jonsson, 2011; Denton, 2002; Vincent et al., 2014).

Some study limitations should be noted. Our data included the sex of the patient. As such, we acknowledge that we examined the role of sex in weather-health associations, and that our discussion of gender implications were based on using sex as a proxy as sociocultural factors such as gender were not captured in the BCH health records (Rich-Edwards, Kaiser, Chen, Manson, & Goldstein, 2018). Other limitations that could have impacted the causal pathway for pneumonia but were not captured in this study, including air pollution and other respiratory illnesses. There may have also been residual confounding after adjusting for seasonality in the multivariable timeseries negative binomial models.

Conclusion

While climate change impacts on health are not sex or gender neutral, a recent systematic scoping review found that climate-health research had low levels of sex and/or gender engagement in East Africa (Chapter 2). Furthermore, this review found that when sex and/or gender was considered in the study, it was typically treated it as a confounder and controlled for it within the statistical analysis, without examining how sex and/or gender might differentially impact climate change on health outcomes (Chapter 2). Our study begins to fill this gap in the climate-health literature by demonstrating how the association between weather variables and hospital visits varied by sex across a spectrum of health outcomes in Uganda. Our results suggest that sex *quantitatively* matters in the context of climate change and health in Southwestern Uganda. Incorporating a sex and gender-based analysis in climate-health studies will allow for more meaningful, gender-sensitive approaches to informing climate change adaptation response, programming, and planning.

Acknowledgements

Thank you to Jacqueline Middleton and Kaitlin Patterson for providing your knowledge and guidance on conducting statistical analyses. Thank you to the Bwindi Community Hospital and vibrant communities within the Kanungu District, without you this work would not be possible. Thank you to the Canadian Institutes of Health Research and the University of Alberta Queen Elizabeth II scholarship for funding this work.

References

Ampaire, E. L., Acosta, M., Huyer, S., Kigonya, R., Muchunguzi, P., Muna, R., & Jassogne, L. (2020). Gender in climate change, agriculture, and natural resource policies: insights from East Africa. *Climatic Change*, *158*(1), 43–60. https://doi.org/10.1007/s10584-019-02447-0

Anderson, I., Robson, B., Connolly, M., Al-Yaman, F., Bjertness, E., King, A., … Yap, L. (2016). Indigenous and tribal peoples' health (The Lancet-Lowitja Institute Global Collaboration): a population study. *The Lancet*, *388*(10040), 131–157. https://doi.org/10.1016/S0140-6736(16)00345-7

Appelman, Y., Rijn, B. B. Van, Monique, E., Boersma, E., & Peters, S. A. E. (2015). Sex differences in cardiovascular risk factors and disease prevention. *Atherosclerosis*, *241*(1), 211–218. https://doi.org/10.1016/j.atherosclerosis.2015.01.027

Armstrong, B. (2006). Models for the relationship between ambient temperature and daily mortality. *Epidemiology*, *17*(6), 624–631. https://doi.org/10.1097/01.ede.0000239732.50999.8f

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. https://doi.org/10.1016/j.gloenvcha.2011.01.005

Baaghideh, M., & Mayvaneh, F. (2017). Climate Change and Simulation of Cardiovascular Disease Mortality : A Case Study of Mashhad , Iran. *Iranian Journal of Public Health*, *46*(3), 396–407.

Baars, A., Oosting, A., Lohuis, M., Koehorst, M., El, S., Hugenholt, F., … Vos, P. De. (2018). Sex differences in lipid metabolism are affected by presence of the gut microbiota. *Scientific Reports*, *8*(13426), 1–11. https://doi.org/10.1038/s41598-018-31695-w

Bernard, B., Anthony, E., & Patrick, O. (2010). Dynamics of Land Use / Cover Trends in Kanungu District , South-western Uganda. *Journal of Applied Sciences and Environmental Management*, *14*(4), 67–70.

Berrang-Ford, L., Dingle, K., Ford, J. D., Lee, C., Lwasa, S., Namanya, D. B., … Edge, V. (2012). Vulnerability of indigenous health to climate change: a case study of Uganda's Batwa Pygmies. *Social Science & Medicine (1982)*, *75*(6), 1067–1077. https://doi.org/https://dx.doi.org/10.1016/j.socscimed.2012.04.016

Bharadwaj, S., Barber, M. D., Graff, L. A., & Shen, B. (2015). Symptomatology of irritable bowel syndrome and inflammatory bowel disease during the menstrual cycle. *Gastroenterology Report*, *3*(3), 185–193. https://doi.org/10.1093/gastro/gov010

Bhaskaran, K., Gasparrini, A., Hajat, S., Smeeth, L., & Armstrong, B. (2013). Time series regression studies in environmental epidemiology. *International Journal of Epidemiology*, *42*(4), 1187–1195. https://doi.org/10.1093/ije/dyt092

Bishop-Williams, K. E. (2020). Acute respiratory infections, weather, and Indigenous peoples in Southwestern Uganda. In *Climate change and health outcomes by Indigenous identity : Exploring factors that modify climate change effects on health in Uganda* (pp. 133–151).

Bishop-Williams, K. E., Berrang-Ford, L., Sargeant, J. M., Pearl, D. L., Lwasa, S., Namanya, D. B., … Harper, S. L. (2018). Understanding Weather and Hospital Admissions Patterns to Inform Climate Change Adaptation Strategies in the Healthcare Sector in Uganda. *International Journal of Environmental Research and Public Health*, *15*(11). https://doi.org/https://dx.doi.org/10.3390/ijerph15112402

Bunce, A., & Ford, J. (2015). How is adaptation , resilience , and vulnerability research engaging with gender ? *Environmental Research Letters*, *10*(12). https://doi.org/10.1088/1748-9326/10/12/123003

Busch, J., Berrang-Ford, L., Clark, S., Patterson, K., Windfeld, E., Donnelly, B., … Harper, S. L. (2019). Is the effect of precipitation on acute gastrointestinal illness in southwestern Uganda different between

Indigenous and non-Indigenous communities? *PLoS ONE*, *14*(5), 1–12. https://doi.org/10.1371/journal.pone.0214116

Bwindi Community Hospital. (2014). Bwindi Community Hospital & Uganda Nursing School Bwindi: UCU affiliate annual report 2013/2014. Retrieved from http://www.bwindihospital.com/pdf/Annual report 2013-2014.pdf

Cantor, B. M. N., & Thorpe, L. (2018). Integrating Data On Social Determinants Of Health Into Electronic Health Records. *Health Affairs*, *37*(4), 585–590.

Caruso, B. A., Clasen, T. F., Hadley, C., Yount, K. M., Haardörfer, R., Rout, M., … Cooper, H. L. F. (2017). Understanding and defining sanitation insecurity: Women's gendered experiences of urination, defecation and menstruation in rural Odisha, India. *BMJ Global Health*, *2*(4). https://doi.org/10.1136/bmjgh-2017-000414

Choi, W., Rho, B. H., & Lee, M. (2011). Male predominance of pneumonia and hospitalization in pandemic influenza A (H1N1) 2009 infection. *BMC Research Notes*, *4*(1), 351. https://doi.org/10.1186/1756-0500-4-351

Chris, F., Jim, R., Gary, E., & Libby, W. (2012). *Famine Early Warning Systems Network—Informing Climate Change Adaptation Series A Climate Trend Analysis of Uganda*.

Clark, S., Lwasa, S., Namanya, D. B., Edge, V. L., IHACC Research Team, & Harper, S. L. (2015). The burden and determinants of self-reported acute gastrointestinal illness in an Indigenous Batwa Pygmy population in southwestern Uganda. *Epidemiology and Infection*, *143*, 2287–2298. https://doi.org/10.1017/S0950268814003124

De Blois, J., Kjellstrom, T., Agewall, S., Ezekowitz, J. A., Armstrong, P. W., & Atar, D. (2015). The Effects of Climate Change on Cardiac Health. *Cardiology*, *131*(4), 209–217. https://doi.org/10.1159/000398787

Dębiak, M., Groth, K., Kolossa-Gehring, M., Sauer, A., Tobollik, M., & Wintermeyer, D. (2019). Sex and gender approaches in environmental health research: two exemplary case studies of the German environment agency. *Interdisciplinary Science Reviews*, *44*(2), 114–130. https://doi.org/10.1080/03080188.2019.1603860

Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gender and Development*, *10*(2), 10–20. https://doi.org/10.1080/13552070215903

Donnelly, B., Berrang-Ford, L., Labbé, J., Twesigomwe, S., Lwasa, S., Namanya, D. B., … Michel, P. (2016). Plasmodium falciparum malaria parasitaemia among indigenous Batwa and non-indigenous communities of Kanungu district, Uganda. *Malaria Journal*, *15*(1). https://doi.org/10.1186/s12936-016-1299-1

Druyan, A., Makranz, C., Moran, D., Yanovich, R., Epstein, Y., & Heled, Y. (2012). Heat tolerance in women-Reconsidering the criteria. *Aviation Space and Environmental Medicine*, *83*(1), 58–60. https://doi.org/10.3357/ASEM.3130.2012

Ebi, K. L., Exuzides, K. A., Lau, E., Kelsh, M., & Barnston, A. (2004). Weather changes associated with hospitalizations for cardiovascular diseases and stroke in California , 1983 – 1998. *International Journal of Biometeorology*, *49*, 48–58. https://doi.org/10.1007/s00484-004-0207-5

Egeru, A., Barasa, B., Nampijja, J., Siya, A., Makooma, M. T., & Majaliwa, M. G. J. (2019). Past, present and future climate trends under varied representative concentration pathways for a sub-humid region in Uganda. *Climate*, *7*(3). https://doi.org/10.3390/cli7030035

Falagas, M. E., Mourtzoukou, E. G., & Vardakas, K. Z. (2007). Sex differences in the incidence and severity of respiratory tract infections. *Respiratory Medicine*, *101*, 1845–1863. https://doi.org/10.1016/j.rmed.2007.04.011

Fazey, I., Wise, R. M., Lyon, C., Câmpeanu, C., Moug, P., & Davies, T. E. (2016). Past and future adaptation pathways. *Climate and Development*, *8*(1), 26–44. https://doi.org/10.1080/17565529.2014.989192

Funk, C., Harrison, L., Shukla, S., Pomposi, C., Galu, G., Korecha, D., … Verdin, J. (2018). Examining the role of unusually warm Indo-Pacific sea-surface temperatures in recent African droughts. *QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY*, *144*(1), 360–383. https://doi.org/10.1002/qj.3266

Graham, J. P., Hirai, M., & Kim, S. (2016). An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. *Plos One*, *11*(6), 1–14. https://doi.org/10.1371/journal.pone.0155981

Gupta, R., Helms, P. J., Jolliffe, I. T., & Douglas, A. S. (1996). Seasonal variation in sudden infant death syndrome and bronchiolitis - A common mechanism? *American Journal of Respiratory and Critical Care Medicine*, *154*(2), 431–435. https://doi.org/10.1164/ajrccm.154.2.8756818

Harper, S. L., Edge, V. L., Ford, J., Thomas, M. K., Pearl, D. L., Shirley, J., & McEwen, S. A. (2015). Acute gastrointestinal illness in two Inuit communities: Burden of illness in Rigolet and Iqaluit, Canada. *Epidemiology and Infection*, *143*(14), 3048–3063. https://doi.org/10.1017/S0950268814003744

Hemingway, H., Langenberg, C., Damant, J., Frost, C., Pyörälä, K., & Barrett-Connor, E. (2008). Prevalence of Angina in Women Versus Men A Systematic Review and Meta-Analysis of International Variations Across 31 Countries. *Circulation*, *117*, 1526–1536. https://doi.org/10.1161/CIRCULATIONAHA.107.720953

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., … Zhou, G. (2018). Impacts of 1.5^{o}C Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, … T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*.

Humphries, K. H., Izadnegadar, M., Sedlak, T., Saw, J., Johnston, N., Schneck-Gustafsson, K., … Bairey Merz, C. N. (2017). Sex differences in cardiovascular disease - Impact on care and outcomes. *Frontiers in Neuroendocrinology*, *46*, 46–70. https://doi.org/10.1016/j.yfrne.2017.04.001.Sex

Janele, D., Lang, T., Capellino, S., Cutolo, M., Da Silva, J. A. P., & Straub, R. H. (2006). Effects of testosterone, 17β-estradiol, and downstream estrogens on cytokine secretion from human leukocytes in the presence and absence of cortisol. *Annals of the New York Academy of Sciences*, *1069*, 168–182. https://doi.org/10.1196/annals.1351.015

Kabale District Council. (2011). Kabale District Local Government – Five Year Development Plan. Retrieved from http://npa.ug/wp-content/themes/npatheme/documents/West/Kabale DDP.pdf

Kaplan, V., Angus, D. C., Griffin, M. F., Clermont, G., Watson, R. S., & Linde-zwirble, W. T. (2002). Hospitalized Community-acquired Pneumonia in the Elderly Age- and Sex-related Patterns of Care and Outcome in the United States. *American Journal of Respiratory and Critical Care Medicine*, *165*, 766–772. https://doi.org/10.1164/rccm.2103038

Kim, Y. S., Unno, T., Kim, B., & Park, M. (2020). Sex Differences in Gut Microbiota. *The World Journal of Men's Health*, *38*(1), 48–60.

Kirmayer, L. J., & Brass, G. (2016). Addressing global health disparities among Indigenous peoples. *The Lancet*, *388*(10040), 105–106. https://doi.org/10.1016/S0140-6736(16)30194-5

Kulkarni, M. A., Garrod, G., Berrang-Ford, L., Ssewanyana, I., Harper, S. L., Baraheberwa, N., … Drakeley, C. (2017). Examination of antibody responses as a measure of exposure to Malaria in the indigenous batwa and their non-indigenous neighbors in southwestern Uganda. *American Journal of*

Tropical Medicine and Hygiene, *96*(2), 330–334. https://doi.org/10.4269/ajtmh.16-0559

Kwiringira, J., Atekyereza, P., Niwagaba, C., & Günther, I. (2014). Gender variations in access, choice to use and cleaning of shared latrines; experiences from Kampala Slums, Uganda. *BMC Public Health*, *14*(1), 1–11. https://doi.org/10.1186/1471-2458-14-1180

Labbe, J., Ford, J. D., Berrang-Ford, L., Donnelly, B., Lwasa, S., Namanya, D. B., … Team, I. R. (2016). Vulnerability to the health effects of climate variability in rural southwestern Uganda. *MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE*, *21*(6), 931–953. https://doi.org/10.1007/s11027-015-9635-2

Landrigan, P. J., Fuller, R., Acosta, N. J. R., Adeyi, O., Arnold, R., Basu, N. (Nil), … Zhong, M. (2017). The Lancet Commission on pollution and health. *The Lancet*, *391*(10119), 462–512. https://doi.org/10.1016/S0140-6736(17)32345-0

Levy, K., Woster, A. P., Goldstein, R. S., & Carlton, E. J. (2016). Untangling the Impacts of Climate Change on Waterborne Diseases: a Systematic Review of Relationships between Diarrheal Diseases and Temperature, Rainfall, Flooding, and Drought. *Environmental Science & Technology*, *50*(10), 4905–4922. https://doi.org/10.1021/acs.est.5b06186

Li, A., & Ford, J. (2019). Understanding Socio-Ecological Vulnerability to Climatic Change through a Trajectories of Change Approach : A Case Study from an Indigenous Community in Panama. *Weather Climate and Society*, *11*, 577–593. https://doi.org/10.1175/WCAS-D-18-0093.1

Lim, S. M., Nam, C. M., Kim, Y. N., Lee, S. A., Kim, E. H., Hong, S. P., … Cheon, J. H. (2013). The Effect of the Menstrual Cycle on Inflammatory Bowel Disease : A Prospective Study. *Gut and Liver*, *7*(1), 51–57.

Maas, A. H. E. M., & Appelman, Y. E. A. (2010). Gender differences in coronary heart disease. *Netherlands Heart Journal*, *18*(12), 598–603. https://doi.org/10.1007/s12471-010-0841-y

Magrath, J. (2008). Turning up the Heat: Climate Change and Poverty in Uganda. *Oxfam Policy and Practice: Agriculture, Food and Land*, *8*, 96–125.

Majowicz, S. E., Horrocks, J., & Bocking, K. (2007). Demographic determinants of acute gastrointestinal illness in Canada : a population study. *BMC Public Health*, *7*(162), 1–8. https://doi.org/10.1186/1471-2458-7-162

Martinez Garcia, D., & Sheehan, M. C. (2016). Extreme weather-driven disasters and children’s health. *International Journal of Health Services*, *46*(1), 79–105. https://doi.org/10.1177/0020731415625254

McSweeney, C., New, M., Lizcano, G., & Lu, X. (2010). The UNDP climate change country profiles. *Bulletin of the American Meteorological Society*, *91*(2), 157–166. https://doi.org/10.1175/2009BAMS2826.1

Moosa, C. S., & Tuana, N. (2014). Mapping a Research Agenda Concerning Gender and Climate Change : A Review of the Literature. *Hypatia*, *29*(3).

Mugumya, F., Asaba, R. B., & Kamya, I. R. (2017). Children and Domestic Water Collection in Uganda: Exploring Policy and Intervention Options that Promote Child Protection. In D. Kaawa-Mafigiri & E. J. Walakira (Eds.), *Child Abuse and Neglect in Uganda* (pp. 95–112). https://doi.org/10.1007/978-3-319-48535-5

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). IPCC fifth assessment report. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 1199–1266). Cambridge University Press. https://doi.org/10.1017/CBO9781107415386.002

Okello, G., Devereux, G., & Semple, S. (2018). Women and girls in resource poor countries experience much greater exposure to household air pollutants than men : Results from Uganda and Ethiopia.

Environment International, *119*, 429–437. https://doi.org/10.1016/j.envint.2018.07.002

Omonijo, A. G., & Matzarakis, A. (2014). Pneumonia occurrence in relation to population and thermal environment in Ondo State, Nigeria. *The African Review of Physics*, *9*, 511–525.

Patricola, C. M., & Cook, K. H. (2011). Sub-Saharan Northern African climate at the end of the twenty-first century: Forcing factors and climate change processes. *Climate Dynamics*, *37*(5), 1165–1188. https://doi.org/10.1007/s00382-010-0907-y

Patterson, K., Berrang-Ford, L., Lwasa, S., Namanya, D. B., Ford, J., Twebaze, F., … Harper, S. L. (2017). Seasonal variation of food security among the Batwa of Kanungu, Uganda. *Public Health Nutrition*, *20*(1), 1–11. https://doi.org/https://dx.doi.org/10.1017/S1368980016002494

Polk, D. M., & Naqvi, T. Z. (2005). Cardiovascular disease in women: Sex differences in presentation, risk factors, and evaluation. *Current Cardiology Reports*, *7*(3), 166–172. https://doi.org/10.1007/s11886-005-0072-9

Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., Angula, M. N., Rao, N., … Solomon, D. (2019). Gendered vulnerabilities to climate change : insights from the semi-arid regions of Africa and Asia. *Climate and Development*, *11*(1), 14–26. https://doi.org/10.1080/17565529.2017.1372266

Regitz-Zagrosek, V., & Kararigas, G. (2017). Mechanistic pathways of sex differences in cardiovascular disease. *Physiological Reviews*, *97*(1), 1–37. https://doi.org/10.1152/physrev.00021.2015

Rich-Edwards, J. W., Kaiser, U. B., Chen, G. L., Manson, J. E., & Goldstein, J. M. (2018). Sex and gender differences research design for basic, clinical, and population studies: Essentials for investigators. *Endocrinology Reviews*, *39*, 424–439. https://doi.org/10.1210/er.2017-00246

Rosano, G. M. C., Vitale, C., Marazzi, G., & Volterrani, M. (2007). Menopause and cardiovascular disease: The evidence. *Climacteric*, *10*(SUPPL. 1), 19–24. https://doi.org/10.1080/13697130601114917

Sauer, J., Berrang-Ford, L., Patterson, K., Donnelly, B., Lwasa, S., Namanya, D., … Harper, S. (2018). An analysis of the nutrition status of neighboring Indigenous and non-Indigenous populations in Kanungu District, southwestern Uganda: Close proximity, distant health realities. *Social Science and Medicine*, *217*(September), 55–64. https://doi.org/10.1016/j.socscimed.2018.09.027

Sheffield, P. E., & Landrigan, P. J. (2011). Global climate change and children's health: Threats and strategies for prevention. *Environmental Health Perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

Smith, K. R., Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., … Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 709–754). Cambridge, UK and New York City, USA: Cambridge University Press.

Sorensen, C., Murray, V., Lemery, J., & Balbus, J. (2018). Climate change and women's health: Impacts and policy directions. *PLoS Medicine*, *15*(7), 1–10. https://doi.org/10.1371/journal.pmed.1002603

Takaro, T. K., Knowlton, K., Balmes, J., & Francisco, S. (2013). Climate change and respiratory health : current evidence and knowledge gaps. *Expert Review of Respiratory Medicine*, *7*(4), 349–361. https://doi.org/10.1586/17476348.2013.814367

Uganda Bureau of Statistics. (2016). *National Population and Housing Census 2014 - Main Report*. Kampala, Uganda. https://doi.org/10.1017/CBO9781107415324.004

Uganda Department of Relief Disaster Preparedness and Management. (2016). *Kanungu District Hazard, Risk, and Vulnerability Profile*. Kanungu District.

Uganda Ministry of Health. (2012). *Uganda Clinical Guidelines*.

Vasconcelos, J., Freire, E., Almendra, R., & Silva, G. L. (2013). The impact of winter cold weather on acute myocardial infarctions in Portugal. *Environmental Pollution*, *183*, 14–18. https://doi.org/10.1016/j.envpol.2013.01.037

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014). Cross-chapter box on gender and climate change. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 105–107).

Wang, H., Naghavi, M., Allen, C., Barber, R. M., Bhutta, Z. A., Carter, A., … Death, C. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. *LANCET*, *388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., … Montgomery, H. (2019). The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, *394*(10211), 1836–1878. https://doi.org/10.1016/S0140-6736(19)32596-6

Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., Boykoff, M., … Costello, A. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *Lancet (London, England)*, *391*(10120), 581–630. https://doi.org/https://dx.doi.org/10.1016/S0140-6736(17)32464-9

Yang, W., Cummings, M. J., Bakamutumaho, B., Kayiwa, J., Owor, N., Namagambo, B., … Shaman J. AO - Yang, W. O. http://orcid. org/000.-0002-7555-9728. (2018). Dynamics of influenza in tropical Africa: Temperature, humidity, and co-circulating (sub)types. *Influenza and Other Respiratory Viruses*, *12*(4), 446–456. https://doi.org/http://dx.doi.org/10.1111/irv.12556

Zhang, Y., Feng, R., Wu, R., Zhong, P., Tan, X., Wu, K., & Ma, L. (2017). Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. *Global Health Research and Policy*, *2*(1), 1–9. https://doi.org/10.1186/s41256-017-0030-2

Zhou, Y. J., Dai, Y., Yuan, B. J., Zhen, S. Q., Tang, Z., Wu, G. L., … Chen, Y. (2013). Population-based estimate of the burden of acute gastrointestinal illness in Jiangsu province , China, 2010 – 2011. *Epidemiology and Infection*, *141*, 944–952. https://doi.org/10.1017/S0950268812001331

Chapter 4: Discussion

The Intergovernmental Panel for Climate Change's fifth assessment report identified sex and gender as critical factors impacting the differentiating ways in which climate change is experienced (Smith et al., 2014; Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014a). With climate change known to multiply existing vulnerabilities, it has been theorized that climate change may increase sex and gender-based disparities (Niang et al., 2014; van Daalen, Jung, Dhatt, & Phelan, 2020). This notion of widening health inequities from sex and gender-based disparities is especially worrisome for populations that are already experiencing multiple vulnerabilities, in particular the East African regions of Sub-Saharan Africa (Niang et al., 2014). Sex and gender considerations have emerged within climate-health research as important factors in developing more focused strategies to mitigate and adapt to the impacts of climate change (Ampaire et al., 2020, 2017; van Daalen et al., 2020). This thesis research characterized the sex and gender dimensions of climate-health in East Africa. This research aim was addressed through two research objectives:

1. A scoping review that summarized the current nature and extent of sex and gender considerations in the climate-health literature in East Africa (Chapter 2); and
2. A quantitative exploration of the effect of sex on the association of meteorological parameters with hospital visits at Bwindi Community Hospital in Southwestern, Uganda (Chapter 3).

Summary of thesis findings

Chapter Two revealed that the number of climate-health articles in East Africa that considered sex and/ or gender increased over time, and studies were concentrated on specific countries (i.e. Uganda, Ethiopia, Kenya, and Tanzania). The depth of gender engagement in each study, however remained marginal, with fewer articles with high levels of gender engagement in recent years. A large proportion of qualitative studies scored high in total gender engagement, and tended to contextualize results within a larger framework considering the socio-ecological determinants of health; many discussed and explored the health implications of sex and gender. Conversely, a small proportion of the quantitative literature scored high in total gender engagement; articles often only considered sex and/ or gender as a confounder within regression analyses without further discussion of the implications that sex and/ or gender have on health. This highlighted a gap in the climate-health literature in East Africa: few quantitative climate-health studies had meaningfully engaged with sex and gender considerations.

Most articles that considered sex and/ or gender were rooted in the female experience of climate-health, and were centered on female vulnerability. There was a lack of examination and discussion within the climate-health literature on the sex and gender dimensions on health for males and groups that exist outside of the gender binary. Many climate-health articles were also found to incorrectly used the terms “sex” and “gender” interchangeably and incorrectly. Findings from Chapter 2 presented future directions for climate-health research in East Africa and highlighted the importance of integrating sex and/ or gender considerations within climate-health research.

Chapter Three was situated within the nexus of sex, health, and weather in Uganda, and filled a knowledge gap that was identified in Chapter Two. We conducted a quantitative study exploring the varying associations between weather and health by sex, to explore potential impacts sex and gender have on health within a changing climate. This chapter suggested that meteorological associations with climate-sensitive health outcomes (i.e. acute gastrointestinal illness, pneumonia, and cardiovascular disease) varied by sex. We found that for acute gastrointestinal illness, there was a negative association between average temperature and maximum temperature with hospital visits. While there was a positive association between average precipitation and hospital visits in the model without sex consideration, precipitation was no longer statistically significant in the female-stratified multivariable models. The proportion of hospital visits were similar for females and males for acute gastrointestinal illness.

For pneumonia, we found that there was also a negative association between average temperature, and maximum temperature with hospital visits. There was a positive association between precipitation and hospital visits for the female sex-stratified model and model without sex considerations, and precipitation was not significant in the male sex-stratified model. Differences in the significance and magnitude of associations between meteorological parameters and hospital visits for pneumonia suggest sex and gender influences the transmission pathway. Our findings also revealed a higher proportion of hospital visits for pneumonia in males than females.

Findings for hospital visits for cardiovascular disease included a negative association for average temperature across the three statistical models (i.e. model without sex considerations, female-stratified model, and male-stratified model). There was a positive association for precipitation with hospital visits, which was significant in the model without sex considerations and male-stratified model. Maximum temperature was only significant in the model without sex considerations. These differences suggest that sex influenced the weather-sex transmission pathway. Females represented a higher proportion of hospital visits at the Bwindi Community Hospital for cardiovascular disease than males.

Overall, separately building the models by sex did not change the majority of the direction of relationships; however we found important differences in the significance and magnitude of association for meteorological parameters, indicating sex and gender may influence the transmissions pathways across a variety of health outcomes. Chapter Three highlighted the importance of quantitatively considering sex at the intersection of climate and health. Findings from this chapter confirm the value of climate-health papers meaningfully incorporating sex into quantitative analyses in order to inform more sex- and gender-sensitive climate adaptation and response.

Cross-cutting themes

Future research requires more meaningful integration of sex and gender

There is not enough meaningful engagement with sex and gender in the climate-health literature in East Africa. This theme was discussed and examined in detail in Chapter Two, and Chapter Three worked to fill in this gap. While the number of articles that considered sex and gender have increased in frequency over time, this area of research is still in in its infancy stages where the depth of engagement per article is marginal in East Africa (Chapter 2), and reflects trends in general climate change literature (ie. literature on climate change and not climate-health) globally (Bunce & Ford, 2015). Current climate-health research in East Africa have noted the sex and gender dimensions of health, but have not moved into the next phase of adapting this knowledge into practice (Chapter 2). Much of the climate-health literature in East Africa were quantitative studies that considered sex and gender at the surface-level, noting descriptive differences or including sex as a confounder in the regression modelling, but lacking an in-depth consideration and examination of the direct and indirect pathways of sex and gender on health. Quantitative climate-health studies must go beyond this superficial coverage of sex and gender in analyses, and begin examining and discussing the implications of sex and/ or gender on health in the context of climate change.

There is value in considering sex and gender within the context of climate change

This thesis revealed a common cross-cutting theme, that there is value in considering and understanding how sex and gender impact and influence health in a changing climate. Examining and exploring sex and gender as determinants of health reveal differential underlying vulnerability, and dimensions of health (Vincent, Tschakert, Barnett, Rivera-Ferre, & Woodward, 2014b). Recognizing that climate change is a multiplier of existing vulnerability, research intended to inform climate responses, programming, and planning should consider sex and gender impacts. Developing gender-sensitive and gender-mainstreaming responses can reduce sex and gender-based health inequities and developing resiliency in a changing climate (Niang et al., 2014; Vincent et al., 2014b).

Study strengths and limitations

This research was rooted in the integration and engagement of sex and gender in the examination of climatic impacts on health. Bringing insight into the complex and interacting pathways through which sex and gender effect weather and health will help inform climate-resilient development pathways that are grounded in health equity.

There were some limitations within the scoping review. While the literature review captured non-English articles which were reviewed and included in this study, the search terms were entered in the databases in English. Therefore, it is possible that articles that were indexed in databases in non-English languages may not have been captured in Chapter 2. A limitation from Chapter 3 was the use of sex as a proxy for gender from the hospital data in our discussion of the results. Furthermore, only hospital visits for those who accessed the eQuality insurance scheme were included in this study; this likely contributed to selection bias, as those who were not in the eQuality databases were excluded.

Future directions and implications

This thesis identified several gaps in the climate-health research that should be considered for future research. Chapter 2 identified a gap in the literature on quantitative studies that meaningfully engage and examine the sex and gender dimensions on health. Future quantitative research should go beyond surface-level considerations of sex and gender, and examine the implications of sex and gender on health. Furthermore, future research should fill in research gaps from Djibouti, Eritrea, Mauritius, Comoros, French Southern Territories, British Indian Ocean Territory, and Seychelles on sex and/ or gender considerations on the impacts of climate and health.

Importantly, increasing considerations for sex and gender starts at the level of study design and data collection. Hospital data are often limited in collecting sociodemographic data related to gender and other dimensions of intersectionality. Future electronic healthcare systems should consider collecting data related to the socioecological determinants of health in order to understand how climate-health impacts are modified beyond sex and gender binaries (Cantor & Thorpe, 2018).

Future research situated at the intersection of climate and health should prioritize considerations in how sex and gender impact health. Gender engagement was strikingly low across the climate-health literature in East Africa; therefore there is an urgent need for studies to move towards considering sex and gender within climate-health research to inform climate change responses and strategies. Stakeholders in climate negotiations, climate-response, and policy makers are encouraged to consider sex and gender in all decisions to address underlying vulnerability and health inequities within the context of a warming climate.

Conclusion

Overall, the number of studies considering the concepts of sex and gender within the climate-health literature was increasing overtime; however, the level of gender engagement within these studies was generally low and lacked in-depth and critical examination over time. There is a gap in the climate-health research for meaningful engagement with sex and gender in East Africa, perhaps due to challenges with acknowledging the strengths of integrating sex and gender into research, and a lack of guidelines on how to meaningfully integrate sex and gender considerations. The practice of integrating sex and gender considerations in research bridges knowledge gaps, increases the rigour of scientific research, and informs more equitable and relevant health policy and practice (Day, Mason, Lagosky, & Rochon, 2016; Heidari, Babor, De Castro, Tort, & Curno, 2016). Sex and gender considerations in research is not only good practice, but can also inform policy that improves health and wellbeing (Day et al., 2016). Future climate-health studies are recommended to consider the ways in which sex and gender impact, interact, and intersect with health when conducting climate-health research, ranging from the biomedical sciences, to health geography, to population health.

References

Ampaire, E. L., Acosta, M., Huyer, S., Kigonya, R., Muchunguzi, P., Muna, R., & Jassogne, L. (2020). Gender in climate change, agriculture, and natural resource policies: insights from East Africa. *Climatic Change*, *158*(1), 43–60. https://doi.org/10.1007/s10584-019-02447-0

Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L., & van Asten, P. (2017). Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science and Policy*, *75*(October 2016), 81–90. https://doi.org/10.1016/j.envsci.2017.05.013

Bunce, A., & Ford, J. (2015). How is adaptation , resilience , and vulnerability research engaging with gender ? *Environmental Research Letters*, *10*(12). https://doi.org/10.1088/1748-9326/10/12/123003

Cantor, B. M. N., & Thorpe, L. (2018). Integrating Data On Social Determinants Of Health Into Electronic Health Records. *Health Affairs*, *37*(4), 585–590.

Day, S., Mason, R., Lagosky, S., & Rochon, P. A. (2016). Integrating and evaluating sex and gender in health research. *Health Research Policy and Systems*, *14*(1), 1–5. https://doi.org/10.1186/s12961-016-0147-7

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, *1*(1), 1–9. https://doi.org/10.1186/s41073-016-0007-6

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). IPCC fifth assessment report. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 1199–1266). Cambridge University Press. https://doi.org/10.1017/CBO9781107415386.002

Smith, K. R., Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., … Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 709–754). Cambridge, UK and New York City, USA: Cambridge University Press.

van Daalen, K., Jung, L., Dhatt, R., & Phelan, A. L. (2020). Climate change and gender-based health disparities. *The Lancet Planetary Health*, *4*(2), e44–e45. https://doi.org/10.1016/S2542-5196(20)30001-2

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014a). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *IPCC Fifth Assessment Report* (Vol. 1999, pp. 101–103).

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014b). Cross-chapter box on gender and climate change. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 105–107).

Bibliography

Ampaire, E. L., Acosta, M., Huyer, S., Kigonya, R., Muchunguzi, P., Muna, R., & Jassogne, L. (2020). Gender in climate change, agriculture, and natural resource policies: insights from East Africa. *Climatic Change*, *158*(1), 43–60. https://doi.org/10.1007/s10584-019-02447-0

Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L., & van Asten, P. (2017). Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science and Policy*, *75*(October 2016), 81–90. https://doi.org/10.1016/j.envsci.2017.05.013

Anderson, I., Robson, B., Connolly, M., Al-Yaman, F., Bjertness, E., King, A., … Yap, L. (2016). Indigenous and tribal peoples' health (The Lancet-Lowitja Institute Global Collaboration): a population study. *The Lancet*, *388*(10040), 131–157. https://doi.org/10.1016/S0140-6736(16)00345-7

Anyah, R. O., & Qiu, W. (2012). Characteristic 20th and 21st century precipitation and temperature patterns and changes over the Greater Horn of Africa. *International Journal of Climatology*, *363*(January 2011), 347–363. https://doi.org/10.1002/joc.2270

Appelman, Y., Rijn, B. B. Van, Monique, E., Boersma, E., & Peters, S. A. E. (2015). Sex differences in cardiovascular risk factors and disease prevention. *Atherosclerosis*, *241*(1), 211–218. https://doi.org/10.1016/j.atherosclerosis.2015.01.027

Arksey, H., & O'Malley, L. (2005). Scoping studies: toward a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32.

Armstrong, B. (2006). Models for the relationship between ambient temperature and daily mortality. *Epidemiology*, *17*(6), 624–631. https://doi.org/10.1097/01.ede.0000239732.50999.8f

Arora-Jonsson, S. (2011). Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change*, *21*(2), 744–751. https://doi.org/10.1016/j.gloenvcha.2011.01.005

Baaghideh, M., & Mayvaneh, F. (2017). Climate Change and Simulation of Cardiovascular Disease Mortality : A Case Study of Mashhad , Iran. *Iranian Journal of Public Health*, *46*(3), 396–407.

Baars, A., Oosting, A., Lohuis, M., Koehorst, M., El, S., Hugenholt, F., … Vos, P. De. (2018). Sex differences in lipid metabolism are affected by presence of the gut microbiota. *Scientific Reports*, *8*(13426), 1–11. https://doi.org/10.1038/s41598-018-31695-w

Balehey, S., Tesfay, G., & Balehegn, M. (2018). Traditional gender inequalities limit pastoral women's opportunities for adaptation to climate change: Evidence from the Afar pastoralists of Ethiopia. *PASTORALISM-RESEARCH POLICY AND PRACTICE*, *8*. https://doi.org/10.1186/s13570-018-0129-1

Balikoowa, K., Nabanoga, G., Tumusiime, D. M., & Mbogga, M. S. (2019). Gender differentiated vulnerability to climate change in Eastern Uganda. *Climate and Development*, *11*(10), 839–849. https://doi.org/10.1080/17565529.2019.1580555

Bee, B., Biermann, M., & Tshakhert, P. (2012). Gender, Development, and Rights-Based Approaches: Lessons for Climate Change Adaptation and Adaptive Social Protection. In M. Alston & K. Whittenbury (Eds.), *Research, Action and Policy: Addressing the Gendered Impacts of Climate Change* (pp. 95–108). Dordrecht: Springer.

Bekele, A., Zemenfes, D., Kassa, S., Deneke, A., Taye, M., & Wondimu, S. (2017). Patterns and seasonal variations of perforated peptic ulcer disease: Experience from Ethiopia. *Annals of African Surgery*, *14*(2). Retrieved from http://www.annalsofafricansurgery.com/file_download/271/Article+6.pdf

Bernard, B., Anthony, E., & Patrick, O. (2010). Dynamics of Land Use / Cover Trends in Kanungu District , South-western Uganda. *Journal of Applied Sciences and Environmental Management*, *14*(4), 67–70.

Berrang-Ford, L., Dingle, K., Ford, J. D., Lee, C., Lwasa, S., Namanya, D. B., … Edge, V. (2012). Vulnerability of indigenous health to climate change: a case study of Uganda's Batwa Pygmies. *Social Science & Medicine (1982)*, *75*(6), 1067–1077. https://doi.org/https://dx.doi.org/10.1016/j.socscimed.2012.04.016

Bett, B., Said, M. Y., Sang, R., Bukachi, S., Wanyoike, S., Kifugo, S. C., … Grace, D. (2017). Effects of flood irrigation on the risk of selected zoonotic pathogens in an arid and semi-arid area in the eastern Kenya. *PloS One*, *12*(5), e0172626. https://doi.org/https://dx.doi.org/10.1371/journal.pone.0172626

Bharadwaj, S., Barber, M. D., Graff, L. A., & Shen, B. (2015). Symptomatology of irritable bowel syndrome and inflammatory bowel disease during the menstrual cycle. *Gastroenterology Report*, *3*(3), 185–193. https://doi.org/10.1093/gastro/gov010

Bhaskaran, K., Gasparrini, A., Hajat, S., Smeeth, L., & Armstrong, B. (2013). Time series regression studies in environmental epidemiology. *International Journal of Epidemiology*, *42*(4), 1187–1195. https://doi.org/10.1093/ije/dyt092

Bindoff, N. L., Cheung, W. W. L., Kairo, J. G., Arístegui, J., Guinder, V. A., Hallberg, R., … Williamson, P. (2019). Changing Ocean, Marine Ecosystems, and Dependent Communities. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, … N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*.

Bishop-Williams, K. E. (2020). Acute respiratory infections, weather, and Indigenous peoples in Southwestern Uganda. In *Climate change and health outcomes by Indigenous identity : Exploring factors that modify climate change effects on health in Uganda* (pp. 133–151).

Bishop-Williams, K. E., Berrang-Ford, L., Sargeant, J. M., Pearl, D. L., Lwasa, S., Namanya, D. B., … Harper, S. L. (2018). Understanding Weather and Hospital Admissions Patterns to Inform Climate Change Adaptation Strategies in the Healthcare Sector in Uganda. *International Journal of Environmental Research and Public Health*, *15*(11). https://doi.org/https://dx.doi.org/10.3390/ijerph15112402

Bizimana, J.-P., Twarabamenye, E., Kienberger, S., J.-P., B., & E., T. (2015). Assessing the social vulnerability to malaria in Rwanda. *Malaria Journal*, *14*(1), 2. https://doi.org/http://dx.doi.org/10.1186/1475-2875-14-2

Brottet, E., Jaffar-Bandjee, M.-C., Li-Pat-Yuen, G., Filleul, L., E., B., M.-C., J.-B., & G., L.-P.-Y. (2016). Etiology of Influenza-Like Illnesses from Sentinel Network Practitioners in Reunion Island, 2011-2012. *PLoS ONE*, *11*(9), e0163377. https://doi.org/https://dx.doi.org/10.1371/journal.pone.0163377

Bryson, J. M., Bishop-Williams, K. E., Berrang-Ford, L., Nunez, E. C., Lwasa, S., Namanya, D. B., & Harper, S. L. (2020). Neglected Tropical Diseases in the Context of Climate Change in East Africa: A Systematic Scoping Review. *The American Journal of Tropical Medicine and Hygiene*, *00*(0), 1–12. https://doi.org/10.4269/ajtmh.19-0380

Bunce, A., & Ford, J. (2015). How is adaptation , resilience , and vulnerability research engaging with gender ? *Environmental Research Letters*, *10*(12). https://doi.org/10.1088/1748-9326/10/12/123003

Busch, J., Berrang-Ford, L., Clark, S., Patterson, K., Windfeld, E., Donnelly, B., … Harper, S. L. (2019). Is the effect of precipitation on acute gastrointestinal illness in southwestern Uganda different between Indigenous and non-Indigenous communities? *PLoS ONE*, *14*(5), 1–12. https://doi.org/10.1371/journal.pone.0214116

Bwindi Community Hospital. (2014). Bwindi Community Hospital & Uganda Nursing School Bwindi: UCU affiliate annual report 2013/2014. Retrieved from http://www.bwindihospital.com/pdf/Annual report 2013-2014.pdf

Bwire, G., Malimbo, M., Makumbi, I., Kagirita, A., Wamala, J. F., Kalyebi, P., … Dahlke, M. (2013). Cholera surveillance in Uganda: an analysis of notifications for the years 2007-2011. *The Journal of Infectious Diseases*, *208 Suppl*, S78-85. https://doi.org/https://dx.doi.org/10.1093/infdis/jit203

Bwire, G., Munier, A., Ouedraogo, I., Heyerdahl, L., Komakech, H., Kagirita, A., … Mengel, M. A. (2017). Epidemiology of cholera outbreaks and socio-economic characteristics of the communities in the fishing villages of Uganda: 2011-2015. *PLoS Neglected Tropical Diseases*, *11*(3), e0005407. https://doi.org/http://dx.doi.org/10.1371/journal.pntd.0005407

Canadian Institutes of Health Research. (2019). How to integrate sex and gender into research. Retrieved May 1, 2020, from https://cihr-irsc.gc.ca/e/50836.html

Cantor, B. M. N., & Thorpe, L. (2018). Integrating Data On Social Determinants Of Health Into Electronic Health Records. *Health Affairs*, *37*(4), 585–590.

Caruso, B. A., Clasen, T. F., Hadley, C., Yount, K. M., Haardörfer, R., Rout, M., … Cooper, H. L. F. (2017). Understanding and defining sanitation insecurity: Women's gendered experiences of urination, defecation and menstruation in rural Odisha, India. *BMJ Global Health*, *2*(4). https://doi.org/10.1136/bmjgh-2017-000414

Choi, W., Rho, B. H., & Lee, M. (2011). Male predominance of pneumonia and hospitalization in pandemic influenza A (H1N1) 2009 infection. *BMC Research Notes*, *4*(1), 351. https://doi.org/10.1186/1756-0500-4-351

Chris, F., Jim, R., Gary, E., & Libby, W. (2012). *Famine Early Warning Systems Network—Informing Climate Change Adaptation Series A Climate Trend Analysis of Uganda*.

Christianson, M., Alex, L., Wiklund, A. F., Hammarstrom, A., & Lundman, B. (2012). Sex and Gender Traps and Springboards : A Focus Group Study Among Gender Researchers in Medicine and Health Sciences. *Health Care for Women International*, *33*(8), 739–755. https://doi.org/10.1080/07399332.2011.645970

Clark, S., Lwasa, S., Namanya, D. B., Edge, V. L., IHACC Research Team, & Harper, S. L. (2015). The burden and determinants of self-reported acute gastrointestinal illness in an Indigenous Batwa Pygmy population in southwestern Uganda. *Epidemiology and Infection*, *143*, 2287–2298. https://doi.org/10.1017/S0950268814003124

Cunsolo Willox, A., Stephenson, E., Allen, J., Bourque, F. F., Drossos, A., Elgarøy, S., … Wexler, L. (2015). Examining relationships between climate change and mental health in the Circumpolar North. *REGIONAL ENVIRONMENTAL CHANGE*, *15*(1), 169–182. https://doi.org/10.1007/s10113-014-0630-z

Day, S., Mason, R., Lagosky, S., & Rochon, P. A. (2016). Integrating and evaluating sex and gender in health research. *Health Research Policy and Systems*, *14*(1), 1–5. https://doi.org/10.1186/s12961-016-0147-7

De Blois, J., Kjellstrom, T., Agewall, S., Ezekowitz, J. A., Armstrong, P. W., & Atar, D. (2015). The Effects of Climate Change on Cardiac Health. *Cardiology*, *131*(4), 209–217. https://doi.org/10.1159/000398787

Dębiak, M., Groth, K., Kolossa-Gehring, M., Sauer, A., Tobollik, M., & Wintermeyer, D. (2019). Sex and gender approaches in environmental health research: two exemplary case studies of the German environment agency. *Interdisciplinary Science Reviews*, *44*(2), 114–130. https://doi.org/10.1080/03080188.2019.1603860

Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: Why does gender matter?

Gender and Development, *10*(2), 10–20. https://doi.org/10.1080/13552070215903

Denton, F., Wilbanks, T. J., Abeysinghe, A. C., Burton, I., Gao, Q., Lemos, M. C., … Warner, K. (2014). Climate-resilient pathways: Adaptation, mitigation, and sustainable development. In C. B. Field, V. R. Barros, D. . J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L.White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1101–1131). https://doi.org/10.1017/CBO9781107415379.025

Djoudi, H., Locatelli, B., Vaast, C., Asher, K., Brockhaus, M., & Basnett Sijapati, B. (2016). Beyond dichotomies: Gender and intersecting inequalities in climate change studies. *Ambio*, *45*(s3), 248–262. https://doi.org/10.1007/s13280-016-0825-2

Donnelly, B., Berrang-Ford, L., Labbé, J., Twesigomwe, S., Lwasa, S., Namanya, D. B., … Michel, P. (2016). Plasmodium falciparum malaria parasitaemia among indigenous Batwa and non-indigenous communities of Kanungu district, Uganda. *Malaria Journal*, *15*(1). https://doi.org/10.1186/s12936-016-1299-1

Druyan, A., Makranz, C., Moran, D., Yanovich, R., Epstein, Y., & Heled, Y. (2012). Heat tolerance in women-Reconsidering the criteria. *Aviation Space and Environmental Medicine*, *83*(1), 58–60. https://doi.org/10.3357/ASEM.3130.2012

Dymén, C., Andersson, M., & Langlais, R. (2013). Gendered dimensions of climate change response in Swedish municipalities. *Local Environment*, *18*(9), 1066–1078. https://doi.org/10.1080/13549839.2012.752802

Ebi, K. L., Exuzides, K. A., Lau, E., Kelsh, M., & Barnston, A. (2004). Weather changes associated with hospitalizations for cardiovascular diseases and stroke in California , 1983 – 1998. *International Journal of Biometeorology*, *49*, 48–58. https://doi.org/10.1007/s00484-004-0207-5

Egeru, A., Barasa, B., Nampijja, J., Siya, A., Makooma, M. T., & Majaliwa, M. G. J. (2019). Past, present and future climate trends under varied representative concentration pathways for a sub-humid region in Uganda. *Climate*, *7*(3). https://doi.org/10.3390/cli7030035

Enbiale, W., & Ayalew, A. (2018). Investigation of a Scabies Outbreak in Drought-Affected Areas in Ethiopia. *Tropical Medicine and Infectious Disease*, *3*(4). https://doi.org/https://dx.doi.org/10.3390/tropicalmed3040114

Falagas, M. E., Mourtzoukou, E. G., & Vardakas, K. Z. (2007). Sex differences in the incidence and severity of respiratory tract infections. *Respiratory Medicine*, *101*, 1845–1863. https://doi.org/10.1016/j.rmed.2007.04.011

Fazey, I., Wise, R. M., Lyon, C., Câmpeanu, C., Moug, P., & Davies, T. E. (2016). Past and future adaptation pathways. *Climate and Development*, *8*(1), 26–44. https://doi.org/10.1080/17565529.2014.989192

Ford, J. D., & Smit, B. (2004). A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. *Arctic*, *57*(4), 389–400. https://doi.org/10.14430/arctic516

Funk, C., Harrison, L., Shukla, S., Pomposi, C., Galu, G., Korecha, D., … Verdin, J. (2018). Examining the role of unusually warm Indo-Pacific sea-surface temperatures in recent African droughts. *QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY*, *144*(1), 360–383. https://doi.org/10.1002/qj.3266

Gebrechorkos, S. H., Hülsmann, S., & Bernhofer, C. (2019). Long-term trends in rainfall and temperature using high-resolution climate datasets in East Africa. *Scientific Reports*, *9*(11376), 1–9. https://doi.org/10.1038/s41598-019-47933-8

Gender in conservation and climate policy. (2019). *Nature Climate Change*, *9*(4), 255.

https://doi.org/10.1038/s41558-019-0448-2

Geographic Region. (n.d.). Retrieved June 13, 2019, from https://unstats.un.org/unsd/methodology/m49/

Ghazani, M., Fitzgerald, G., Hu, W., Toloo, G. S., & Xu, Z. (2018). Temperature variability and gastrointestinal infections: A review of impacts and future perspectives. *International Journal of Environmental Research and Public Health*, *15*(4). https://doi.org/10.3390/ijerph15040766

Githinji, V., & Crane, T. A. (2014). Compound Vulnerabilities: The Intersection of Climate Variability and HIV/AIDS in Northwestern Tanzania. *WEATHER CLIMATE AND SOCIETY*, *6*(1), 9–21. https://doi.org/10.1175/WCAS-D-12-00052.1

Golassa, L., Baliraine, F. N., Enweji, N., Erko, B., Swedberg, G., & Aseffa, A. (2015). Microscopic and molecular evidence of the presence of asymptomatic Plasmodium falciparum and Plasmodium vivax infections in an area with low, seasonal and unstable malaria transmission in Ethiopia. *BMC Infectious Diseases*, *15*, 310. https://doi.org/https://dx.doi.org/10.1186/s12879-015-1070-1

Golassa, L., & White, M. T. (2017). Population-level estimates of the proportion of Plasmodium vivax blood-stage infections attributable to relapses among febrile patients attending Adama Malaria Diagnostic Centre, East Shoa Zone, Oromia, Ethiopia. *Malaria Journal*, *16*(1), 301. https://doi.org/https://dx.doi.org/10.1186/s12936-017-1944-3

Graham, J. P., Hirai, M., & Kim, S. (2016). An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. *Plos One*, *11*(6), 1–14. https://doi.org/10.1371/journal.pone.0155981

Gupta, R., Helms, P. J., Jolliffe, I. T., & Douglas, A. S. (1996). Seasonal variation in sudden infant death syndrome and bronchiolitis - A common mechanism? *American Journal of Respiratory and Critical Care Medicine*, *154*(2), 431–435. https://doi.org/10.1164/ajrccm.154.2.8756818

Harper, S. L., Edge, V. L., & Cunsolo Willox, A. (2012). “Changing climate, changing health, changing stories” profile: Using an EcoHealth approach to explore impacts of climate change on inuit health. *EcoHealth*, *9*(1), 89–101. https://doi.org/10.1007/s10393-012-0762-x

Harper, S. L., Edge, V. L., Ford, J., Thomas, M. K., Pearl, D. L., Shirley, J., & McEwen, S. A. (2015). Acute gastrointestinal illness in two Inuit communities: Burden of illness in Rigolet and Iqaluit, Canada. *Epidemiology and Infection*, *143*(14), 3048–3063. https://doi.org/10.1017/S0950268814003744

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, *1*(1), 1–9. https://doi.org/10.1186/s41073-016-0007-6

Hemingway, H., Langenberg, C., Damant, J., Frost, C., Pyörälä, K., & Barrett-Connor, E. (2008). Prevalence of Angina in Women Versus Men A Systematic Review and Meta-Analysis of International Variations Across 31 Countries. *Circulation*, *117*, 1526–1536. https://doi.org/10.1161/CIRCULATIONAHA.107.720953

Herlihy, N., Bar-hen, A., Verner, G., Fischer, H., Sauerborn, R., Depoux, A., … Schütte, S. (2016). Climate change and human health: what are the research trends? A scoping review protocol. *BMJ Open*, *6*(e012022). https://doi.org/10.1136/bmjopen-2016-012022

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., … Zhou, G. (2018). Impacts of 1.5^{o}C Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, … T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*.

Huang, C., Cheng, J., Phung, D., Tawatsupa, B., Hu, W., & Xu, Z. (2018). Mortality burden attributable to heatwaves in Thailand: A systematic assessment incorporating evidence-based lag structure. *Environment International*, *121*, 41–50. https://doi.org/10.1016/j.envint.2018.08.058

Humphries, K. H., Izadnegadar, M., Sedlak, T., Saw, J., Johnston, N., Schneck-Gustafsson, K., … Bairey Merz, C. N. (2017). Sex differences in cardiovascular disease - Impact on care and outcomes. *Frontiers in Neuroendocrinology*, *46*, 46–70. https://doi.org/10.1016/j.yfrne.2017.04.001.Sex

Hutchins, S. S., Bouye, K., Luber, G., Briseno, L., Hunter, C., & Corso, L. (2018). Public Health Agency Responses and Opportunities to Protect Against Health Impacts of Climate Change Among US Populations with Multiple Vulnerabilities. *Journal of Racial and Ethnic Health Disparities*, *5*(6), 1159–1170. https://doi.org/10.1007/s40615-017-0402-9

James, R., Washington, R., Rowell, D. P., & James, R. (2013). Implications of global warming for the climate of African rainforests. *Philosophical Transactions of the Royal Society B*, *368*.

Janele, D., Lang, T., Capellino, S., Cutolo, M., Da Silva, J. A. P., & Straub, R. H. (2006). Effects of testosterone, 17β-estradiol, and downstream estrogens on cytokine secretion from human leukocytes in the presence and absence of cortisol. *Annals of the New York Academy of Sciences*, *1069*, 168–182. https://doi.org/10.1196/annals.1351.015

Johnson, J., Sharman, Z., Vissandje, B., & Stewart, D. E. (2014). Does a Change in Health Research Funding Policy Related to the Integration of Sex and Gender Have an Impact? *PloS One*, *9*(6). https://doi.org/10.1371/journal.pone.0099900

Kabale District Council. (2011). Kabale District Local Government – Five Year Development Plan. Retrieved from http://npa.ug/wp-content/themes/npatheme/documents/West/Kabale DDP.pdf

Kaplan, V., Angus, D. C., Griffin, M. F., Clermont, G., Watson, R. S., & Linde-zwirble, W. T. (2002). Hospitalized Community-acquired Pneumonia in the Elderly Age- and Sex-related Patterns of Care and Outcome in the United States. *American Journal of Respiratory and Critical Care Medicine*, *165*, 766–772. https://doi.org/10.1164/rccm.2103038

Kim, Y. S., Unno, T., Kim, B., & Park, M. (2020). Sex Differences in Gut Microbiota. *The World Journal of Men's Health*, *38*(1), 48–60.

King, B. M. (2010). Point: A call for proper usage of “gender” and “sex” in biomedical publications. *American Journal of Physiology - Regulatory Integrative and Comparative Physiology*, *298*(6), 2009–2010. https://doi.org/10.1152/ajpregu.00694.2009

Kirmayer, L. J., & Brass, G. (2016). Addressing global health disparities among Indigenous peoples. *The Lancet*, *388*(10040), 105–106. https://doi.org/10.1016/S0140-6736(16)30194-5

Kirstein, O. D., Skrip, L., Abassi, I., Iungman, T., Horwitz, B. Z., Gebresilassie, A., … Warburg, A. (2018a). A fine scale eco-epidemiological study on endemic visceral leishmaniasis in north ethiopian villages. *Acta Tropica*, *183*, 64–77. https://doi.org/https://dx.doi.org/10.1016/j.actatropica.2018.04.005

Kirstein, O. D., Skrip, L., Abassi, I., Iungman, T., Horwitz, B. Z., Gebresilassie, A., … Warburg, A. (2018b). A fine scale eco-epidemiological study on endemic visceral leishmaniasis in north ethiopian villages. *Acta Tropica*, *183*, 64–77. https://doi.org/http://dx.doi.org/10.1016/j.actatropica.2018.04.005

Kisauzi, T., Mangheni, M. N., Sseguya, H., & Bashaasha, B. (2012). Gender dimensions of farmer's perceptions and knowledge on climate change in Teso sub-region, Eastern Uganda. *African Crop Science Journal*, *20*(2), 443–451. https://doi.org/10.4314/acsj.v20i2

Kiser, M. M., Samuel, J. C., Mclean, S. E., Muyco, A. P., & Cairns, B. A. (2012). Epidemiology of pediatric injury in Malawi: Burden of disease and implications for prevention. *International Journal of Surgery*, *10*(10), 611–617. https://doi.org/http://dx.doi.org/10.1016/j.ijsu.2012.10.004

Kulkarni, M. A., Garrod, G., Berrang-Ford, L., Ssewanyana, I., Harper, S. L., Baraheberwa, N., …

Drakeley, C. (2017). Examination of antibody responses as a measure of exposure to Malaria in the indigenous batwa and their non-indigenous neighbors in southwestern Uganda. *American Journal of Tropical Medicine and Hygiene*, *96*(2), 330–334. https://doi.org/10.4269/ajtmh.16-0559

Kwiringira, J., Atekyereza, P., Niwagaba, C., & Günther, I. (2014). Gender variations in access, choice to use and cleaning of shared latrines; experiences from Kampala Slums, Uganda. *BMC Public Health*, *14*(1), 1–11. https://doi.org/10.1186/1471-2458-14-1180

Labbe, J., Ford, J. D., Berrang-Ford, L., Donnelly, B., Lwasa, S., Namanya, D. B., … Team, I. R. (2016). Vulnerability to the health effects of climate variability in rural southwestern Uganda. *MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE*, *21*(6), 931–953. https://doi.org/10.1007/s11027-015-9635-2

Lam, S., Dodd, W., Skinner, K., Papadopoulos, A., Zivot, C., & Ford, J. (2019). Community-based monitoring of Indigenous food security in a changing climate : global trends and future directions. *Environmental Research Letters*, *14*(7).

Landrigan, P. J., Fuller, R., Acosta, N. J. R., Adeyi, O., Arnold, R., Basu, N. (Nil), … Zhong, M. (2017). The Lancet Commission on pollution and health. *The Lancet*, *391*(10119), 462–512. https://doi.org/10.1016/S0140-6736(17)32345-0

Levy, K., Woster, A. P., Goldstein, R. S., & Carlton, E. J. (2016). Untangling the Impacts of Climate Change on Waterborne Diseases: a Systematic Review of Relationships between Diarrheal Diseases and Temperature, Rainfall, Flooding, and Drought. *Environmental Science & Technology*, *50*(10), 4905–4922. https://doi.org/10.1021/acs.est.5b06186

Li, A., & Ford, J. (2019). Understanding Socio-Ecological Vulnerability to Climatic Change through a Trajectories of Change Approach : A Case Study from an Indigenous Community in Panama. *Weather Climate and Society*, *11*, 577–593. https://doi.org/10.1175/WCAS-D-18-0093.1

Lim, S. M., Nam, C. M., Kim, Y. N., Lee, S. A., Kim, E. H., Hong, S. P., … Cheon, J. H. (2013). The Effect of the Menstrual Cycle on Inflammatory Bowel Disease : A Prospective Study. *Gut and Liver*, *7*(1), 51–57.

Maas, A. H. E. M., & Appelman, Y. E. A. (2010). Gender differences in coronary heart disease. *Netherlands Heart Journal*, *18*(12), 598–603. https://doi.org/10.1007/s12471-010-0841-y

Magrath, J. (2008). Turning up the Heat: Climate Change and Poverty in Uganda. *Oxfam Policy and Practice: Agriculture, Food and Land*, *8*, 96–125.

Majowicz, S. E., Horrocks, J., & Bocking, K. (2007). Demographic determinants of acute gastrointestinal illness in Canada : a population study. *BMC Public Health*, *7*(162), 1–8. https://doi.org/10.1186/1471-2458-7-162

Martinez Garcia, D., & Sheehan, M. C. (2016). Extreme weather-driven disasters and children's health. *International Journal of Health Services*, *46*(1), 79–105. https://doi.org/10.1177/0020731415625254

Mayala, B. K., Fahey, C. A., Wei, D., Zinga, M. M., Bwana, V. M., Mlacha, T., … Mboera, L. E. (2015). Knowledge, perception and practices about malaria, climate change, livelihoods and food security among rural communities of central Tanzania. *Infectious Diseases of Poverty*, *4*, 21. https://doi.org/https://dx.doi.org/10.1186/s40249-015-0052-2

Mboera, L. E. G., Senkoro, K. P., Mayala, B. K., Rumisha, S. F., Rwegoshora, R. T., Mlozi, M. R. S., & Shayo, E. H. (2010). Spatio-temporal variation in malaria transmission intensity in five agro-ecosystems in Mvomero district, Tanzania. *Geospatial Health*, *4*(2), 167–178. https://doi.org/http://dx.doi.org/10.4081/gh.2010.198

McIver, L., Kim, R., Woodward, A., Hales, S., Spickett, J., Katscherian, D., … Ebi, K. L. (2016). Health impacts of climate change in pacific island countries: A regional assessment of vulnerabilities and adaptation priorities. *Environmental Health Perspectives*, *124*(11), 1707–1714.

https://doi.org/10.1289/ehp.1509756

McSweeney, C., New, M., Lizcano, G., & Lu, X. (2010). The UNDP climate change country profiles. *Bulletin of the American Meteorological Society*, *91*(2), 157–166. https://doi.org/10.1175/2009BAMS2826.1

Mena, E., & Bolte, G. (2019). Intersectionality-based quantitative health research and sex/gender sensitivity: A scoping review. *International Journal for Equity in Health*, *18*(1), 1–12. https://doi.org/10.1186/s12939-019-1098-8

Middleton, J., Cunsolo, A., Jones-Bitton, A., Wright, C. J., & Harper, S. L. (2020). Indigenous mental health in a changing climate: A systematic scoping review of the global literature. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/ab68a9

Moosa, C. S., & Tuana, N. (2014). Mapping a Research Agenda Concerning Gender and Climate Change : A Review of the Literature. *Hypatia*, *29*(3).

Mugumya, F., Asaba, R. B., & Kamya, I. R. (2017). Children and Domestic Water Collection in Uganda: Exploring Policy and Intervention Options that Promote Child Protection. In D. Kaawa-Mafigiri & E. J. Walakira (Eds.), *Child Abuse and Neglect in Uganda* (pp. 95–112). https://doi.org/10.1007/978-3-319-48535-5

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). IPCC fifth assessment report. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 1199–1266). Cambridge University Press. https://doi.org/10.1017/CBO9781107415386.002

Okello, G., Devereux, G., & Semple, S. (2018). Women and girls in resource poor countries experience much greater exposure to household air pollutants than men : Results from Uganda and Ethiopia. *Environment International*, *119*, 429–437. https://doi.org/10.1016/j.envint.2018.07.002

Oketcho, R., Karimuribo, E. D., & Nyaruhucha, C. N. M. (2012). Epidemiological factors in admissions for diarrhoea in 6 - 60-month-old children admitted to Morogoro Regional Hospital, Tanzania. *South African Journal of Child Health*, *6*(3), 81–84. https://doi.org/http://dx.doi.org/10.7196/SAJCH.479

Oksuzyan, A., Juel, K., Vaupel, J. W., & Christensen, K. (2008). Men : good health and high mortality . Sex differences in health and aging *. *Aging Clinical and Experimental Research*, *20*(2), 25–28.

Olive, M.-M., Chevalier, V., Grosbois, V., Tran, A., Andriamandimby, S.-F., Durand, B., … C., R. (2016). Integrated Analysis of Environment, Cattle and Human Serological Data: Risks and Mechanisms of Transmission of Rift Valley Fever in Madagascar. *PLoS Neglected Tropical Diseases*, *10*(7), e0004827. https://doi.org/https://dx.doi.org/10.1371/journal.pntd.0004827

Omonijo, A. G., & Matzarakis, A. (2014). Pneumonia occurrence in relation to population and thermal environment in Ondo State, Nigeria. *The African Review of Physics*, *9*, 511–525.

Oppenheimer, M., Glavovic, B. C., Hinkel, J., Wal, R. van de, Magnan, A. K., Abd-Elgawad, A., … Sebesvari, Z. (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, … N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*.

Patel, S. K., Asia, S., & Mathew, B. (2020). Climate change and women in South Asia : a review and future policy implications and women in. *World Journal of Science, Technology and Sustainable Development*, *17*(2), 145–166. https://doi.org/10.1108/WJSTSD-10-2018-0059

Patricola, C. M., & Cook, K. H. (2011). Sub-Saharan Northern African climate at the end of the twenty-first century: Forcing factors and climate change processes. *Climate Dynamics*, *37*(5), 1165–1188. https://doi.org/10.1007/s00382-010-0907-y

Patterson, K., Berrang-Ford, L., Lwasa, S., Namanya, D. B., Ford, J., Twebaze, F., … Harper, S. L. (2017). Seasonal variation of food security among the Batwa of Kanungu, Uganda. *Public Health Nutrition*, *20*(1), 1–11. https://doi.org/https://dx.doi.org/10.1017/S1368980016002494

Pinchoff, J., Chipeta, J., Banda, G. C., Miti, S., Shields, T., F., C., … Moss, W. J. (2015). Spatial clustering of measles cases during endemic (1998-2002) and epidemic (2010) periods in Lusaka, Zambia. *BMC Infectious Diseases*, *15*(1), 121. https://doi.org/https://dx.doi.org/10.1186/s12879-015-0842-y

Polk, D. M., & Naqvi, T. Z. (2005). Cardiovascular disease in women: Sex differences in presentation, risk factors, and evaluation. *Current Cardiology Reports*, *7*(3), 166–172. https://doi.org/10.1007/s11886-005-0072-9

Preet, R., Nilsson, M., Schumann, B., & Evengård, B. (2010). The gender perspective in climate change and global health. *Global Health Action*, *3*(1), 5720. https://doi.org/10.3402/gha.v3i0.5720

Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., Angula, M. N., Rao, N., … Solomon, D. (2019). Gendered vulnerabilities to climate change : insights from the semi-arid regions of Africa and Asia. *Climate and Development*, *11*(1), 14–26. https://doi.org/10.1080/17565529.2017.1372266

Regitz-Zagrosek, V., & Kararigas, G. (2017). Mechanistic pathways of sex differences in cardiovascular disease. *Physiological Reviews*, *97*(1), 1–37. https://doi.org/10.1152/physrev.00021.2015

Rich-Edwards, J. W., Kaiser, U. B., Chen, G. L., Manson, J. E., & Goldstein, J. M. (2018). Sex and gender differences research design for basic, clinical, and population studies: Essentials for investigators. *Endocrinology Reviews*, *39*, 424–439. https://doi.org/10.1210/er.2017-00246

Ristvedt, S. L. (2014). The evolution of gender. *JAMA Psychiatry*, *71*(1), 13–14. https://doi.org/10.1001/jamapsychiatry.2013.3199

Roba, K. T., O’Connor, T. P., Belachew, T., & O’Brien, N. M. (2015). Seasonal variation in nutritional status and anemia among lactating mothers in two agro-ecological zones of rural Ethiopia: A longitudinal study. *Nutrition (Burbank, Los Angeles County, Calif.)*, *31*(10), 1213–1218. https://doi.org/https://dx.doi.org/10.1016/j.nut.2015.03.007

Roba, K. T., O’Connor, T. P., Belachew, T., O’Brien, N. M., K.T., R., T.P., O., & T., B. (2016). Variations between post- and pre-harvest seasons in stunting, wasting, and Infant and Young Child Feeding (IYCF) practices among children 6-23 months of age in lowland and midland agro-ecological zones of rural Ethiopia. *The Pan African Medical Journal*, *24*, 163. https://doi.org/http://dx.doi.org/10.11604/pamj.2016.24.163.9387

Rosano, G. M. C., Vitale, C., Marazzi, G., & Volterrani, M. (2007). Menopause and cardiovascular disease: The evidence. *Climacteric*, *10*(SUPPL. 1), 19–24. https://doi.org/10.1080/13697130601114917

Rulisa, S., Mens, P. F., Karema, C., Schallig, H. D. F. H., Kaligirwa, N., Vyankandondera, J., & de Vries, P. J. (2009). Malaria has no effect on birth weight in Rwanda. *Malaria Journal*, *8*(1), 194. https://doi.org/http://dx.doi.org/10.1186/1475-2875-8-194

Sallee, M. W., & Flood, J. T. (2012). Using Qualitative Research to Bridge Research, Policy, and Practice. *Theory into Practice*, *51*(2), 137–144. https://doi.org/10.1080/00405841.2012.662873

Sanderson, B. M., Neill, B. C. O., Kiehl, J. T., Meehl, G. A., Knutti, R., & Washington, W. M. (2011). The response of the climate system to very high greenhouse gas emission scenarios. *Environmental Research Letters*, *6*(034005). https://doi.org/10.1088/1748-9326/6/3/034005

Sasaki, S., Suzuki, H., Fujino, Y., Kimura, Y., & Cheelo, M. (2009). Impact of drainage networks on cholera outbreaks in Lusaka, Zambia. *American Journal of Public Health*, *99*(11), 1982–1987. https://doi.org/https://dx.doi.org/10.2105/AJPH.2008.151076

Sauer, J., Berrang-Ford, L., Patterson, K., Donnelly, B., Lwasa, S., Namanya, D., … Harper, S. (2018). An analysis of the nutrition status of neighboring Indigenous and non-Indigenous populations in Kanungu District, southwestern Uganda: Close proximity, distant health realities. *Social Science and Medicine*, *217*(September), 55–64. https://doi.org/10.1016/j.socscimed.2018.09.027

Schiebinger, L., & Stefanick, M. L. (2016). Gender Matters in Biological Research and Medical Practice. *Journal of the American College of Cardiology*, *67*(2), 2–4. https://doi.org/10.1016/j.jacc.2015.11.029

Schramm, S., Kaducu, F. O., Smedemark, S. A., Ovuga, E., & Sodemann, M. (2016). Gender and age disparities in adult undernutrition in northern Uganda: high-risk groups not targeted by food aid programmes. *Tropical Medicine & International Health : TM & IH*, *21*(6), 807–817. https://doi.org/http://dx.doi.org/10.1111/tmi.12708

Shaffer, L. J., & Naiene, L. (2011). Why Analyze Mental Models of Local Climate Change? A Case from Southern Mozambique. *WEATHER CLIMATE AND SOCIETY*, *3*(4), 223–237. https://doi.org/10.1175/WCAS-D-10-05004.1

Sheffield, P. E., & Landrigan, P. J. (2011). Global climate change and children's health: Threats and strategies for prevention. *Environmental Health Perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Smith, K. R., Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., … Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 709–754). Cambridge, UK and New York City, USA: Cambridge University Press.

Smith, P. H., Bessette, A. J., Weinberger, A. H., Sheffer, C. E., & Mckee, S. A. (2016). Sex / gender differences in smoking cessation : A review. *Preventive Medicine*, *92*, 135–140. https://doi.org/10.1016/j.ypmed.2016.07.013

Sorensen, C., Murray, V., Lemery, J., & Balbus, J. (2018). Climate change and women's health: Impacts and policy directions. *PLoS Medicine*, *15*(7), 1–10. https://doi.org/10.1371/journal.pmed.1002603

Souverijns, N., Thiery, W., Demuzere, M., & Lipzig, N. P. M. Van. (2016). Drivers of future changes in East African precipitation Drivers of future changes in East African precipitation. *Environmental Research Letters*, *11*(11).

Sun, S., Tian, L., Cao, W., Lai, P. C., Wong, P. P. Y., Lee, R. S. yin, … Wong, C. M. (2019). Urban climate modified short-term association of air pollution with pneumonia mortality in Hong Kong. *Science of the Total Environment*, *646*, 618–624. https://doi.org/10.1016/j.scitotenv.2018.07.311

Takaro, T. K., Knowlton, K., Balmes, J., & Francisco, S. (2013). Climate change and respiratory health : current evidence and knowledge gaps. *Expert Review of Respiratory Medicine*, *7*(4), 349–361. https://doi.org/10.1586/17476348.2013.814367

Thomas, D. S. G., & Twyman, C. (2005). Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change*, *15*(2), 115–124. https://doi.org/10.1016/j.gloenvcha.2004.10.001

Tricco, A. C., Lillie, E., Zarin, W., Brien, K. K. O., Colquhoun, H., Levac, D., … Garritty, C. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Uganda Bureau of Statistics. (2016). *National Population and Housing Census 2014 - Main Report*.

Kampala, Uganda. https://doi.org/10.1017/CBO9781107415324.004

Uganda Department of Relief Disaster Preparedness and Management. (2016). *Kanungu District Hazard, Risk, and Vulnerability Profile*. Kanungu District.

Uganda Ministry of Health. (2012). *Uganda Clinical Guidelines*.

United Nations Framework Convention for Climate Change. (n.d.). Introduction to gender and climate change. Retrieved June 19, 2020, from https://unfccc.int/gender

van Daalen, K., Jung, L., Dhatt, R., & Phelan, A. L. (2020). Climate change and gender-based health disparities. *The Lancet Planetary Health*, *4*(2), e44–e45. https://doi.org/10.1016/S2542-5196(20)30001-2

Vasconcelos, J., Freire, E., Almendra, R., & Silva, G. L. (2013). The impact of winter cold weather on acute myocardial infarctions in Portugal. *Environmental Pollution*, *183*, 14–18. https://doi.org/10.1016/j.envpol.2013.01.037

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014a). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *IPCC Fifth Assessment Report* (Vol. 1999, pp. 101–103).

Vincent, K. E., Tschakert, P., Barnett, J., Rivera-Ferre, M. G., & Woodward, A. (2014b). Cross-chapter box on gender and climate change. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (pp. 105–107).

Wang, H., Naghavi, M., Allen, C., Barber, R. M., Carter, A., Casey, D. C., … Zuhlke, L. J. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

Wang, Haidong, Naghavi, M., Allen, C., Barber, R. M., Bhutta, Z. A., Carter, A., … Death, C. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. *LANCET*, *388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., … Costello, A. (2015). Health and climate change: policy responses to protect public health. *The Lancet*, *386*(10006), 1861–1914. https://doi.org/https://dx.doi.org/10.1016/S0140-6736(15)60854-6

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Berry, H., … H., M. (2018). The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *The Lancet*, *392*(10163), 2479–2514. https://doi.org/http://dx.doi.org/10.1016/S0140-6736%2818%2932594-7

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., … Montgomery, H. (2019). The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, *394*(10211), 1836–1878. https://doi.org/10.1016/S0140-6736(19)32596-6

Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., Boykoff, M., … Costello, A. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *Lancet (London, England)*, *391*(10120), 581–630. https://doi.org/https://dx.doi.org/10.1016/S0140-6736(17)32464-9

WHO Constitution. (1946). Retrieved May 1, 2020, from https://www.who.int/about/who-we-are/constitution

Wilunda, C., Scanagatta, C., Putoto, G., Montalbetti, F., Segafredo, G., Takahashi, R., … Betran, A. P. (2017). Barriers to utilisation of antenatal care services in South Sudan: a qualitative study in Rumbek North County. *Reproductive Health*, *14*(1), 65. https://doi.org/https://dx.doi.org/10.1186/s12978-017-0327-0

Yang, W., Cummings, M. J., Bakamutumaho, B., Kayiwa, J., Owor, N., Namagambo, B., … Shaman J. AO - Yang, W. O. http://orcid. org/000.-0002-7555-9728. (2018). Dynamics of influenza in tropical Africa: Temperature, humidity, and co-circulating (sub)types. *Influenza and Other Respiratory Viruses*, *12*(4), 446–456. https://doi.org/http://dx.doi.org/10.1111/irv.12556

Yanovich, R., Ketko, I., & Charkoudian, N. (2020). Sex differences in human thermoregulation: Relevance for 2020 and beyond. *Physiology*, *35*(3), 177–184. https://doi.org/10.1152/physiol.00035.2019

Zhang, Y., Feng, R., Wu, R., Zhong, P., Tan, X., Wu, K., & Ma, L. (2017). Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. *Global Health Research and Policy*, *2*(1), 1–9. https://doi.org/10.1186/s41256-017-0030-2

Zhou, Y. J., Dai, Y., Yuan, B. J., Zhen, S. Q., Tang, Z., Wu, G. L., … Chen, Y. (2013). Population-based estimate of the burden of acute gastrointestinal illness in Jiangsu province , China, 2010 – 2011. *Epidemiology and Infection*, *141*, 944–952. https://doi.org/10.1017/S0950268812001331

Appendices

Appendix 1: Scoping review protocol

Research question:

"What is the nature, range, and extent of sex and gender considerations in published literature on climatic variables and health in East Africa?"

SEARCH STRATEGY

Search Methods

An inclusive search string and location search terms will be utilized with relevant databases, in consultation with a university librarian (Sandra Campbell, UofA).

Databases

An initial search through Ovid Medline® will identify literature from the health sciences. Databases EMBASE® and Scopus® will capture literature from the social, natural, and biomedical sciences.

Search String (Search Jan 1, 2001 – Dec 31, 2018: total 13 704 results before deduplication)

The final search was conducted on June 21, 2019 at 1:48pm. Citations from *Ovid Medline*®, *Ovid EMBASE* ®, and *Web of Science*® were exported into DistillerSR® systematic review software. After deduplication 8396 citations were exported from Mendeley® reference management software into DistillerSR® on June 23, 2019.

Ovid Medline® (2001-2018: 3128 results)

Variable	***Search String***
Location *Adapted from the United Nations, Department of Economic and Social Affairs* (https://unstats.un.org/unsd/methodology/m49/)	(East* Africa*) OR (British Indian Ocean) OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR (French Southern Territories) OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR (Reunion island) OR Rwanda OR Seychelles OR Somalia OR (South Sudan) OR Tanzania OR Uganda OR Zambia OR Zimbabwe
Climate variable *Adapted from* Lam et al., 2019; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020.	(climate chang*) OR (climatic chang*) OR (climate variability) OR (climatic variability) OR (weather variability) OR (climate extreme*) OR (global warming) OR weather* OR storm* OR temperature* OR flood* OR drought* OR (sea level rise) OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR (forest fire*) OR (wildfire*) OR humid* OR season* OR (el nino) OR (la nina)
Outcome (health variable)	Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR (well-being) OR (well being) OR wellbeing OR wellness OR nutrition*

Adapted from Herlihy et al., 2016; Watts et al., 2018.	OR morbidity OR mortality OR death OR injur* OR emotion*

Ovid Medline

Multi-field search (all fields): ((East* Africa*) OR (British Indian Ocean) OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR (French Southern Territories) OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR (Reunion island) OR Rwanda OR Seychelles OR Somalia OR (South Sudan) OR Tanzania OR Uganda OR Zambia OR Zimbabwe).af.

AND

Search fields (title, abstract, keyword heading words): ((climate chang*) OR (climatic chang*) OR (climate variability) OR (climatic variability) OR (weather variability) OR (climate extreme*) OR (global warming) OR weather* OR storm* OR temperature* OR flood* OR drought* OR (sea level rise) OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR (forest fire*) OR (wildfire*) OR humid* OR season* OR (el nino) OR (la nina)).ab,kf,ti.

AND

Search fields (title, abstract, keyword heading words): (Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR (well-being) OR (well being) OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*).ab,kf,ti.

DATE RESTRICTION: 2001-2018

Ovid EMBASE® *(2001-2018:4335 results)*

Variable	***Search String***
Location *Adapted from the United Nations, Department of Economic and Social Affairs* (https://unstats.un.org/unsd/methodology/m49/)	(East* Africa*) OR (British Indian Ocean) OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR (French Southern Territories) OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR (Reunion island) OR Rwanda OR Seychelles OR Somalia OR (South Sudan) OR Tanzania OR Uganda OR Zambia OR Zimbabwe
Climate variable *Adapted from* Lam et al., 2019; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020.	(climate chang*) OR (climatic chang*) OR (climate variability) OR (climatic variability) OR (weather variability) OR (climate extreme*) OR (global warming) OR weather* OR storm* OR temperature* OR flood* OR drought* OR (sea level rise) OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR (forest fire*) OR (wildfire*) OR humid* OR season* OR (el nino) OR (la nina)
Outcome (health variable) *Adapted from* Herlihy et al., 2016; Watts et al., 2018.	Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR (well-being) OR (well being) OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*

Ovid EMBASE

Multi-field search (all fields): ((East* Africa*) OR (British Indian Ocean) OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR (French Southern Territories) OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR (Reunion island) OR Rwanda OR Seychelles OR Somalia OR (South Sudan) OR Tanzania OR Uganda OR Zambia OR Zimbabwe).af.

AND

Search fields (title, abstract, keywords): ((climate chang*) OR (climatic chang*) OR (climate variability) OR (climatic variability) OR (weather variability) OR (climate extreme*) OR (global warming) OR weather* OR storm* OR temperature* OR flood* OR drought* OR (sea level rise) OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR (forest fire*) OR (wildfire*) OR humid* OR season* OR (el nino) OR (la nina)).ab,kw,ti.

AND

Search fields (title, abstract, keywords): (Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR (well-being) OR (well being) OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*).ab,kw,ti.

DATE RESTRICTION: 2001-2018

Web of Science® *(Core Collection 2001-2018: 6241 results)*

Variable	***Search String***
Location *Adapted from the United Nations, Department of Economic and Social Affairs (https://unstats.un.org/unsd/methodology/m49/)*	“East* Africa*” OR “British Indian Ocean” OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR “French Southern Territories” OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR Reunion OR Rwanda OR Seychelles OR Somalia OR “South Sudan” OR Tanzania OR Uganda OR Zambia OR Zimbabwe
Climate variable *Adapted from* Lam et al., 2019; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020.	“climate chang*” OR “climatic chang*” OR “climate variability” OR “climatic variability” OR “weather variability” OR climate extreme* OR “global warming” OR weather* OR storm* OR temperature* OR flood* OR drought* OR “sea level rise” OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR “forest fire” OR “wildfire” OR humid* OR season* OR “el nino” OR “la nina”
Outcome (health variable) *Adapted from* Herlihy et al., 2016; Watts et al., 2018.	Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR “well-being” OR “well being” OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*

Web of Science Core Collection:

ALL=("East* Africa*" OR "British Indian Ocean" OR Burundi OR Comoros OR Djibouti OR Ethiopia OR Eritrea OR "French Southern Territories" OR Kenya OR Madagascar OR Malawi OR Mauritius OR Mayotte OR Mozambique OR Reunion OR Rwanda OR Seychelles OR Somalia OR "South Sudan" OR Tanzania OR Uganda OR Zambia OR Zimbabwe) AND TS=("climate chang*" OR "climatic chang*" OR "climate variability" OR "climatic variability" OR "weather variability" OR climate extreme* OR "global warming" OR weather* OR storm* OR temperature* OR flood* OR drought* OR "sea level rise" OR rain* OR heat* OR cool* OR cold* OR snow OR precipitation* OR "forest fire" OR "wildfire" OR humid* OR season* OR "el nino" OR "la nina") AND TS=(Health* OR disease* OR pathogen OR illness* OR ailment OR allerg* OR zoonos* OR infect* OR "well-being" OR "well being" OR wellbeing OR wellness OR nutrition* OR morbidity OR mortality OR death OR injur* OR emotion*)

DATE RESTRICTION: 2001-2018

Refined by: [excluding] **DOCUMENT TYPES:** (BOOK OR PROCEEDINGS PAPER OR MEETING ABSTRACT OR BOOK REVIEW OR NEWS ITEM OR BOOK CHAPTER)

SCREENING

Restrictions

Language restrictions will not be placed on the search string, but all search terms will be entered in English. Date restrictions will be applied for all the literature published from January 1, 2001 to Dec 31, 2018.

Level 1 – Title and Abstract Screening

The titles and abstracts captured by the database searches will undergo Level 1 screening. When all inclusion criteria are met, the article can be placed into Level 2 – full article review screening. If the article partially meets inclusion criteria (e.g. If the article is yes and/ or unsure for selective inclusion criteria), the article moves into Level 2 screening. If the article meets any exclusion criteria, it does not enter full article screening. A second independent reviewer will confirm exclusion of the citation. Stacked forms will be implemented.

Level 2 – Full Article Review

Two independent reviewers will assess articles that passed Level 1 screening for the full article review according to inclusion and exclusion criteria. "Unsure" will not be an option for Level 2 screening. Only articles that meet all Level 2 inclusion criteria will be included in the review. Stacked questions will not be implemented for full article review screening.

Inclusion Criteria

- Published study (primary or secondary publication)
- Population/ Location: region of interest is East Africa[1]
- Outcome: Topic must discuss climatic variables[2] impacts on health outcomes[3]
- Must focus on humans

Exclusion Criteria

- Governmental report, abstract, conference proceeding

- Population does not include: East Africa[1]
- Outcome does not discuss the impact of climatic variables[2] on health[3]
- Does not focus on humans

Screening Questions

Level 1:

1. Does the research discuss issues related to human health? (yes/no/unsure)
2. Does the research have a climatic-focus? (yes/no/unsure)
3. Does the article take place in East Africa? (yes/no/unsure)

Level 2:

1. Is the article a published primary or secondary study? (yes/no)
2. Does the article discuss issues related to human health? (yes/no)
3. Does the article have a climatic-focus? (yes/no)
4. Does the article take place in East Africa? (yes/no)
5. Is sex or gender considered in the methods, results, or discussion? (yes/no)
6. Is the article published between 2001-2018? (yes/no)

DATA COLLECTION AND ANALYSIS

Software

Mendeley® will be used as the reference manager for the scoping review. All of the eligible studies will be uploaded onto the software for reference tracking. Mendeley™ will remove duplicates.

Next, all of the citations from the database searches will be uploaded onto DistillerSR©. The screening forms will be created on the DistillerSR© as per inclusion/ exclusion criteria and will also be used to track reference eligibility as determined by independent reviewers. Screening results will be exported following the PRISMA charting criteria.

Data Extraction

Data extraction will be conducted via DistillerSR© and exported into Microsoft Excel©.

Descriptive Statistics

Data will be collected and reported based on article type (e.g. Primary research, secondary research, governmental report, post-secondary institutional thesis, etc.), publication details, geographic location, and health outcome.

Analysis

A sex and gender-based analysis[4] will be applied during the data analysis to further the understanding of the impacts of climate change on sex-based and gender-based health in East Africa. This framework will consider the ways in which the social determinants of health contribute to various risk factors and disease outcomes.

References

Geographic region of East Africa. United Nations Statistics Division. (2014). Retrieved from: https://unstats.un.org/unsd/methodology/m49/

Lam, S., Dodd, W., Skinner, K., Papadopoulos, A., Zivot, C., Ford, J., ... & IHACC Research Team. (2019). Community-based monitoring of Indigenous food security in a changing climate: Global trends and future directions. *Environmental Research Letters*.

Middleton, J., Cunsolo, A., Jones-Bitton, A., Wright, C. J., & Harper, S. L. (2020). Indigenous mental health in a changing climate: a systematic scoping review of the global literature. *Environmental Research Letters*, *15*(5), 053001.

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Berry, H., ... & Campbell-Lendrum, D. (2018). The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *The Lancet*, *392*(10163), 2479-2514.

How to integrate sex and gender into research. CIHR. (2019). Retrieved from: http://www.cihr-irsc.gc.ca/e/50836.html

Appendix 2: Data extraction form

Question #	Question	Criteria
1	What year was the study published online? (select one)	a) 2009 b) 2010 c) 2011 d) 2012 e) 2013 f) 2014 g) 2015 h) 2016 i) 2017 j) 2018
2	In what region were the data collected? (select all that apply)	a) Not specified b) British Indian Ocean c) Burundi d) Comoros e) Djibouti f) Ethiopia g) Eritrea h) French Southern Territories i) Kenya j) Madagascar k) Malawi l) Mauritius m) Mayotte n) Mozambique o) Reunion Island p) Rwanda q) Seychelles r) Somalia s) South Sudan (formed 2011) t) Tanzania u) Uganda v) Zambia w) Zimbabwe
3	What was the study methodology? (select one)	a) Quantitative b) Qualitative c) Mixed methods
4	What was the climatic variable and/or hazard of the climate-health research? (select all that apply) Climate is defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.	Climate hazards: a) Drought b) Flood c) Storm d) Fire Climate variables: e) Rain/ precipitation f) Temperature g) Humidity h) Seasonality i) Other:

	Hazard is the potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. Drought is a period of abnormally dry weather long enough to cause a serious hydrological imbalance. A period with abnormal precipitation deficit is defined as a meteorological drought. A megadrought is a very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more. Floods are the overflowing of the normal confined of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods. Definitions are adapted from the IPCC glossary of terms (IPCC, 2012).	
5	What was the health outcome of the study? (select all that apply) Grouped by the major research areas of climate and human health according to the National Institute of Environmental Health Sciences.	a) Asthma, respiratory allergies, and airway diseases b) Cancer c) Cardiovascular disease and stroke d) Effects of heat on health e) Foodborne diseases and nutrition f) Mental health, stress-related disorders, and wellbeing g) Vector-borne disease and zoonotic disease h) Water-borne disease i) Weather-related injury, morbidity, mortality j) Neglected tropic diseases k) Human developmental effects, perinatal health, infant health l) Maternal health, antenatal health m) Other:
6	Was sex and /or gender considered within the study? (select one)	a) Yes b) No a. If "No" questions stop here
6.a	Were the terms "sex" and/ or gender" used correctly in the study? (select one) According to the CIHR definitions of sex and gender.	a) Yes c) No
6.1	Was sex and/ or gender considered in the title/abstract? (select one)	a) Yes b) No

6.2	Was sex and/ or gender considered in the introduction? (select one)	a) Yes b) No
6.3	Was sex and/ or gender considered in the design of the study? (select one)	a) Yes b) No
6.3.a	If "yes" to Q6.3 Did authors report **how** sex and/or gender were considered in the study design? (i.e. More explanatory; in the data collection and/or data analysis, justification of exclusion of specific sex/ gender groups) (select one)	a) Yes b) No
6.4	Was sex/ gender considered in the results? (select one)	a) Yes b) No
6.4.a	If "yes" to Q6.4 Were data disaggregated by sex and/or gender? (select one)	a) Yes b) No
6.5	Was sex and/ or gender considered in the discussion? (select one)	a) Yes b) No
6.5.a	If "yes" to Q6.5 Were potential implications of sex and/or gender on the study results and analyses discussed? (select one)	a) Yes b) No
7	What are the sex and/ or gender of study participants? (select one)	a) Males b) Females c) Both d) Other:
Gender Assessment Tool Questions:		
Gender-mainstreaming: extent to which gender concepts are being applied to the health and climate literature in East Africa		
Is there evidence of gender-sensitivity?		
	1. Is there explicit recognition of the different needs and experiences by gender? (select one)	a) Yes b) No
	2. Are there objectives, actions, and/ or indicators that aim to reduce gender disparities? (select one)	a) Yes b) No
	3. Is gender-sensitive language used? (select one)	a) Yes b) No
Is there evidence of gender-responsiveness?		
	1. Are the research findings presented in a gender-disaggregated manner? (select one)	a) Yes b) No
	2. Do progress indicators measure the different impacts experienced by each gender? (select one)	a) Yes b) No
	3. Are there recommendations or evidence of equal participation in decision making processes by all genders? (select one)	a) Yes b) No

Is there evidence of gender-transformativeness?		
	1. Does the research critically analyze social values, organizational practices, and goals? (select one)	a) Yes b) Noa
	2. Does the research promote the rethinking of structures of power as they relate to gender? (select one)	a) Yes b) No
Experience of gender: extent to which the specific needs of different genders are acknowledged and addressed throughout the research processes.		
	Practical needs: Does the research focus on improving the practical and differentiated needs each gender experiences within current gender norms? (select one)	a) Yes b) No
	Strategic needs: Does the research aim to reduce gender inequality through a re-evaluation of power distribution/ social roles/ economic inequality and responsibilities/ legal rights? (select one)	a) Yes b) No
Degree of action: extent of action being taken to reduce gender inequality in climate-health research processes		
	Statements of recognition Does the paper acknowledge that a relationship exists between gender and climate-health research? (select one)	a) Yes b) No
	Groundwork Are recommendations made that would reduce gender inequality in climate-health research? (select one)	a) Yes b) No
	Are recommendations made that aim to reduce gender inequality in climate-health research? (select one)	a) Yes b) No
	Action Does the paper describe concrete actions that have been taken or are being taken to reduce gender inequality in climate-health research? (select one)	a) Yes b) No

Sex and gender-based analysis questions were adapted from the sex and gender equity in research (SAGER) guidelines and the gender assessment tool questions were adapted from Bunce et al. 2015.

References

Glossary of terms. In: *Managing the risks of extreme events and disasters to advance climate change adaptation*. (2012). Retrieved from: https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

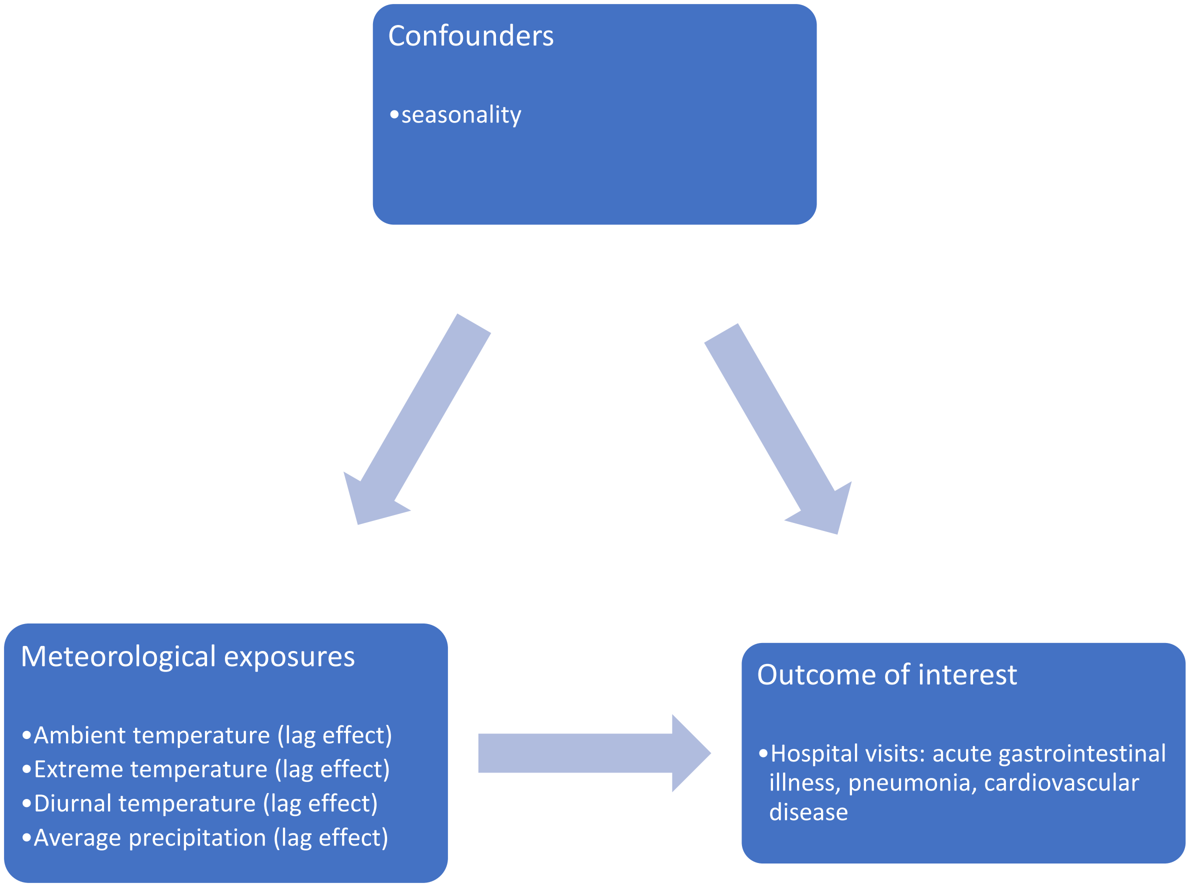
Health Impacts. Climate and Human Health. (n.d.). Retrieved November 11, 2019 from: https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/index.cfm

Sex, Gender and Health Research. (2019). Retrieved December 6, 2019 from: http://cihr-irsc.gc.ca/e/50833.html

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and gender equity in research: rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, *1*(1), 2.

Bunce, A., & Ford, J. (2015). How is adaptation, resilience, and vulnerability research engaging with gender?. *Environmental Research Letters*, *10*(12), 123003.

Appendix 3: Causal Diagram



Appendix 4: Chapter 3 Data Analysis

```
. ***Univariable Poisson analysis for no sex dataset
.
. clear

.
. *1) AGI
.
. tsset date
        time variable:  date, 01jan2011 to 30jun2015
                delta:  1 day

. sort date

.
. *i) Univariable analyses for AGI
. **Generating fourier terms for AGI
. gen degreesn10=(date/365.25)*360

. fourier degreesn10, n(10)

              storage   display    value
variable name   type    format     label      variable label
-------------------------------------------------------------------------------------------------
-------------------------------------------------------
cos_1           float   %9.0g                 cos(degreesn10)
sin_1           float   %9.0g                 sin(degreesn10)
cos_2           float   %9.0g                 cos(2 * degreesn10)
sin_2           float   %9.0g                 sin(2 * degreesn10)
cos_3           float   %9.0g                 cos(3 * degreesn10)
sin_3           float   %9.0g                 sin(3 * degreesn10)
cos_4           float   %9.0g                 cos(4 * degreesn10)
sin_4           float   %9.0g                 sin(4 * degreesn10)
cos_5           float   %9.0g                 cos(5 * degreesn10)
sin_5           float   %9.0g                 sin(5 * degreesn10)
cos_6           float   %9.0g                 cos(6 * degreesn10)
sin_6           float   %9.0g                 sin(6 * degreesn10)
cos_7           float   %9.0g                 cos(7 * degreesn10)
sin_7           float   %9.0g                 sin(7 * degreesn10)
cos_8           float   %9.0g                 cos(8 * degreesn10)
sin_8           float   %9.0g                 sin(8 * degreesn10)
cos_9           float   %9.0g                 cos(9 * degreesn10)
sin_9           float   %9.0g                 sin(9 * degreesn10)
cos_10          float   %9.0g                 cos(10 * degreesn10)
sin_10          float   %9.0g                 sin(10 * degreesn10)

. glm agi cos* sin* date, family(poisson)

Iteration 0:   log likelihood =  -2021.741
Iteration 1:   log likelihood = -1984.2358
Iteration 2:   log likelihood = -1984.2067
Iteration 3:   log likelihood = -1984.2067

Generalized linear models                          No. of obs      =        995
Optimization     : ML                              Residual df     =        973
                                                   Scale parameter =          1
Deviance         =  2149.243371                    (1/df) Deviance =   2.208883
Pearson          =  2114.957734                    (1/df) Pearson  =   2.173646

Variance function: V(u) = u                        [Poisson]
Link function    : g(u) = ln(u)                    [Log]

                                                   AIC             =   4.032576
Log likelihood   = -1984.206732                    BIC             =  -4567.125

------------------------------------------------------------------------------
             |                 OIM
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
       cos_1 |   .1445863   .0321802     4.49   0.000     .0815143    .2076584
       cos_2 |  -.1818671   .0323732    -5.62   0.000    -.2453175   -.1184167
       cos_3 |  -.0246787   .0323017    -0.76   0.445    -.0879889    .0386316
       cos_4 |    .056686   .0319622     1.77   0.076    -.0059587    .1193308
       cos_5 |   .0337005   .0324455     1.04   0.299    -.0298915    .0972926
       cos_6 |   .0441626   .0320452     1.38   0.168    -.0186449    .1069701
       cos_7 |  -.0499907   .0318495    -1.57   0.117    -.1124145    .0124332
       cos_8 |   .0082521   .0315823     0.26   0.794    -.0536482    .0701524
       cos_9 |  -.0559636     .03213    -1.74   0.082    -.1189372      .00701
      cos_10 |  -.0447869   .0311345    -1.44   0.150    -.1058094    .0162355
       sin_1 |   .1664087    .032356     5.14   0.000     .1029921    .2298253
       sin_2 |  -.0031604   .0318882    -0.10   0.921    -.0656602    .0593394
       sin_3 |   .0015121   .0318497     0.05   0.962    -.0609122    .0639364
       sin_4 |  -.0387022   .0319681    -1.21   0.226    -.1013585     .023954
       sin_5 |   .0272731   .0315301     0.86   0.387    -.0345248     .089071
       sin_6 |  -.0749896   .0319823    -2.34   0.019    -.1376737   -.0123054
       sin_7 |   .0364815    .032099     1.14   0.256    -.0264315    .0993945
       sin_8 |  -.0695822   .0321937    -2.16   0.031    -.1326808   -.0064837
       sin_9 |   .0904676   .0316698     2.86   0.004      .028396    .1525392
      sin_10 |   .0549403   .0312897     1.76   0.079    -.0063863     .116267
        date |  -.0018531   .0000807   -22.96   0.000    -.0020112   -.0016949
       _cons |   36.61008    1.55643    23.52   0.000     33.55954    39.66063
------------------------------------------------------------------------------

.
. *Same date mean T
. *unconditional
. xi: poisson agi i.T_C
i.T_C             _IT_C_1-4           (naturally coded; _IT_C_1 omitted)

Iteration 0:   log likelihood = -2346.3662
Iteration 1:   log likelihood =  -2346.366

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =      65.20
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2346.366                       Pseudo R2         =     0.0137

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     _IT_C_2 |  -.0575864   .0568562    -1.01   0.311    -.1690225    .0538498
     _IT_C_3 |  -.0730837   .0565062    -1.29   0.196    -.1838337    .0376663
     _IT_C_4 |   -.494111   .0674552    -7.33   0.000    -.6263207   -.3619013
       _cons |   .9071582   .0391031    23.20   0.000     .8305176    .9837989
------------------------------------------------------------------------------

. testparm _IT_C*

 ( 1)  [agi]_IT_C_2 = 0
 ( 2)  [agi]_IT_C_3 = 0
 ( 3)  [agi]_IT_C_4 = 0

           chi2(  3) =   59.18
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.T_C cos* sin*
i.T_C             _IT_C_1-4           (naturally coded; _IT_C_1 omitted)

Iteration 0:   log likelihood = -2261.0504
Iteration 1:   log likelihood =  -2261.046
Iteration 2:   log likelihood =  -2261.046

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     235.84
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2261.046                       Pseudo R2         =     0.0496
```

```
------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     _IT_C_2 |  -.0822194   .0608084    -1.35   0.176    -.2014017    .0369628
     _IT_C_3 |  -.0704716   .0628615    -1.12   0.262    -.1936779    .0527346
     _IT_C_4 |  -.4671226   .0759226    -6.15   0.000    -.6159283    -.318317
       cos_1 |   .1885932   .0344036     5.48   0.000     .1211634     .256023
       cos_2 |  -.0832696   .0325999    -2.55   0.011    -.1471642    -.019375
       cos_3 |  -.0450524    .032724    -1.38   0.169    -.1091903    .0190855
       cos_4 |   .0458987   .0319768     1.44   0.151    -.0167747     .108572
       cos_5 |   .0338121     .03248     1.04   0.298    -.0298476    .0974717
       cos_6 |  -.0230325   .0320212    -0.72   0.472    -.0857928    .0397279
       cos_7 |  -.0140542   .0320272    -0.44   0.661    -.0768263    .0487179
       cos_8 |  -.0162922   .0315178    -0.52   0.605    -.0780659    .0454816
       cos_9 |  -.0340663   .0321063    -1.06   0.289    -.0969934    .0288609
      cos_10 |  -.0615584   .0310687    -1.98   0.048    -.1224519   -.0006649
       sin_1 |   .2502365   .0333252     7.51   0.000     .1849203    .3155527
       sin_2 |   .0886916   .0324351     2.73   0.006     .0251198    .1522633
       sin_3 |  -.0471993   .0319235    -1.48   0.139    -.1097682    .0153697
       sin_4 |  -.0174477   .0321126    -0.54   0.587    -.0803872    .0454918
       sin_5 |  -.0176733   .0314992    -0.56   0.575    -.0794107     .044064
       sin_6 |   -.044425   .0320695    -1.39   0.166    -.1072801    .0184301
       sin_7 |   .0318412   .0320789     0.99   0.321    -.0310322    .0947146
       sin_8 |  -.0878353   .0323445    -2.72   0.007    -.1512294   -.0244412
       sin_9 |    .113737   .0317278     3.58   0.000     .0515517    .1759223
      sin_10 |   .0387963   .0313714     1.24   0.216    -.0226906    .1002832
       _cons |   .8670193   .0440407    19.69   0.000     .7807011    .9533375
------------------------------------------------------------------------------

. testparm _IT_C_*

 ( 1)  [agi]_IT_C_2 = 0
 ( 2)  [agi]_IT_C_3 = 0
 ( 3)  [agi]_IT_C_4 = 0

           chi2(  3) =   43.42
         Prob > chi2 =    0.0000

. *p<0.0001
. *Include
.
. *mean T lag 0-3 days
. *unconditional
. xi: poisson agi i.avmean_TL0_3
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2315.7684
Iteration 1:   log likelihood = -2315.7643
Iteration 2:   log likelihood = -2315.7643

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     126.41
                                                  Prob > chi2       =     0.0000
Log likelihood = -2315.7643                       Pseudo R2         =     0.0266

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.1330223   .0548811    -2.42   0.015    -.2405873   -.0254572
_Iavmean_TL_3 |  -.2431261   .0578799    -4.20   0.000    -.3565686   -.1296835
_Iavmean_TL_4 |   -.796113   .0774858   -10.27   0.000    -.9479823   -.6442436
        _cons |   1.007422   .0409273    24.61   0.000     .9272061    1.087638
-------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  110.42
```

```
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmean_TL0_3 cos* sin*
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2229.0807
Iteration 1:   log likelihood = -2229.0721
Iteration 2:   log likelihood = -2229.0721

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     299.79
                                                  Prob > chi2       =     0.0000
Log likelihood = -2229.0721                       Pseudo R2         =     0.0630

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.3150416   .0651377    -4.84   0.000    -.4427092   -.1873741
_Iavmean_TL_3 |  -.4114735    .071961    -5.72   0.000    -.5525144   -.2704325
_Iavmean_TL_4 |    -.94353     .09271   -10.18   0.000    -1.125238   -.7618217
        cos_1 |    .083196   .0366189     2.27   0.023     .0114242    .1549677
        cos_2 |  -.0577114   .0332169    -1.74   0.082    -.1228154    .0073925
        cos_3 |  -.0754296   .0329414    -2.29   0.022    -.1399935   -.0108657
        cos_4 |   .0379876   .0319809     1.19   0.235    -.0246938    .1006689
        cos_5 |   .0385923   .0324684     1.19   0.235    -.0250445    .1022291
        cos_6 |  -.0340866   .0322128    -1.06   0.290    -.0972226    .0290493
        cos_7 |  -.0296674    .031987    -0.93   0.354    -.0923608    .0330259
        cos_8 |  -.0038054    .031722    -0.12   0.905    -.0659794    .0583687
        cos_9 |  -.0206905    .032224    -0.64   0.521    -.0838483    .0424673
       cos_10 |  -.0608594   .0310768    -1.96   0.050    -.1217688      .00005
        sin_1 |   .3045278   .0344497     8.84   0.000     .2370077     .372048
        sin_2 |   .1322604    .032783     4.03   0.000     .0680069    .1965139
        sin_3 |  -.0112622   .0321963    -0.35   0.726    -.0743658    .0518414
        sin_4 |   .0037645   .0322264     0.12   0.907    -.0593981    .0669271
        sin_5 |    .000199   .0315495     0.01   0.995    -.0616369    .0620348
        sin_6 |  -.0401263   .0322051    -1.25   0.213    -.1032472    .0229945
        sin_7 |   .0400945   .0324278     1.24   0.216    -.0234628    .1036519
        sin_8 |  -.0917793   .0323992    -2.83   0.005    -.1552806   -.0282779
        sin_9 |   .0940291    .031857     2.95   0.003     .0315904    .1564677
       sin_10 |   .0501974   .0314626     1.60   0.111    -.0114681     .111863
        _cons |    1.09822   .0506637    21.68   0.000     .9989211    1.197519
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  104.06
         Prob > chi2 =    0.0000

. *p<0.0001
. *include in model
.
. *mean T lag 0-7 days
. *uncoditional
. xi: poisson agi i.avmean_TL0_7
i.avmean_TL0_7    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2325.0827
Iteration 1:   log likelihood = -2325.0814
Iteration 2:   log likelihood = -2325.0814

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     107.77
                                                  Prob > chi2       =     0.0000
Log likelihood = -2325.0814                       Pseudo R2         =     0.0227
```

```
------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmean_TL_2 |   -.128335   .0561558    -2.29   0.022    -.2383983   -.0182717
_Iavmean_TL_3 |  -.3537561   .0603732    -5.86   0.000    -.4720854   -.2354268
_Iavmean_TL_4 |  -.7460584   .0828859    -9.00   0.000    -.9085119   -.5836049
       _cons |   1.025643   .0446322    22.98   0.000     .9381658    1.113121
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =   99.09
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi i.avmean_TL0_7 cos* sin*
i.avmean_TL0_7    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood =  -2229.647
Iteration 1:   log likelihood =  -2229.642
Iteration 2:   log likelihood =  -2229.642

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     298.65
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2229.642                       Pseudo R2         =     0.0628

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmean_TL_2 |   -.492086   .0787205    -6.25   0.000    -.6463753   -.3377967
_Iavmean_TL_3 |  -.6953432   .0874463    -7.95   0.000    -.8667347   -.5239517
_Iavmean_TL_4 |  -1.096298   .1100816    -9.96   0.000    -1.312054   -.8805422
       cos_1 |   .0288809   .0392296     0.74   0.462    -.0480077    .1057694
       cos_2 |  -.0772761   .0334304    -2.31   0.021    -.1427984   -.0117538
       cos_3 |  -.0905859   .0335166    -2.70   0.007    -.1562772   -.0248946
       cos_4 |   .0620955   .0321571     1.93   0.053    -.0009312    .1251222
       cos_5 |   .0433588   .0325207     1.33   0.182    -.0203805    .1070981
       cos_6 |  -.0564261   .0327784    -1.72   0.085    -.1206705    .0078183
       cos_7 |   -.045123   .0323387    -1.40   0.163    -.1085058    .0182597
       cos_8 |   .0037249    .031881     0.12   0.907    -.0587607    .0662106
       cos_9 |  -.0117645   .0323294    -0.36   0.716     -.075129       .0516
      cos_10 |  -.0556222   .0309722    -1.80   0.073    -.1163265    .0050822
       sin_1 |   .3480397   .0362021     9.61   0.000     .2770849    .4189944
       sin_2 |   .1627292   .0338496     4.81   0.000     .0963852    .2290733
       sin_3 |   .0140091   .0328252     0.43   0.670    -.0503271    .0783452
       sin_4 |    .043814   .0332754     1.32   0.188    -.0214047    .1090327
       sin_5 |   .0047497   .0316957     0.15   0.881    -.0573728    .0668722
       sin_6 |  -.0382352   .0321509    -1.19   0.234    -.1012498    .0247793
       sin_7 |   .0504142   .0327345     1.54   0.124    -.0137443    .1145727
       sin_8 |  -.0796353   .0323805    -2.46   0.014    -.1430999   -.0161706
       sin_9 |   .0845031   .0321279     2.63   0.009     .0215335    .1474727
      sin_10 |   .0476962   .0315028     1.51   0.130    -.0140481    .1094405
       _cons |   1.270199   .0646322    19.65   0.000     1.143522    1.396875
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  105.98
         Prob > chi2 =    0.0000

. *p-value<0.0001
```

```
. *include in model
.
. *mean T lag 8-14
. *unconditional
. xi: poisson agi i.avmean_TL8_14
i.avmean_TL8_14   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2310.5032
Iteration 1:   log likelihood = -2310.4987
Iteration 2:   log likelihood = -2310.4987

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     136.94
                                                  Prob > chi2       =     0.0000
Log likelihood = -2310.4987                       Pseudo R2         =     0.0288

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.1175441   .0554512    -2.12   0.034    -.2262264   -.0088617
_Iavmean_TL_3 |  -.3622295   .0598923    -6.05   0.000    -.4796162   -.2448427
_Iavmean_TL_4 |  -.8463184   .0842223   -10.05   0.000    -1.011391   -.6812458
        _cons |   1.033835   .0437269    23.64   0.000     .9481315    1.119538
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  122.12
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmean_TL8_14 cos* sin*
i.avmean_TL8_14   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2209.5803
Iteration 1:   log likelihood = -2209.5705
Iteration 2:   log likelihood = -2209.5705

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     338.79
                                                  Prob > chi2       =     0.0000
Log likelihood = -2209.5705                       Pseudo R2         =     0.0712

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.3931527   .0727321    -5.41   0.000    -.5357051   -.2506004
_Iavmean_TL_3 |  -.6287421   .0819813    -7.67   0.000    -.7894225   -.4680618
_Iavmean_TL_4 |   -1.21288   .1054761   -11.50   0.000    -1.419609    -1.00615
        cos_1 |   .0160925   .0388191     0.41   0.678    -.0599915    .0921765
        cos_2 |  -.0932823   .0336105    -2.78   0.006    -.1591576    -.027407
        cos_3 |  -.1302129   .0335482    -3.88   0.000    -.1959661   -.0644597
        cos_4 |   .0245938   .0323833     0.76   0.448    -.0388763    .0880639
        cos_5 |   .0456922   .0324332     1.41   0.159    -.0178757      .10926
        cos_6 |  -.0476015   .0329745    -1.44   0.149    -.1122303    .0170274
        cos_7 |  -.0231437   .0325661    -0.71   0.477    -.0869721    .0406848
        cos_8 |  -.0132781   .0317064    -0.42   0.675    -.0754214    .0488653
        cos_9 |   .0021226   .0325011     0.07   0.948    -.0615785    .0658236
       cos_10 |  -.0733868   .0312367    -2.35   0.019    -.1346097   -.0121638
        sin_1 |   .2986387   .0341376     8.75   0.000     .2317303    .3655471
        sin_2 |   .1708836   .0333948     5.12   0.000      .105431    .2363361
        sin_3 |  -.0416057   .0320724    -1.30   0.195    -.1044664    .0212551
        sin_4 |    .032343   .0327233     0.99   0.323    -.0317935    .0964794
        sin_5 |  -.0080789   .0317829    -0.25   0.799    -.0703722    .0542143
        sin_6 |  -.0763199   .0318086    -2.40   0.016    -.1386637   -.0139761
        sin_7 |   .0221992   .0320946     0.69   0.489     -.040705    .0851034
```

```
       sin_8 |  -.0926495   .0323635    -2.86   0.004    -.1560808   -.0292181
       sin_9 |    .147281    .031838     4.63   0.000     .0848798    .2096823
      sin_10 |   .0317384   .0313313     1.01   0.311    -.0296699    .0931466
       _cons |   1.224651   .0596633    20.53   0.000     1.107713    1.341589
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  139.03
         Prob > chi2 =    0.0000

. *p<0.0001
. *include in model
.
. *mean T lag 15-21
. *unconditional
. xi: poisson agi i.avmean_TL15_21
i.avmean_TL1~21   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2298.9964
Iteration 1:   log likelihood = -2298.9932
Iteration 2:   log likelihood = -2298.9932

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     159.95
                                                  Prob > chi2       =     0.0000
Log likelihood = -2298.9932                       Pseudo R2         =     0.0336

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.1594809   .0542902    -2.94   0.003    -.2658877   -.0530742
_Iavmean_TL_3 |  -.4705595   .0593654    -7.93   0.000    -.5869136   -.3542055
_Iavmean_TL_4 |  -.8850711   .0836803   -10.58   0.000    -1.049081   -.7210608
        _cons |   1.081099   .0420331    25.72   0.000     .9987153    1.163482
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  146.65
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi i.avmean_TL15_21 cos* sin*
i.avmean_TL1~21   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2186.7904
Iteration 1:   log likelihood = -2186.7801
Iteration 2:   log likelihood = -2186.7801

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     384.37
                                                  Prob > chi2       =     0.0000
Log likelihood = -2186.7801                       Pseudo R2         =     0.0808

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.4859938   .0713812    -6.81   0.000    -.6258985   -.3460892
_Iavmean_TL_3 |   -.804887   .0820869    -9.81   0.000    -.9657744   -.6439996
_Iavmean_TL_4 |  -1.345674   .1031481   -13.05   0.000    -1.547841   -1.143507
        cos_1 |  -.0316906   .0395971    -0.80   0.424    -.1092996    .0459184
```

```
        cos_2 |  -.1432928   .0335976    -4.26   0.000    -.2091428  -.0774427
        cos_3 |  -.1412175   .0334045    -4.23   0.000    -.2066891   -.075746
        cos_4 |  -.0164268   .0328574    -0.50   0.617    -.0808261   .0479725
        cos_5 |   .0336677   .0325298     1.03   0.301    -.0300896    .097425
        cos_6 |  -.0192405   .0323501    -0.59   0.552    -.0826455   .0441644
        cos_7 |  -.0133523   .0324788    -0.41   0.681    -.0770095   .0503049
        cos_8 |  -.0233204   .0319673    -0.73   0.466    -.0859752   .0393344
        cos_9 |  -.0381015   .0325194    -1.17   0.241    -.1018383   .0256354
       cos_10 |  -.0741314   .0311124    -2.38   0.017    -.1351105  -.0131522
        sin_1 |    .287924    .033615     8.57   0.000     .2220398   .3538082
        sin_2 |    .194012   .0333869     5.81   0.000     .1285749   .2594491
        sin_3 |  -.0737139   .0318704    -2.31   0.021    -.1361788  -.0112491
        sin_4 |   .0074471   .0322157     0.23   0.817    -.0556946   .0705888
        sin_5 |  -.0050578    .031678    -0.16   0.873    -.0671455   .0570298
        sin_6 |  -.1193158   .0327812    -3.64   0.000    -.1835659  -.0550658
        sin_7 |   .0198985   .0323969     0.61   0.539    -.0435982   .0833953
        sin_8 |  -.0805078   .0321963    -2.50   0.012    -.1436113  -.0174043
        sin_9 |    .165388   .0319632     5.17   0.000     .1027413   .2280347
       sin_10 |   .0158368   .0315281     0.50   0.615    -.0459572   .0776308
        _cons |   1.322045   .0576822    22.92   0.000      1.20899     1.4351
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  183.64
         Prob > chi2 =    0.0000

. *p<0.0001
. ***include in model
. 
. *mean T lag 22-28
. *unconditional
. xi: poisson agi i.avmean_TL22_28
i.avmean_TL2~28   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)

Iteration 0:   log likelihood = -2311.5505  
Iteration 1:   log likelihood = -2311.5455  
Iteration 2:   log likelihood = -2311.5455  

Poisson regression                               Number of obs     =        995
                                                 LR chi2(3)        =     134.84
                                                 Prob > chi2       =     0.0000
Log likelihood = -2311.5455                      Pseudo R2         =     0.0283

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
_Iavmean_TL_2 |  -.1615956   .0544094    -2.97   0.003    -.2682361   -.054955
_Iavmean_TL_3 |  -.3756142   .0589117    -6.38   0.000    -.4910791  -.2601494
_Iavmean_TL_4 |  -.8728817   .0855889   -10.20   0.000    -1.040633  -.7051304
        _cons |   1.048559   .0420703    24.92   0.000     .9661024   1.131015
------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  120.59
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi i.avmean_TL22_28 cos* sin*
i.avmean_TL2~28   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
```

```
Iteration 0:   log likelihood = -2205.7667  
Iteration 1:   log likelihood = -2205.7513  
Iteration 2:   log likelihood = -2205.7513  

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     346.43
                                                  Prob > chi2       =     0.0000
Log likelihood = -2205.7513                       Pseudo R2         =     0.0728

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmean_TL_2 |  -.4457091   .0728608    -6.12   0.000    -.5885138   -.3029045
_Iavmean_TL_3 |  -.6760621   .0825692    -8.19   0.000    -.8378948   -.5142295
_Iavmean_TL_4 |  -1.251984   .1059756   -11.81   0.000    -1.459693   -1.044276
        cos_1 |   .0007853   .0397569     0.02   0.984    -.0771367    .0787073
        cos_2 |  -.1764152   .0341418    -5.17   0.000    -.2433318   -.1094985
        cos_3 |  -.1205696   .0333752    -3.61   0.000    -.1859837   -.0551555
        cos_4 |  -.0050162   .0330652    -0.15   0.879    -.0698228    .0597903
        cos_5 |   .0133117   .0327328     0.41   0.684    -.0508435    .0774669
        cos_6 |   .0255212   .0320316     0.80   0.426    -.0372595    .0883019
        cos_7 |  -.0052101   .0321247    -0.16   0.871    -.0681734    .0577531
        cos_8 |  -.0150489   .0316354    -0.48   0.634    -.0770531    .0469554
        cos_9 |   -.085268   .0325713    -2.62   0.009    -.1491066   -.0214294
       cos_10 |  -.0468823   .0310636    -1.51   0.131    -.1077659    .0140014
        sin_1 |   .2554166    .032981     7.74   0.000     .1907751    .3200581
        sin_2 |   .1662923   .0331225     5.02   0.000     .1013733    .2312112
        sin_3 |  -.1078334   .0320076    -3.37   0.001     -.170567   -.0450997
        sin_4 |  -.0205085    .031996    -0.64   0.522    -.0832196    .0422026
        sin_5 |  -.0130259   .0314855    -0.41   0.679    -.0747362    .0486845
        sin_6 |  -.1094707   .0333643    -3.28   0.001    -.1748635   -.0440779
        sin_7 |   .0214286   .0327742     0.65   0.513    -.0428077    .0856648
        sin_8 |  -.0965045   .0325959    -2.96   0.003    -.1603913   -.0326177
        sin_9 |   .1540276   .0321321     4.79   0.000     .0910498    .2170055
       sin_10 |   .0303989   .0315176     0.96   0.335    -.0313744    .0921722
        _cons |      1.254   .0591318    21.21   0.000     1.138104    1.369897
-------------------------------------------------------------------------------

. testparm _Iavmean_TL_*

 ( 1)  [agi]_Iavmean_TL_2 = 0
 ( 2)  [agi]_Iavmean_TL_3 = 0
 ( 3)  [agi]_Iavmean_TL_4 = 0

           chi2(  3) =  145.92
         Prob > chi2 =    0.0000

. *p<0.0001
. ***include in model
. 
. *Tmax L0
. *unconditional
. xi: poisson agi i.Tmax_C
i.Tmax_C          _ITmax_C_1-4        (naturally coded; _ITmax_C_1 omitted)

Iteration 0:   log likelihood = -2353.7405  
Iteration 1:   log likelihood = -2353.7405  

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =      50.45
                                                  Prob > chi2       =     0.0000
Log likelihood = -2353.7405                       Pseudo R2         =     0.0106

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  _ITmax_C_2 |  -.0691775   .0558734    -1.24   0.216    -.1786875    .0403324
  _ITmax_C_3 |  -.2094046   .0585032    -3.58   0.000    -.3240689   -.0947403
  _ITmax_C_4 |  -.4215652   .0644275    -6.54   0.000    -.5478408   -.2952896
       _cons |    .934175   .0384331    24.31   0.000     .8588474    1.009502
------------------------------------------------------------------------------
```

```
. testparm _ITmax_C_*

 ( 1)  [agi]_ITmax_C_2 = 0
 ( 2)  [agi]_ITmax_C_3 = 0
 ( 3)  [agi]_ITmax_C_4 = 0

           chi2(  3) =   48.44
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.Tmax_C cos* sin*
i.Tmax_C          _ITmax_C_1-4        (naturally coded; _ITmax_C_1 omitted)

Iteration 0:   log likelihood = -2270.1809
Iteration 1:   log likelihood = -2270.1776
Iteration 2:   log likelihood = -2270.1776

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     217.58
                                                  Prob > chi2       =     0.0000
Log likelihood = -2270.1776                       Pseudo R2         =     0.0457

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  _ITmax_C_2 |  -.0930045   .0582803    -1.60   0.111    -.2072319    .0212228
  _ITmax_C_3 |  -.1489516   .0633487    -2.35   0.019    -.2731127   -.0247905
  _ITmax_C_4 |  -.3650585   .0709991    -5.14   0.000    -.5042141   -.2259029
       cos_1 |   .1982997   .0339804     5.84   0.000     .1316994    .2649001
       cos_2 |  -.0916825   .0324414    -2.83   0.005    -.1552665   -.0280985
       cos_3 |   -.025033   .0325565    -0.77   0.442    -.0888426    .0387765
       cos_4 |   .0395899   .0320066     1.24   0.216     -.023142    .1023217
       cos_5 |   .0412064   .0324398     1.27   0.204    -.0223744    .1047873
       cos_6 |  -.0166533   .0320372    -0.52   0.603    -.0794451    .0461385
       cos_7 |  -.0173004   .0320467    -0.54   0.589    -.0801108    .0455101
       cos_8 |  -.0076649   .0315799    -0.24   0.808    -.0695603    .0542306
       cos_9 |  -.0479502   .0321956    -1.49   0.136    -.1110523     .015152
      cos_10 |  -.0619379   .0310691    -1.99   0.046    -.1228323   -.0010435
       sin_1 |   .2441057   .0326515     7.48   0.000       .18011    .3081014
       sin_2 |   .0780984   .0324309     2.41   0.016     .0145351    .1416617
       sin_3 |  -.0438912   .0320482    -1.37   0.171    -.1067044    .0189221
       sin_4 |  -.0109198   .0319992    -0.34   0.733    -.0736372    .0517975
       sin_5 |  -.0199286   .0314578    -0.63   0.526    -.0815848    .0417275
       sin_6 |  -.0377241   .0319862    -1.18   0.238    -.1004159    .0249676
       sin_7 |   .0306212   .0319917     0.96   0.338    -.0320814    .0933238
       sin_8 |  -.0861473   .0322913    -2.67   0.008    -.1494371   -.0228574
       sin_9 |   .1179634    .031693     3.72   0.000     .0558464    .1800805
      sin_10 |   .0398375   .0313809     1.27   0.204    -.0216678    .1013428
       _cons |   .8743499   .0425747    20.54   0.000      .790905    .9577948
------------------------------------------------------------------------------

. testparm _ITmax_C_*

 ( 1)  [agi]_ITmax_C_2 = 0
 ( 2)  [agi]_ITmax_C_3 = 0
 ( 3)  [agi]_ITmax_C_4 = 0

           chi2(  3) =   27.19
         Prob > chi2 =    0.0000

. *p<0.0001
. *include
.
. *Tmax L0-3
. *unconditional
. xi: poisson agi i.avmax_TL0_3
i.avmax_TL0_3     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)

Iteration 0:   log likelihood = -2331.1678
```

```
Iteration 1:   log likelihood =  -2331.167
Iteration 2:   log likelihood =  -2331.167

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =      95.60
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2331.167                       Pseudo R2         =     0.0201

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmax_TL0_2 |  -.1664575   .0543931    -3.06   0.002     -.273066   -.0598491
_Iavmax_TL0_3 |  -.3355765   .0601184    -5.58   0.000    -.4534064   -.2177466
_Iavmax_TL0_4 |  -.7076433   .0797904    -8.87   0.000    -.8640297   -.5512569
        _cons |   1.023234   .0421825    24.26   0.000     .9405581     1.10591
------------------------------------------------------------------------------

. testparm _Iavmax_TL0_*

 ( 1)  [agi]_Iavmax_TL0_2 = 0
 ( 2)  [agi]_Iavmax_TL0_3 = 0
 ( 3)  [agi]_Iavmax_TL0_4 = 0

           chi2(  3) =   88.75
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmax_TL0_3 cos* sin*
i.avmax_TL0_3     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)

Iteration 0:   log likelihood = -2247.8459
Iteration 1:   log likelihood = -2247.8412
Iteration 2:   log likelihood = -2247.8412

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     262.25
                                                  Prob > chi2       =     0.0000
Log likelihood = -2247.8412                       Pseudo R2         =     0.0551

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmax_TL0_2 |  -.3144816   .0622347    -5.05   0.000    -.4364593   -.1925039
_Iavmax_TL0_3 |  -.4236273   .0726344    -5.83   0.000    -.5659882   -.2812664
_Iavmax_TL0_4 |  -.7622909   .0924204    -8.25   0.000    -.9434315   -.5811503
        cos_1 |   .1276456   .0359357     3.55   0.000      .057213    .1980783
        cos_2 |  -.0850179   .0329665    -2.58   0.010    -.1496309   -.0204048
        cos_3 |  -.0423071   .0326852    -1.29   0.196     -.106369    .0217548
        cos_4 |   .0302603   .0320491     0.94   0.345    -.0325547    .0930754
        cos_5 |   .0390059   .0325467     1.20   0.231    -.0247845    .1027962
        cos_6 |  -.0198506   .0318963    -0.62   0.534    -.0823662     .042665
        cos_7 |  -.0203986   .0321198    -0.64   0.525    -.0833522    .0425551
        cos_8 |   .0053015   .0317037     0.17   0.867    -.0568365    .0674395
        cos_9 |  -.0378324   .0322189    -1.17   0.240    -.1009802    .0253154
       cos_10 |  -.0592826   .0311251    -1.90   0.057    -.1202866    .0017214
        sin_1 |   .2876485   .0337621     8.52   0.000     .2214761     .353821
        sin_2 |   .1177229   .0327527     3.59   0.000     .0535287    .1819171
        sin_3 |  -.0103062   .0324632    -0.32   0.751    -.0739328    .0533205
        sin_4 |    .004394   .0322326     0.14   0.892    -.0587807    .0675687
        sin_5 |  -.0181964   .0315077    -0.58   0.564    -.0799504    .0435575
        sin_6 |  -.0200292   .0322316    -0.62   0.534    -.0832019    .0431435
        sin_7 |   .0211897   .0325299     0.65   0.515    -.0425677    .0849472
        sin_8 |  -.0791635   .0324609    -2.44   0.015    -.1427856   -.0155413
        sin_9 |   .0949198    .031887     2.98   0.003     .0324225    .1574171
       sin_10 |   .0447314    .031528     1.42   0.156    -.0170623    .1065252
        _cons |     1.0714    .050265    21.32   0.000     .9728829    1.169918
------------------------------------------------------------------------------

. testparm _Iavmax_TL0_*
```

```
 ( 1)  [agi]_Iavmax_TL0_2 = 0
 ( 2)  [agi]_Iavmax_TL0_3 = 0
 ( 3)  [agi]_Iavmax_TL0_4 = 0

           chi2(  3) =   71.63
         Prob > chi2 =    0.0000

. *p<0.0001
. *include
.
. *Tmax L0-7
. *unconditional
. xi: poisson agi i.avmax_TL0_7
i.avmax_TL0_7     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)

Iteration 0:   log likelihood = -2319.4575
Iteration 1:   log likelihood =  -2319.456
Iteration 2:   log likelihood =  -2319.456

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     119.02
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2319.456                       Pseudo R2         =     0.0250

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmax_TL0_2 |   -.203693   .0556577    -3.66   0.000    -.3127802   -.0946059
_Iavmax_TL0_3 |  -.4524089   .0630717    -7.17   0.000    -.5760272   -.3287906
_Iavmax_TL0_4 |  -.8258193   .0883288    -9.35   0.000    -.9989405   -.6526981
       _cons |    1.07795   .0456912    23.59   0.000     .9883974    1.167503
------------------------------------------------------------------------------

. testparm _Iavmax_TL0_*

 ( 1)  [agi]_Iavmax_TL0_2 = 0
 ( 2)  [agi]_Iavmax_TL0_3 = 0
 ( 3)  [agi]_Iavmax_TL0_4 = 0

           chi2(  3) =  110.94
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmax_TL0_7 cos* sin*
i.avmax_TL0_7     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)

Iteration 0:   log likelihood = -2225.8065
Iteration 1:   log likelihood =  -2225.802
Iteration 2:   log likelihood =  -2225.802

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     306.33
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2225.802                       Pseudo R2         =     0.0644

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Iavmax_TL0_2 |  -.5810418   .0761084    -7.63   0.000    -.7302115    -.431872
_Iavmax_TL0_3 |  -.7763554   .0878821    -8.83   0.000    -.9486012   -.6041096
_Iavmax_TL0_4 |  -1.135497   .1114655   -10.19   0.000    -1.353965   -.9170284
       cos_1 |   .0403327   .0383447     1.05   0.293    -.0348216     .115487
       cos_2 |   -.073243   .0328761    -2.23   0.026     -.137679   -.0088071
       cos_3 |  -.0590109   .0329605    -1.79   0.073    -.1236123    .0055904
       cos_4 |   .0322651   .0320767     1.01   0.314    -.0306041    .0951342
       cos_5 |   .0361312   .0324958     1.11   0.266    -.0275594    .0998218
       cos_6 |  -.0367938   .0320342    -1.15   0.251    -.0995796     .025992
       cos_7 |  -.0344276   .0324426    -1.06   0.289    -.0980139    .0291588
       cos_8 |   .0119301   .0316356     0.38   0.706    -.0500746    .0739347
       cos_9 |  -.0111655   .0324424    -0.34   0.731    -.0747514    .0524205
```

```
       cos_10 |  -.0510992   .0307971    -1.66   0.097    -.1114604    .0092619
        sin_1 |   .3590661   .0366836     9.79   0.000     .2871676    .4309646
        sin_2 |   .1750545   .0342332     5.11   0.000     .1079587    .2421503
        sin_3 |   .0147391   .0326253     0.45   0.651    -.0492053    .0786834
        sin_4 |    .030151   .0325043     0.93   0.354    -.0335562    .0938582
        sin_5 |  -.0009563    .031813    -0.03   0.976    -.0633086    .0613961
        sin_6 |   .0035867   .0325462     0.11   0.912    -.0602026    .0673761
        sin_7 |   .0507955   .0330311     1.54   0.124    -.0139442    .1155352
        sin_8 |  -.0651709   .0326643    -2.00   0.046    -.1291917   -.0011501
        sin_9 |   .0845661   .0318908     2.65   0.008     .0220612     .147071
       sin_10 |   .0482638   .0318163     1.52   0.129     -.014095    .1106225
        _cons |   1.322889   .0631905    20.93   0.000     1.199038     1.44674
-------------------------------------------------------------------------------

. testparm _Iavmax_TL0_*

 ( 1)  [agi]_Iavmax_TL0_2 = 0
 ( 2)  [agi]_Iavmax_TL0_3 = 0
 ( 3)  [agi]_Iavmax_TL0_4 = 0

           chi2(  3) =  115.19
         Prob > chi2 =    0.0000

. *p<0.0001
. *include
.
. *Tmax 8-14
. *unconditional
. xi: poisson agi i.avmax_TL8_14
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)

Iteration 0:   log likelihood = -2304.0019
Iteration 1:   log likelihood = -2303.9943
Iteration 2:   log likelihood = -2303.9943

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     149.95
                                                  Prob > chi2       =     0.0000
Log likelihood = -2303.9943                       Pseudo R2         =     0.0315

-------------------------------------------------------------------------------
          agi |     Coef.  Std. Err.      z     P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmax_TL8_2 |  -.1173485   .0557917    -2.10   0.035    -.2266982   -.0079988
_Iavmax_TL8_3 |  -.4294031   .0628058    -6.84   0.000    -.5525002    -.306306
_Iavmax_TL8_4 |  -.9142214   .0920822    -9.93   0.000    -1.094699   -.7337436
        _cons |   1.043214   .0459315    22.71   0.000     .9531894    1.133238
-------------------------------------------------------------------------------

. testparm _Iavmax_TL8_*

 ( 1)  [agi]_Iavmax_TL8_2 = 0
 ( 2)  [agi]_Iavmax_TL8_3 = 0
 ( 3)  [agi]_Iavmax_TL8_4 = 0

           chi2(  3) =  132.89
         Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmax_TL8_14 cos* sin*
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)

Iteration 0:   log likelihood = -2213.3724
Iteration 1:   log likelihood = -2213.3594
Iteration 2:   log likelihood = -2213.3594

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     331.22
                                                  Prob > chi2       =     0.0000
Log likelihood = -2213.3594                       Pseudo R2         =     0.0696
```

```
-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmax_TL8_2 |  -.3641347   .0712089    -5.11   0.000    -.5037016   -.2245679
_Iavmax_TL8_3 |  -.6456773   .0835284    -7.73   0.000    -.8093899   -.4819647
_Iavmax_TL8_4 |   -1.21495   .1114422   -10.90   0.000    -1.433373   -.9965278
        cos_1 |   .0366671   .0382813     0.96   0.338    -.0383628    .1116969
        cos_2 |  -.0933006   .0327644    -2.85   0.004    -.1575177   -.0290835
        cos_3 |  -.1084319   .0332181    -3.26   0.001    -.1735382   -.0433256
        cos_4 |   .0167517   .0323586     0.52   0.605      -.04667    .0801733
        cos_5 |    .050734    .032384     1.57   0.117    -.0127375    .1142056
        cos_6 |  -.0598962   .0326125    -1.84   0.066    -.1238155    .0040231
        cos_7 |   -.007268   .0325976    -0.22   0.824    -.0711582    .0566222
        cos_8 |  -.0349593   .0317236    -1.10   0.270    -.0971364    .0272179
        cos_9 |   .0070524   .0322039     0.22   0.827    -.0560661    .0701708
       cos_10 |  -.0779347   .0312758    -2.49   0.013    -.1392341   -.0166352
        sin_1 |   .2798345   .0343052     8.16   0.000     .2125976    .3470715
        sin_2 |    .164573   .0335952     4.90   0.000     .0987276    .2304185
        sin_3 |  -.0224994   .0321708    -0.70   0.484     -.085553    .0405541
        sin_4 |   .0147855   .0322539     0.46   0.647     -.048431     .078002
        sin_5 |  -.0247071   .0318351    -0.78   0.438    -.0871028    .0376886
        sin_6 |  -.0349332   .0316595    -1.10   0.270    -.0969846    .0271182
        sin_7 |   .0052626   .0322999     0.16   0.871    -.0580441    .0685693
        sin_8 |  -.0771396   .0323789    -2.38   0.017    -.1406011   -.0136781
        sin_9 |    .118664   .0319738     3.71   0.000     .0559965    .1813315
       sin_10 |   .0500066   .0313124     1.60   0.110    -.0113645    .1113777
        _cons |    1.20674   .0606806    19.89   0.000     1.087808    1.325672
-------------------------------------------------------------------------------

. testparm _Iavmax_TL8_*

 ( 1)  [agi]_Iavmax_TL8_2 = 0
 ( 2)  [agi]_Iavmax_TL8_3 = 0
 ( 3)  [agi]_Iavmax_TL8_4 = 0

           chi2(  3) =  130.41
         Prob > chi2 =    0.0000

. *p<0.0001
. *include
.
. *Tmax 15-21
. *unconditional
. xi: poisson agi i.avmax_TL15_21
i.avmax_TL15_21   _Iavmax_TL1_1-4     (naturally coded; _Iavmax_TL1_1 omitted)

Iteration 0:   log likelihood = -2296.6854
Iteration 1:   log likelihood = -2296.6814
Iteration 2:   log likelihood = -2296.6814

Poisson regression                                Number of obs     =         995
                                                  LR chi2(3)        =      164.57
                                                  Prob > chi2       =      0.0000
Log likelihood = -2296.6814                       Pseudo R2         =      0.0346

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmax_TL1_2 |   -.141152   .0546816    -2.58   0.010     -.248326   -.0339781
_Iavmax_TL1_3 |  -.5188576   .0628399    -8.26   0.000    -.6420216   -.3956936
_Iavmax_TL1_4 |  -.9054803   .0903378   -10.02   0.000    -1.082539   -.7284215
        _cons |   1.073096   .0445878    24.07   0.000     .9857052    1.160486
-------------------------------------------------------------------------------

. testparm _Iavmax_TL1_*

 ( 1)  [agi]_Iavmax_TL1_2 = 0
 ( 2)  [agi]_Iavmax_TL1_3 = 0
 ( 3)  [agi]_Iavmax_TL1_4 = 0
```

```
          chi2(  3) =  149.69
        Prob > chi2 =    0.0000

. *p<0.0001
. *conditional
. xi: poisson agi i.avmax_TL15_21 cos* sin*
i.avmax_TL15_21   _Iavmax_TL1_1-4     (naturally coded; _Iavmax_TL1_1 omitted)

Iteration 0:   log likelihood =  -2194.371
Iteration 1:   log likelihood =  -2194.361
Iteration 2:   log likelihood =  -2194.361

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     369.21
                                                  Prob > chi2       =     0.0000
Log likelihood =  -2194.361                       Pseudo R2         =     0.0776

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
_Iavmax_TL1_2 |  -.4099761   .0705754    -5.81   0.000    -.5483015   -.2716508
_Iavmax_TL1_3 |  -.7826961   .0846871    -9.24   0.000    -.9486798   -.6167123
_Iavmax_TL1_4 |  -1.314603   .1088376   -12.08   0.000    -1.527921   -1.101285
        cos_1 |   .0026525   .0390365     0.07   0.946    -.0738576    .0791625
        cos_2 |  -.1329347   .0330531    -4.02   0.000    -.1977176   -.0681518
        cos_3 |   -.134203   .0334731    -4.01   0.000    -.1998091   -.0685969
        cos_4 |  -.0044216   .0325762    -0.14   0.892    -.0682699    .0594266
        cos_5 |   .0489309   .0324879     1.51   0.132    -.0147443    .1126061
        cos_6 |  -.0512647    .032493    -1.58   0.115    -.1149498    .0124205
        cos_7 |   .0124802   .0325975     0.38   0.702    -.0514097    .0763701
        cos_8 |  -.0424234   .0319066    -1.33   0.184    -.1049592    .0201123
        cos_9 |  -.0034527    .032528    -0.11   0.915    -.0672064     .060301
       cos_10 |   -.089867   .0312344    -2.88   0.004    -.1510854   -.0286487
        sin_1 |   .2609989   .0336461     7.76   0.000     .1950537    .3269441
        sin_2 |   .1835167   .0334999     5.48   0.000     .1178582    .2491752
        sin_3 |  -.0410556   .0319372    -1.29   0.199    -.1036513      .02154
        sin_4 |  -.0138342    .032049    -0.43   0.666    -.0766491    .0489807
        sin_5 |  -.0229453    .031662    -0.72   0.469    -.0850016    .0391111
        sin_6 |  -.0859789   .0319012    -2.70   0.007    -.1485041   -.0234537
        sin_7 |   .0196937   .0323089     0.61   0.542    -.0436307     .083018
        sin_8 |  -.0834101   .0322548    -2.59   0.010    -.1466284   -.0201919
        sin_9 |   .1513677   .0317252     4.77   0.000     .0891875    .2135478
       sin_10 |   .0191152   .0314819     0.61   0.544    -.0425883    .0808186
        _cons |   1.271152   .0598335    21.24   0.000     1.153881    1.388424
------------------------------------------------------------------------------

. testparm _Iavmax_TL1_2*

 ( 1)  [agi]_Iavmax_TL1_2 = 0

          chi2(  1) =   33.75
        Prob > chi2 =    0.0000

. *p<0.0001
. ***include in model
.
. *Tmax 22-28
. *unconditional
. xi: poisson agi i.avmax_TL22_28
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Iteration 0:   log likelihood =  -2318.716
Iteration 1:   log likelihood = -2318.7133
Iteration 2:   log likelihood = -2318.7133

Poisson regression                                Number of obs     =        995
                                                  LR chi2(3)        =     120.51
                                                  Prob > chi2       =     0.0000
Log likelihood = -2318.7133                       Pseudo R2         =     0.0253

------------------------------------------------------------------------------
```

```
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmax_TL2_2 |  -.1103292   .0546665    -2.02   0.044    -.2174737   -.0031848
_Iavmax_TL2_3 |   -.418176    .062269    -6.72   0.000    -.5402209    -.296131
_Iavmax_TL2_4 |  -.8068942   .0922618    -8.75   0.000    -.9877239   -.6260644
        _cons |   1.017051   .0444554    22.88   0.000     .9299195    1.104182
-------------------------------------------------------------------------------

. testparm _Iavmax_TL2_*

 ( 1)  [agi]_Iavmax_TL2_2 = 0
 ( 2)  [agi]_Iavmax_TL2_3 = 0
 ( 3)  [agi]_Iavmax_TL2_4 = 0

           chi2(  3) =  109.43
         Prob > chi2 =    0.0000

. *p<0.000
. *conditional
. xi: poisson agi i.avmax_TL22_28 cos* sin*
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Iteration 0:   log likelihood = -2218.6421
Iteration 1:   log likelihood = -2218.6323
Iteration 2:   log likelihood = -2218.6323

Poisson regression                                Number of obs     =        995
                                                  LR chi2(23)       =     320.67
                                                  Prob > chi2       =     0.0000
Log likelihood = -2218.6323                       Pseudo R2         =     0.0674

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Iavmax_TL2_2 |  -.3129848   .0701057    -4.46   0.000    -.4503894   -.1755801
_Iavmax_TL2_3 |  -.6188789    .083878    -7.38   0.000    -.7832767   -.4544811
_Iavmax_TL2_4 |  -1.143618   .1107002   -10.33   0.000    -1.360586   -.9266497
        cos_1 |     .04609   .0391432     1.18   0.239    -.0306294    .1228093
        cos_2 |   -.152589   .0333912    -4.57   0.000    -.2180345   -.0871435
        cos_3 |  -.1102763   .0334966    -3.29   0.001    -.1759285   -.0446241
        cos_4 |   .0097509   .0326124     0.30   0.765    -.0541682      .07367
        cos_5 |   .0354381   .0327498     1.08   0.279    -.0287502    .0996265
        cos_6 |  -.0137925   .0319271    -0.43   0.666    -.0763684    .0487834
        cos_7 |   .0143041   .0323159     0.44   0.658    -.0490338    .0776421
        cos_8 |  -.0199106   .0316169    -0.63   0.529    -.0818786    .0420575
        cos_9 |  -.0566816   .0324079    -1.75   0.080       -.1202    .0068368
       cos_10 |  -.0578125   .0310112    -1.86   0.062    -.1185933    .0029684
        sin_1 |   .2356076   .0331225     7.11   0.000     .1706886    .3005266
        sin_2 |   .1546858   .0331893     4.66   0.000      .089636    .2197355
        sin_3 |  -.0876717    .031828    -2.75   0.006    -.1500534     -.02529
        sin_4 |   -.034707   .0319989    -1.08   0.278    -.0974237    .0280097
        sin_5 |  -.0064711   .0314508    -0.21   0.837    -.0681135    .0551712
        sin_6 |  -.1011417   .0325586    -3.11   0.002    -.1649553    -.037328
        sin_7 |   .0495311   .0325287     1.52   0.128     -.014224    .1132861
        sin_8 |  -.1194806   .0325725    -3.67   0.000    -.1833216   -.0556396
        sin_9 |   .1645748   .0319112     5.16   0.000       .10203    .2271196
       sin_10 |   .0128214   .0315929     0.41   0.685    -.0490995    .0747423
        _cons |   1.158246   .0596202    19.43   0.000     1.041392    1.275099
-------------------------------------------------------------------------------

. testparm _Iavmax_TL2_*

 ( 1)  [agi]_Iavmax_TL2_2 = 0
 ( 2)  [agi]_Iavmax_TL2_3 = 0
 ( 3)  [agi]_Iavmax_TL2_4 = 0

           chi2(  3) =  120.63
         Prob > chi2 =    0.0000

. *p<0.0001
. *include
```

```
.
. *Prec L0
. *unconditional
. xi: poisson agi Prrfe

Iteration 0:   log likelihood = -2377.0138
Iteration 1:   log likelihood = -2377.0138

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =       3.91
                                                  Prob > chi2       =     0.0481
Log likelihood = -2377.0138                       Pseudo R2         =     0.0008

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       Prrfe |   .0086278    .004264     2.02   0.043     .0002706     .016985
       _cons |   .7521102   .0260518    28.87   0.000     .7010496    .8031708
------------------------------------------------------------------------------

. test Prrfe

 ( 1)  [agi]Prrfe = 0

           chi2(  1) =    4.09
         Prob > chi2 =    0.0430

. *p-value=0.0430
. *conditional
. xi: poisson agi Prrfe cos* sin*

Iteration 0:   log likelihood = -2283.5318
Iteration 1:   log likelihood = -2283.5289
Iteration 2:   log likelihood = -2283.5289

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     190.88
                                                  Prob > chi2       =     0.0000
Log likelihood = -2283.5289                       Pseudo R2         =     0.0401

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       Prrfe |   .0055682   .0047261     1.18   0.239    -.0036949    .0148312
       cos_1 |   .2504517   .0318767     7.86   0.000     .1879746    .3129288
       cos_2 |  -.1001756   .0336368    -2.98   0.003    -.1661024   -.0342488
       cos_3 |  -.0101628   .0323622    -0.31   0.753    -.0735916     .053266
       cos_4 |   .0431547   .0319823     1.35   0.177    -.0195294    .1058388
       cos_5 |   .0461555   .0324514     1.42   0.155     -.017448     .109759
       cos_6 |  -.0089442   .0320099    -0.28   0.780    -.0716824     .053794
       cos_7 |  -.0117249    .032019    -0.37   0.714     -.074481    .0510312
       cos_8 |  -.0129767    .031528    -0.41   0.681    -.0747704     .048817
       cos_9 |  -.0378844   .0320653    -1.18   0.237    -.1007313    .0249624
      cos_10 |  -.0634373   .0310476    -2.04   0.041    -.1242894   -.0025852
       sin_1 |   .2273994   .0325213     6.99   0.000     .1636588      .29114
       sin_2 |   .0518789   .0319697     1.62   0.105    -.0107806    .1145385
       sin_3 |    -.06816   .0316392    -2.15   0.031    -.1301717   -.0061484
       sin_4 |  -.0185045   .0319159    -0.58   0.562    -.0810586    .0440496
       sin_5 |  -.0214109   .0314623    -0.68   0.496    -.0830758    .0402541
       sin_6 |  -.0467495   .0318864    -1.47   0.143    -.1092457    .0157467
       sin_7 |   .0364479   .0318703     1.14   0.253    -.0260168    .0989126
       sin_8 |  -.0929445   .0322263    -2.88   0.004    -.1561068   -.0297822
       sin_9 |   .1263034   .0316753     3.99   0.000     .0642208    .1883859
      sin_10 |    .033124   .0313463     1.06   0.291    -.0283136    .0945617
       _cons |    .718786   .0280075    25.66   0.000     .6638924    .7736797
------------------------------------------------------------------------------

. test Prrfe

 ( 1)  [agi]Prrfe = 0
```

```
          chi2(  1) =    1.39
        Prob > chi2 =    0.2387

. *p-value=0.2387
. *include
.
. *Prec L0-3
. *unconditional
. xi: poisson agi avP_TL0_3

Iteration 0:   log likelihood = -2371.3122
Iteration 1:   log likelihood = -2371.3122

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =      15.31
                                                  Prob > chi2       =     0.0001
Log likelihood = -2371.3122                       Pseudo R2         =     0.0032

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   avP_TL0_3 |   .0281755   .0070829     3.98   0.000     .0142933    .0420578
       _cons |   .6857284   .0328406    20.88   0.000     .6213619    .7500948
------------------------------------------------------------------------------

. test avP_TL0_3

 ( 1)  [agi]avP_TL0_3 = 0

          chi2(  1) =   15.82
        Prob > chi2 =    0.0001

. *p-value=0.0001
. *conditional
. xi: poisson agi avP_TL0_3 cos* sin*

Iteration 0:   log likelihood = -2279.3616
Iteration 1:   log likelihood = -2279.3586
Iteration 2:   log likelihood = -2279.3586

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     199.22
                                                  Prob > chi2       =     0.0000
Log likelihood = -2279.3586                       Pseudo R2         =     0.0419

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   avP_TL0_3 |   .0282907   .0089798     3.15   0.002     .0106906    .0458907
       cos_1 |   .2373917   .0321736     7.38   0.000     .1743327    .3004507
       cos_2 |  -.0541491   .0371487    -1.46   0.145    -.1269592     .018661
       cos_3 |  -.0211697   .0326006    -0.65   0.516    -.0850656    .0427262
       cos_4 |   .0458302   .0320019     1.43   0.152    -.0168923    .1085528
       cos_5 |   .0542777   .0325532     1.67   0.095    -.0095254    .1180808
       cos_6 |  -.0095589   .0319645    -0.30   0.765    -.0722082    .0530904
       cos_7 |  -.0112347   .0320255    -0.35   0.726    -.0740036    .0515342
       cos_8 |  -.0097558   .0315641    -0.31   0.757    -.0716203    .0521087
       cos_9 |   -.042124   .0321038    -1.31   0.189    -.1050463    .0207983
      cos_10 |  -.0659881   .0310254    -2.13   0.033    -.1267967   -.0051795
       sin_1 |   .2450188   .0330861     7.41   0.000     .1801712    .3098664
       sin_2 |   .0673913   .0324385     2.08   0.038      .003813    .1309695
       sin_3 |  -.0614874   .0317056    -1.94   0.052    -.1236292    .0006545
       sin_4 |  -.0132221   .0319738    -0.41   0.679    -.0758895    .0494453
       sin_5 |  -.0212858   .0314715    -0.68   0.499    -.0829689    .0403973
       sin_6 |  -.0505636   .0319627    -1.58   0.114    -.1132094    .0120823
       sin_7 |   .0385902   .0318688     1.21   0.226    -.0238715    .1010518
       sin_8 |  -.0914197   .0322075    -2.84   0.005    -.1545453    -.028294
       sin_9 |   .1218426   .0317061     3.84   0.000     .0596998    .1839854
      sin_10 |    .039532   .0314716     1.26   0.209    -.0221512    .1012152
       _cons |   .6403874   .0389535    16.44   0.000     .5640399    .7167349
------------------------------------------------------------------------------
```

```
. test avP_TL0_3

 ( 1)  [agi]avP_TL0_3 = 0

           chi2(  1) =    9.93
         Prob > chi2 =    0.0016

. *p-value=0.0016
. ***include in model
.
. *Prec L0-7
. *unconditional
. xi: poisson agi avP_TL0_7

Iteration 0:   log likelihood = -2358.8111
Iteration 1:   log likelihood = -2358.8111

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =      40.31
                                                  Prob > chi2       =     0.0000
Log likelihood = -2358.8111                       Pseudo R2         =     0.0085

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   avP_TL0_7 |   .0549809    .008544     6.44   0.000      .038235    .0717268
       _cons |   .5925849    .037485    15.81   0.000     .5191156    .6660541
------------------------------------------------------------------------------

. test avP_TL0_7

 ( 1)  [agi]avP_TL0_7 = 0

           chi2(  1) =   41.41
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi avP_TL0_7 cos* sin*

Iteration 0:   log likelihood = -2263.2597
Iteration 1:   log likelihood = -2263.2566
Iteration 2:   log likelihood = -2263.2566

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     231.42
                                                  Prob > chi2       =     0.0000
Log likelihood = -2263.2566                       Pseudo R2         =     0.0486

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   avP_TL0_7 |   .0795243   .0121743     6.53   0.000      .055663    .1033856
       cos_1 |   .2066145   .0325559     6.35   0.000     .1428061    .2704229
       cos_2 |   .0446274   .0404776     1.10   0.270    -.0347073     .123962
       cos_3 |  -.0464624   .0328951    -1.41   0.158    -.1109356    .0180107
       cos_4 |    .054805    .032066     1.71   0.087    -.0080432    .1176533
       cos_5 |   .0712385   .0326249     2.18   0.029     .0072949    .1351822
       cos_6 |  -.0084345   .0318826    -0.26   0.791    -.0709232    .0540543
       cos_7 |  -.0095564   .0320488    -0.30   0.766    -.0723708    .0532581
       cos_8 |  -.0060296   .0315562    -0.19   0.848    -.0678785    .0558194
       cos_9 |  -.0438581   .0322945    -1.36   0.174    -.1071542    .0194381
      cos_10 |  -.0761154   .0310331    -2.45   0.014    -.1369392   -.0152916
       sin_1 |   .2818958   .0336076     8.39   0.000      .216026    .3477656
       sin_2 |   .1142377   .0336044     3.40   0.001     .0483743    .1801011
       sin_3 |  -.0472908   .0317543    -1.49   0.136     -.109528    .0149465
       sin_4 |   .0013949   .0320873     0.04   0.965    -.0614951    .0642849
       sin_5 |  -.0165984   .0315046    -0.53   0.598    -.0783463    .0451495
       sin_6 |   -.058259   .0320882    -1.82   0.069    -.1211507    .0046328
       sin_7 |   .0419252   .0318755     1.32   0.188    -.0205497       .1044
```

```
       sin_8 |  -.0865539   .0322477    -2.68   0.007    -.1497582   -.0233496
       sin_9 |   .1092263    .031595     3.46   0.001     .0473011    .1711514
      sin_10 |   .0473856   .0315612     1.50   0.133    -.0144732    .1092443
       _cons |   .4609022   .0494472     9.32   0.000     .3639873     .557817
------------------------------------------------------------------------------

. test avP_TL0_7

 ( 1)  [agi]avP_TL0_7 = 0

           chi2(  1) =   42.67
         Prob > chi2 =    0.0000

. *p-value<0.0001
. ***include in model
.
. *Prec L8-14
. *unconditional
. xi: poisson agi avP_TL8_14

Iteration 0:   log likelihood = -2357.1839
Iteration 1:   log likelihood = -2357.1839

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =      43.57
                                                  Prob > chi2       =     0.0000
Log likelihood = -2357.1839                       Pseudo R2         =     0.0092

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  avP_TL8_14 |   .0550205    .008207     6.70   0.000      .038935     .071106
       _cons |   .5928768   .0365355    16.23   0.000     .5212687     .664485
------------------------------------------------------------------------------

. test avP_TL8_14

 ( 1)  [agi]avP_TL8_14 = 0

           chi2(  1) =   44.94
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi avP_TL8_14 cos* sin*

Iteration 0:   log likelihood = -2261.6784
Iteration 1:   log likelihood = -2261.6755
Iteration 2:   log likelihood = -2261.6755

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     234.58
                                                  Prob > chi2       =     0.0000
Log likelihood = -2261.6755                       Pseudo R2         =     0.0493

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  avP_TL8_14 |   .0769412   .0113271     6.79   0.000     .0547405    .0991419
       cos_1 |   .2045189   .0325842     6.28   0.000      .140655    .2683827
       cos_2 |   .0194168   .0377415     0.51   0.607    -.0545552    .0933888
       cos_3 |   -.050907   .0329758    -1.54   0.123    -.1155384    .0137243
       cos_4 |   .0468706   .0319844     1.47   0.143    -.0158175    .1095588
       cos_5 |   .0690382   .0326071     2.12   0.034     .0051295    .1329469
       cos_6 |   .0033894   .0321875     0.11   0.916    -.0596969    .0664756
       cos_7 |  -.0083819   .0318682    -0.26   0.793    -.0708425    .0540786
       cos_8 |  -.0097843   .0314654    -0.31   0.756    -.0714553    .0518867
       cos_9 |   -.019022   .0322442    -0.59   0.555    -.0822194    .0441754
      cos_10 |  -.0788945   .0313455    -2.52   0.012    -.1403306   -.0174584
       sin_1 |   .2695521   .0330659     8.15   0.000     .2047442    .3343601
       sin_2 |   .1463901   .0352845     4.15   0.000     .0772337    .2155465
```

```
       sin_3 |  -.0633955   .0316076    -2.01   0.045    -.1253452   -.0014458
       sin_4 |   .0146254   .0324092     0.45   0.652    -.0488954    .0781463
       sin_5 |  -.0034792   .0315603    -0.11   0.912    -.0653363    .0583778
       sin_6 |  -.0559526   .0318429    -1.76   0.079    -.1183635    .0064583
       sin_7 |   .0457643   .0321185     1.42   0.154    -.0171868    .1087154
       sin_8 |  -.0844116   .0323518    -2.61   0.009      -.14782   -.0210032
       sin_9 |   .1141727   .0316854     3.60   0.000     .0520706    .1762749
      sin_10 |   .0130906   .0313314     0.42   0.676    -.0483179    .0744991
       _cons |   .4713519   .0466859    10.10   0.000     .3798492    .5628546
------------------------------------------------------------------------------

. test avP_TL8_14

 ( 1)  [agi]avP_TL8_14 = 0

           chi2(  1) =   46.14
         Prob > chi2 =    0.0000

. *p-value<0.0001
. ***include in model
.
. *Prec L15-21
. *unconditional
. xi: poisson agi avP_TL15_21

Iteration 0:   log likelihood = -2367.0303
Iteration 1:   log likelihood = -2367.0303

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =      23.87
                                                  Prob > chi2       =     0.0000
Log likelihood = -2367.0303                       Pseudo R2         =     0.0050

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 avP_TL15_21 |    .041468   .0083842     4.95   0.000     .0250353    .0579006
       _cons |   .6415619   .0363357    17.66   0.000     .5703452    .7127786
------------------------------------------------------------------------------

. test avP_TL15_21

 ( 1)  [agi]avP_TL15_21 = 0

           chi2(  1) =   24.46
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi avP_TL15_21 cos* sin*

Iteration 0:   log likelihood = -2273.4475
Iteration 1:   log likelihood = -2273.4446
Iteration 2:   log likelihood = -2273.4446

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     211.04
                                                  Prob > chi2       =     0.0000
Log likelihood = -2273.4446                       Pseudo R2         =     0.0444

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 avP_TL15_21 |   .0528098   .0112822     4.68   0.000     .0306971    .0749225
       cos_1 |   .2155633   .0327975     6.57   0.000     .1512814    .2798451
       cos_2 |  -.0466554   .0350976    -1.33   0.184    -.1154453    .0221346
       cos_3 |  -.0353634    .032844    -1.08   0.282    -.0997364    .0290096
       cos_4 |   .0344761   .0320294     1.08   0.282    -.0283004    .0972526
       cos_5 |   .0499484   .0324449     1.54   0.124    -.0136424    .1135392
       cos_6 |   .0001523   .0321892     0.00   0.996    -.0629375     .063242
       cos_7 |  -.0154591   .0320332    -0.48   0.629    -.0782429    .0473247
```

```
       cos_8 |  -.0160588   .0315776    -0.51   0.611    -.0779498    .0458322
       cos_9 |  -.0249483   .0319513    -0.78   0.435    -.0875718    .0376752
      cos_10 |  -.0564732   .0309882    -1.82   0.068    -.1172089    .0042625
       sin_1 |   .2471076    .032723     7.55   0.000     .1829717    .3112434
       sin_2 |   .1337826   .0369554     3.62   0.000     .0613513    .2062138
       sin_3 |  -.0727663   .0316189    -2.30   0.021    -.1347382   -.0107943
       sin_4 |  -.0004212   .0322274    -0.01   0.990    -.0635857    .0627433
       sin_5 |  -.0026581   .0316787    -0.08   0.933    -.0647472     .059431
       sin_6 |  -.0450791   .0317645    -1.42   0.156    -.1073364    .0171783
       sin_7 |   .0425391   .0319116     1.33   0.183    -.0200065    .1050847
       sin_8 |  -.0841945   .0322263    -2.61   0.009    -.1473569    -.021032
       sin_9 |   .1313862   .0318911     4.12   0.000     .0688807    .1938916
      sin_10 |    .015919   .0316523     0.50   0.615    -.0461184    .0779564
       _cons |   .5594533   .0452803    12.36   0.000     .4707056    .6482011
------------------------------------------------------------------------------

. test avP_TL15_21

 ( 1)  [agi]avP_TL15_21 = 0

           chi2(  1) =   21.91
         Prob > chi2 =    0.0000

. *p-value<0.0001
. ***include in model
.
. *Prec L22-28
. *unconditional
. xi: poisson agi avP_TL22_28

Iteration 0:   log likelihood = -2366.4694
Iteration 1:   log likelihood = -2366.4694

Poisson regression                                Number of obs     =        995
                                                  LR chi2(1)        =      25.00
                                                  Prob > chi2       =     0.0000
Log likelihood = -2366.4694                       Pseudo R2         =     0.0053

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 avP_TL22_28 |   .0420549   .0083116     5.06   0.000     .0257644    .0583454
       _cons |   .6362807    .036688    17.34   0.000     .5643735    .7081879
------------------------------------------------------------------------------

. test avP_TL22_28

 ( 1)  [agi]avP_TL22_28 = 0

           chi2(  1) =   25.60
         Prob > chi2 =    0.0000

. *p-value<0.0001
. *conditional
. xi: poisson agi avP_TL22_28 cos* sin*

Iteration 0:   log likelihood = -2264.7863
Iteration 1:   log likelihood = -2264.7832
Iteration 2:   log likelihood = -2264.7832

Poisson regression                                Number of obs     =        995
                                                  LR chi2(21)       =     228.37
                                                  Prob > chi2       =     0.0000
Log likelihood = -2264.7832                       Pseudo R2         =     0.0480

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 avP_TL22_28 |   .0703867   .0111407     6.32   0.000     .0485513    .0922221
       cos_1 |   .2014404   .0328224     6.14   0.000     .1371096    .2657712
       cos_2 |  -.0506918   .0335804    -1.51   0.131    -.1165083    .0151246
```

```
       cos_3 |  -.0361323   .0325885    -1.11   0.268    -.1000046    .0277399
       cos_4 |   .0196013    .032245     0.61   0.543    -.0435977    .0828002
       cos_5 |   .0324614   .0324932     1.00   0.318    -.0312242    .0961469
       cos_6 |  -.0043859   .0320368    -0.14   0.891    -.0671769    .0584051
       cos_7 |   -.020533   .0322417    -0.64   0.524    -.0837256    .0426596
       cos_8 |  -.0241678   .0316126    -0.76   0.445    -.0861273    .0377917
       cos_9 |  -.0368915    .032327    -1.14   0.254    -.1002513    .0264683
      cos_10 |  -.0416946    .031265    -1.33   0.182    -.1029728    .0195836
       sin_1 |   .2572483   .0327893     7.85   0.000     .1929824    .3215142
       sin_2 |   .1817859    .038633     4.71   0.000     .1060667    .2575051
       sin_3 |  -.0890304   .0317994    -2.80   0.005    -.1513561   -.0267046
       sin_4 |  -.0091328   .0319717    -0.29   0.775    -.0717961    .0535306
       sin_5 |    .005128   .0317041     0.16   0.872     -.057011     .067267
       sin_6 |  -.0368791    .031923    -1.16   0.248     -.099447    .0256888
       sin_7 |   .0385455   .0317113     1.22   0.224    -.0236074    .1006985
       sin_8 |   -.091418   .0322024    -2.84   0.005    -.1545336   -.0283025
       sin_9 |   .1447824    .031545     4.59   0.000     .0829553    .2066094
      sin_10 |   .0348067    .031356     1.11   0.267      -.02665    .0962634
       _cons |   .4944336   .0459739    10.75   0.000     .4043263    .5845408
------------------------------------------------------------------------------

. test avP_TL22_28

 ( 1)  [agi]avP_TL22_28 = 0

           chi2(  1) =   39.92
         Prob > chi2 =    0.0000

. *p-value<0.0001
. ***include in model
.
. *look for collinearity for variables to be considered in model
. xi: spearman i.T_C i.avmean_TL0_3 i.avmean_TL0_7 i.avmean_TL8_14 i.avmean_TL15_21
i.avmean_TL22_28 i.Tmax_C i.avmax_TL0_3 i.avmax_TL0_7 i.avmax_TL8_14
>  i.avmax_TL15_21 i.avmax_TL22_28 Prrfe avP_TL0_3 avP_TL0_7 avP_TL8_14 avP_TL15_21 avP_TL22_28
i.T_C             _IT_C_1-4           (naturally coded; _IT_C_1 omitted)
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL0_7    _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL8_14   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmean_TL1~21   _Iavmean_TLc1-4     (naturally coded; _Iavmean_TLc1 omitted)
i.avmean_TL2~28   _Iavmean_TLd1-4     (naturally coded; _Iavmean_TLd1 omitted)
i.Tmax_C          _ITmax_C_1-4        (naturally coded; _ITmax_C_1 omitted)
i.avmax_TL0_3     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)
i.avmax_TL0_7     _Iavmax_TL0a1-4     (naturally coded; _Iavmax_TL0a1 omitted)
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)
i.avmax_TL15_21   _Iavmax_TL1_1-4     (naturally coded; _Iavmax_TL1_1 omitted)
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)
(obs=1620)

             |  _IT_C_2  _IT_C_3  _IT_C_4 _Iav~L_2 _Iav~L_3 _Iav~L_4 _Iav~La2
-------------+---------------------------------------------------------------
     _IT_C_2 |   1.0000
     _IT_C_3 |  -0.3361   1.0000
     _IT_C_4 |  -0.3344  -0.3328   1.0000
_Iavmean_~_2 |   0.2721   0.0458  -0.3261   1.0000
_Iavmean_~_3 |  -0.0371   0.2669   0.0259  -0.4132   1.0000
_Iavmean_~_4 |  -0.2417  -0.0875   0.6204  -0.3551  -0.3184   1.0000
_Iavmean_~a2 |   0.1937   0.0167  -0.2948   0.4711  -0.1127  -0.3886   1.0000
_Iavmean_~a3 |  -0.0501   0.1880   0.0857  -0.1392   0.4502  -0.0251  -0.4985
_Iavmean_~a4 |  -0.1587  -0.0975   0.4981  -0.3017  -0.1522   0.7317  -0.3510
_Iavmean_~b2 |   0.0764   0.0323  -0.1221   0.0612   0.0590  -0.1511   0.0679
_Iavmean_~b3 |  -0.0224   0.0429   0.0959  -0.0121   0.0894   0.0685   0.0006
_Iavmean_~b4 |  -0.0758  -0.0220   0.2254  -0.0892  -0.0712   0.3191  -0.1325
_Iavmean_~c2 |   0.0498   0.0828  -0.1429   0.0473   0.0445  -0.1417   0.0840
_Iavmean_~c3 |  -0.0161   0.0241   0.0802  -0.0004   0.0284   0.0982  -0.0473
_Iavmean_~c4 |  -0.0587  -0.0381   0.2229  -0.0754  -0.0175   0.2451  -0.0914
_Iavmean_~d2 |   0.0171   0.0352  -0.0714   0.0106   0.0500  -0.1129   0.0239
_Iavmean_~d3 |  -0.0005   0.0147   0.0708  -0.0179   0.0375   0.1015  -0.0557
_Iavmean_~d4 |  -0.0375  -0.0054   0.1407  -0.0260  -0.0033   0.1577  -0.0428
  _ITmax_C_2 |   0.5098  -0.0748  -0.3295   0.1469   0.0264  -0.1950   0.1293
  _ITmax_C_3 |  -0.0713   0.4893  -0.0963   0.0356   0.1216  -0.0050  -0.0021
```

```
  _ITmax_C_4 |  -0.3334  -0.0854   0.7531  -0.2278   0.0543   0.4698  -0.2271
_Iavmax_~0_2 |   0.3128   0.0056  -0.3655   0.6822  -0.2131  -0.3943   0.3764
_Iavmax_~0_3 |  -0.0792   0.2716   0.0987  -0.3002   0.6181  -0.0309  -0.1290
_Iavmax_~0_4 |  -0.2496  -0.0899   0.6093  -0.3216  -0.1627   0.7699  -0.3377
_Iavmax_T~a2 |   0.2036   0.0342  -0.3273   0.4756  -0.0999  -0.4215   0.7126
_Iavmax_T~a3 |  -0.0642   0.1840   0.1281  -0.2038   0.4203   0.0774  -0.3989
_Iavmax_T~a4 |  -0.1770  -0.1112   0.5154  -0.2704  -0.1702   0.6915  -0.3132
_Iavmax_~8_2 |   0.0724   0.0328  -0.1317   0.0755   0.0624  -0.1670   0.0839
_Iavmax_~8_3 |  -0.0537   0.0398   0.1244  -0.0435   0.0654   0.1211  -0.0292
_Iavmax_~8_4 |  -0.0424  -0.0247   0.1861  -0.0699  -0.0622   0.2684  -0.1233
_Iavmax_~1_2 |   0.0825   0.0689  -0.1534   0.0818   0.0468  -0.1499   0.1419
_Iavmax_~1_3 |  -0.0577   0.0297   0.1238  -0.0291   0.0006   0.1533  -0.0969
_Iavmax_~1_4 |  -0.0386  -0.0450   0.1833  -0.0506  -0.0189   0.1930  -0.0533
_Iavmax_~2_2 |   0.0471   0.0363  -0.0671   0.0182   0.0739  -0.1226   0.0277
_Iavmax_~2_3 |  -0.0295  -0.0300   0.1238  -0.0525  -0.0055   0.1831  -0.0658
_Iavmax_~2_4 |  -0.0196   0.0188   0.0821  -0.0123   0.0243   0.0768  -0.0225
       Prrfe |   0.2098  -0.1269  -0.3635   0.1860  -0.0955  -0.2600   0.1771
   avP_TL0_3 |   0.2157  -0.1319  -0.4196   0.2882  -0.1599  -0.4280   0.2699
   avP_TL0_7 |   0.2003  -0.0911  -0.4093   0.3052  -0.1657  -0.4470   0.3102
  avP_TL8_14 |   0.0716  -0.0042  -0.2317   0.1389  -0.0385  -0.2875   0.1361
 avP_TL15_21 |   0.0567   0.0127  -0.2289   0.0774  -0.0061  -0.2480   0.0814
 avP_TL22_28 |   0.0506  -0.0199  -0.1764   0.0703  -0.0419  -0.2099   0.0725

             | _Iav~La3 _Iav~La4 _Iavm~b2 _Iavm~b3 _Iavm~b4 _Iavm~c2 _Iavm~c3
-------------+---------------------------------------------------------------
_Iavmean_~a3 |   1.0000
_Iavmean_~a4 |  -0.3071   1.0000
_Iavmean_~b2 |   0.0865  -0.2006   1.0000
_Iavmean_~b3 |   0.0956   0.0581  -0.4837   1.0000
_Iavmean_~b4 |  -0.0223   0.3754  -0.3509  -0.3018   1.0000
_Iavmean_~c2 |   0.0222  -0.1569   0.0755   0.0923  -0.1967   1.0000
_Iavmean_~c3 |   0.0838   0.1041  -0.0065   0.0897   0.0582  -0.4837   1.0000
_Iavmean_~c4 |  -0.0009   0.2527  -0.1292  -0.0265   0.3806  -0.3457  -0.2974
_Iavmean_~d2 |   0.0327  -0.1356   0.0716   0.0240  -0.1487   0.0716   0.0889
_Iavmean_~d3 |   0.1251   0.0900  -0.0404   0.0748   0.1147  -0.0065   0.0897
_Iavmean_~d4 |  -0.0183   0.1876  -0.0672  -0.0014   0.2359  -0.1219  -0.0194
  _ITmax_C_2 |  -0.0226  -0.1422   0.0561  -0.0103  -0.0739   0.0709  -0.0572
  _ITmax_C_3 |   0.1033  -0.0274   0.0016   0.0169   0.0255   0.0134   0.0294
  _ITmax_C_4 |   0.1033   0.3784  -0.0815   0.1013   0.1479  -0.1052   0.0981
_Iavmax_~0_2 |  -0.1153  -0.3035   0.0876  -0.0352  -0.1085   0.0502  -0.0267
_Iavmax_~0_3 |   0.3296   0.0081   0.0074   0.0755   0.0196   0.0219   0.0421
_Iavmax_~0_4 |   0.0271   0.5850  -0.0993   0.0796   0.2105  -0.1060   0.0901
_Iavmax_T~a2 |  -0.3101  -0.3910   0.0954  -0.0059  -0.1454   0.1032  -0.0610
_Iavmax_T~a3 |   0.6954  -0.0684   0.0199   0.0627   0.0621  -0.0109   0.0716
_Iavmax_T~a4 |  -0.2096   0.8149  -0.1477   0.0806   0.2691  -0.1331   0.1151
_Iavmax_~8_2 |   0.0759  -0.2326   0.7346  -0.3043  -0.3925   0.0790  -0.0043
_Iavmax_~8_3 |   0.0669   0.1424  -0.3930   0.6928  -0.0523   0.0400   0.0785
_Iavmax_~8_4 |  -0.0034   0.3197  -0.3127  -0.1965   0.8052  -0.1462   0.0667
_Iavmax_~1_2 |  -0.0076  -0.1648   0.0719   0.0848  -0.2335   0.7324  -0.3058
_Iavmax_~1_3 |   0.0816   0.1589  -0.0192   0.0603   0.1374  -0.3907   0.6968
_Iavmax_~1_4 |  -0.0064   0.2016  -0.1310  -0.0052   0.3355  -0.3096  -0.1934
_Iavmax_~2_2 |   0.0700  -0.1446   0.1297   0.0038  -0.1612   0.0671   0.0807
_Iavmax_~2_3 |   0.0461   0.1838  -0.0901   0.0693   0.1693  -0.0192   0.0603
_Iavmax_~2_4 |   0.0172   0.0940  -0.0274  -0.0128   0.1886  -0.1233   0.0028
       Prrfe |  -0.0951  -0.2126   0.1349  -0.0762  -0.1044   0.1282  -0.0846
   avP_TL0_3 |  -0.1421  -0.3453   0.1287  -0.0857  -0.1407   0.1599  -0.0957
   avP_TL0_7 |  -0.1732  -0.4309   0.1662  -0.1115  -0.1754   0.1977  -0.1192
  avP_TL8_14 |  -0.0845  -0.3219   0.3240  -0.1756  -0.4305   0.1628  -0.1113
 avP_TL15_21 |  -0.0652  -0.2316   0.1726  -0.0985  -0.3225   0.3262  -0.1733
 avP_TL22_28 |  -0.0647  -0.2144   0.0960  -0.0718  -0.2308   0.1695  -0.1011

             | _Iavm~c4 _Iavm~d2 _Iavm~d3 _Iavm~d4 _ITmax~2 _ITmax~3 _ITmax~4
-------------+---------------------------------------------------------------
_Iavmean_~c4 |   1.0000
_Iavmean_~d2 |  -0.1922   1.0000
_Iavmean_~d3 |   0.0661  -0.4862   1.0000
_Iavmean_~d4 |   0.3684  -0.3424  -0.2929   1.0000
  _ITmax_C_2 |  -0.0419   0.0056  -0.0103  -0.0356   1.0000
  _ITmax_C_3 |   0.0062   0.0045   0.0075   0.0620  -0.3350   1.0000
  _ITmax_C_4 |   0.1522  -0.0251   0.0700   0.0734  -0.3350  -0.3355   1.0000
_Iavmax_~0_2 |  -0.0774   0.0115  -0.0662   0.0021   0.1952   0.0282  -0.2916
```

```
_Iavmax_~0_3 |   0.0304  -0.0073   0.0998   0.0267  -0.0129   0.1938   0.0821
_Iavmax_~0_4 |   0.1843  -0.0551   0.0446   0.1111  -0.2298  -0.0464   0.5347
_Iavmax_T~a2 |  -0.0944   0.0414  -0.0692  -0.0424   0.1383   0.0272  -0.2588
_Iavmax_T~a3 |   0.0489  -0.0171   0.1337   0.0140  -0.0149   0.1115   0.1301
_Iavmax_T~a4 |   0.1847  -0.0916   0.0577   0.1496  -0.1635  -0.0394   0.4109
_Iavmax_~8_2 |  -0.1295   0.0954  -0.0566  -0.0679   0.0444   0.0113  -0.0927
_Iavmax_~8_3 |   0.0366  -0.0142   0.0665   0.0408  -0.0260   0.0170   0.1266
_Iavmax_~8_4 |   0.2921  -0.1228   0.1239   0.1798  -0.0567   0.0148   0.1190
_Iavmax_~1_2 |  -0.3877   0.0726  -0.0059  -0.1223   0.0863   0.0128  -0.1028
_Iavmax_~1_3 |  -0.0545   0.0398   0.0813   0.0355  -0.0739   0.0413   0.1166
_Iavmax_~1_4 |   0.8082  -0.1438   0.0717   0.2865  -0.0450  -0.0012   0.1158
_Iavmax_~2_2 |  -0.2288   0.7319  -0.3095  -0.3843   0.0392   0.0149  -0.0342
_Iavmax_~2_3 |   0.1460  -0.3934   0.6968  -0.0477  -0.0300  -0.0403   0.1072
_Iavmax_~2_4 |   0.3209  -0.3059  -0.1878   0.8040  -0.0302   0.1000   0.0182
       Prrfe |  -0.0820   0.0534  -0.0352  -0.0113   0.1360  -0.0632  -0.3826
   avP_TL0_3 |  -0.1194   0.0881  -0.0607   0.0087   0.1490  -0.0888  -0.3703
   avP_TL0_7 |  -0.1289   0.1227  -0.0882  -0.0088   0.1165  -0.0486  -0.3545
  avP_TL8_14 |  -0.1663   0.1888  -0.1147  -0.1246   0.0559  -0.0482  -0.1648
 avP_TL15_21 |  -0.4335   0.1607  -0.1092  -0.1665   0.0644  -0.0412  -0.1689
 avP_TL22_28 |  -0.3190   0.3233  -0.1762  -0.4308   0.0021  -0.0323  -0.1266

             | _Iav~0_2 _Iav~0_3 _Iav~0_4 _Iav~0a2 _Iav~0a3 _Iav~0a4 _Iav~8_2
-------------+---------------------------------------------------------------
_Iavmax_~0_2 |   1.0000
_Iavmax_~0_3 |  -0.4625   1.0000
_Iavmax_~0_4 |  -0.3572  -0.2907   1.0000
_Iavmax_T~a2 |   0.4611  -0.1532  -0.3855   1.0000
_Iavmax_T~a3 |  -0.1992   0.4234   0.0414  -0.5505   1.0000
_Iavmax_T~a4 |  -0.2947  -0.0942   0.6686  -0.3489  -0.2717   1.0000
_Iavmax_~8_2 |   0.0954   0.0283  -0.1285   0.1143   0.0227  -0.1922   1.0000
_Iavmax_~8_3 |  -0.0736   0.0729   0.1280  -0.0621   0.0605   0.1675  -0.5378
_Iavmax_~8_4 |  -0.0866   0.0053   0.1751  -0.1355   0.0758   0.2196  -0.3498
_Iavmax_~1_2 |   0.0700   0.0464  -0.1328   0.1350  -0.0145  -0.1472   0.0939
_Iavmax_~1_3 |  -0.0395   0.0053   0.1583  -0.0919   0.0781   0.1657  -0.0433
_Iavmax_~1_4 |  -0.0601   0.0293   0.1299  -0.0808   0.0313   0.1450  -0.1296
_Iavmax_~2_2 |   0.0054   0.0173  -0.0515   0.0229   0.0497  -0.1107   0.1242
_Iavmax_~2_3 |  -0.0791   0.0572   0.1091  -0.0670   0.0544   0.1426  -0.0876
_Iavmax_~2_4 |   0.0222   0.0413   0.0413  -0.0282   0.0321   0.0719  -0.0488
       Prrfe |   0.2097  -0.1301  -0.2614   0.1691  -0.1201  -0.2129   0.0937
   avP_TL0_3 |   0.2940  -0.1917  -0.4133   0.2495  -0.1719  -0.3431   0.1172
   avP_TL0_7 |   0.2934  -0.1960  -0.3977   0.2944  -0.2215  -0.3996   0.1706
  avP_TL8_14 |   0.1361  -0.0960  -0.2144   0.1358  -0.1267  -0.2697   0.3269
 avP_TL15_21 |   0.0881  -0.0816  -0.1786   0.0914  -0.1221  -0.1681   0.1563
 avP_TL22_28 |   0.0574  -0.1045  -0.1251   0.0668  -0.1109  -0.1533   0.0788

             | _Iav~8_3 _Iav~8_4 _Iav~1_2 _Iav~1_3 _Iav~1_4 _Iav~2_2 _Iav~2_3
-------------+---------------------------------------------------------------
_Iavmax_~8_3 |   1.0000
_Iavmax_~8_4 |  -0.2674   1.0000
_Iavmax_~1_2 |   0.0372  -0.1990   1.0000
_Iavmax_~1_3 |   0.0759   0.1476  -0.5368   1.0000
_Iavmax_~1_4 |   0.0433   0.2612  -0.3472  -0.2636   1.0000
_Iavmax_~2_2 |  -0.0081  -0.1380   0.0864   0.0367  -0.1969   1.0000
_Iavmax_~2_3 |   0.0640   0.1782  -0.0449   0.0787   0.1531  -0.5402   1.0000
_Iavmax_~2_4 |   0.0206   0.1300  -0.1218   0.0418   0.2543  -0.3434  -0.2590
       Prrfe |  -0.0913  -0.0726   0.1239  -0.1112  -0.0498   0.0567  -0.0531
   avP_TL0_3 |  -0.1311  -0.0910   0.1538  -0.1377  -0.0779   0.0680  -0.0873
   avP_TL0_7 |  -0.1445  -0.1499   0.1732  -0.1642  -0.0831   0.0956  -0.1030
  avP_TL8_14 |  -0.2361  -0.3978   0.1717  -0.1409  -0.1474   0.1611  -0.1596
 avP_TL15_21 |  -0.1298  -0.2766   0.3279  -0.2339  -0.4001   0.1691  -0.1388
 avP_TL22_28 |  -0.1132  -0.1757   0.1542  -0.1308  -0.2733   0.3242  -0.2367

             | _Iav~2_4    Prrfe avP_TL~3 avP_TL~7 avP_T~14 avP_T~21 avP_T~28
-------------+---------------------------------------------------------------
_Iavmax_~2_4 |   1.0000
       Prrfe |   0.0085   1.0000
   avP_TL0_3 |   0.0513   0.6752   1.0000
   avP_TL0_7 |   0.0226   0.5720   0.8513   1.0000
  avP_TL8_14 |  -0.0791   0.2608   0.3720   0.4891   1.0000
 avP_TL15_21 |  -0.1479   0.2859   0.3580   0.4012   0.4927   1.0000
 avP_TL22_28 |  -0.3973   0.1720   0.2451   0.3236   0.3884   0.4919   1.0000
```

```
. *no collinearity, except for variables related by design
.
. ***MODEL BUILDING***
. *Full model
. xi: poisson agi cos* sin* i.T_C i.avmean_TL0_3 i.avmean_TL0_7 i.avmean_TL8_14 i.avmean_TL15_21
i.avmean_TL22_28 i.Tmax_C i.avmax_TL0_3 i.avmax_TL0_7 i
> .avmax_TL8_14 i.avmax_TL15_21 i.avmax_TL22_28 Prrfe avP_TL0_3 avP_TL0_7 avP_TL8_14 avP_TL15_21
avP_TL22_28
i.T_C             _IT_C_1-4           (naturally coded; _IT_C_1 omitted)
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL0_7    _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL8_14   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmean_TL1~21   _Iavmean_TLc1-4     (naturally coded; _Iavmean_TLc1 omitted)
i.avmean_TL2~28   _Iavmean_TLd1-4     (naturally coded; _Iavmean_TLd1 omitted)
i.Tmax_C          _ITmax_C_1-4        (naturally coded; _ITmax_C_1 omitted)
i.avmax_TL0_3     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)
i.avmax_TL0_7     _Iavmax_TL0a1-4     (naturally coded; _Iavmax_TL0a1 omitted)
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)
i.avmax_TL15_21   _Iavmax_TL1_1-4     (naturally coded; _Iavmax_TL1_1 omitted)
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Iteration 0:   log likelihood = -1977.6707
Iteration 1:   log likelihood =  -1977.316
Iteration 2:   log likelihood = -1977.3157
Iteration 3:   log likelihood = -1977.3157

Poisson regression                                Number of obs     =        995
                                                  LR chi2(62)       =     803.30
                                                  Prob > chi2       =     0.0000
Log likelihood = -1977.3157                       Pseudo R2         =     0.1688

------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cos_1 |  -.7116008   .0626321   -11.36   0.000    -.8343575    -.588844
        cos_2 |  -.0857167   .0610688    -1.40   0.160    -.2054093     .033976
        cos_3 |  -.4243453   .0390704   -10.86   0.000    -.5009218   -.3477687
        cos_4 |  -.1309035   .0360308    -3.63   0.000    -.2015226   -.0602844
        cos_5 |   .0646765   .0340517     1.90   0.058    -.0020636    .1314165
        cos_6 |  -.1207352   .0369813    -3.26   0.001    -.1932172   -.0482531
        cos_7 |   -.054485   .0370134    -1.47   0.141    -.1270299    .0180598
        cos_8 |  -.0117945   .0346001    -0.34   0.733    -.0796095    .0560205
        cos_9 |   .0281558    .036748     0.77   0.444    -.0438689    .1001806
       cos_10 |  -.1014914   .0342515    -2.96   0.003     -.168623   -.0343597
        sin_1 |   .6258187   .0468813    13.35   0.000     .5339331    .7177043
        sin_2 |   .5994917   .0536982    11.16   0.000     .4942452    .7047383
        sin_3 |   .0613068   .0367518     1.67   0.095    -.0107255    .1333391
        sin_4 |   .0943486   .0371577     2.54   0.011     .0215208    .1671765
        sin_5 |   .0498753   .0337485     1.48   0.139    -.0162706    .1160211
        sin_6 |  -.2230011   .0381148    -5.85   0.000    -.2977047   -.1482975
        sin_7 |   .0714253   .0373596     1.91   0.056    -.0017982    .1446487
        sin_8 |  -.0663917   .0359115    -1.85   0.064    -.1367769    .0039935
        sin_9 |   .1313722   .0356381     3.69   0.000     .0615228    .2012216
       sin_10 |    .022145    .034812     0.64   0.525    -.0460853    .0903754
      _IT_C_2 |   .1961797   .0861046     2.28   0.023     .0274177    .3649417
      _IT_C_3 |   .3385391    .118083     2.87   0.004     .1071007    .5699774
      _IT_C_4 |    .113588   .1601078     0.71   0.478    -.2002176    .4273937
_Iavmean_TL_2 |  -.1627214   .1036217    -1.57   0.116    -.3658162    .0403733
_Iavmean_TL_3 |  -.2541358   .1390739    -1.83   0.068    -.5267155     .018444
_Iavmean_TL_4 |  -.8123773   .2040997    -3.98   0.000    -1.212405   -.4123493
_Iavmean_TLa2 |  -.0926514   .1118424    -0.83   0.407    -.3118586    .1265558
_Iavmean_TLa3 |  -.1925067   .1432354    -1.34   0.179     -.473243    .0882295
_Iavmean_TLa4 |  -.1130486    .210565    -0.54   0.591    -.5257484    .2996513
_Iavmean_TLb2 |  -.1439378    .102945    -1.40   0.162    -.3457062    .0578306
_Iavmean_TLb3 |  -.2868171   .1326078    -2.16   0.031    -.5467235   -.0269107
_Iavmean_TLb4 |  -.5066493    .198292    -2.56   0.011    -.8952946   -.1180041
_Iavmean_TLc2 |  -.3211368   .1025763    -3.13   0.002    -.5221827   -.1200908
_Iavmean_TLc3 |  -.4916875   .1317708    -3.73   0.000    -.7499536   -.2334214
_Iavmean_TLc4 |  -.4386991   .2040046    -2.15   0.032    -.8385408   -.0388575
_Iavmean_TLd2 |  -.4666746   .1062963    -4.39   0.000    -.6750115   -.2583377
```

```
_Iavmean_TLd3 |  -.6458775   .1326814    -4.87   0.000    -.9059282   -.3858267
_Iavmean_TLd4 |   -1.03041   .2042155    -5.05   0.000    -1.430665   -.6301549
   _ITmax_C_2 |  -.1147764   .0790243    -1.45   0.146    -.2696613    .0401084
   _ITmax_C_3 |  -.1976105   .1072727    -1.84   0.065    -.4078611    .0126401
   _ITmax_C_4 |  -.1778182   .1360533    -1.31   0.191    -.4444778    .0888414
_Iavmax_TL0_2 |  -.1055767   .0884504    -1.19   0.233    -.2789362    .0677828
_Iavmax_TL0_3 |   -.087134   .1267327    -0.69   0.492    -.3355255    .1612575
_Iavmax_TL0_4 |   .1919967   .1894594     1.01   0.311    -.1793369    .5633303
_Iavmax_TL0a2 |  -.3385767   .1074346    -3.15   0.002    -.5491447   -.1280088
_Iavmax_TL0a3 |  -.3708768    .140136    -2.65   0.008    -.6455383   -.0962153
_Iavmax_TL0a4 |  -.3408591   .2234072    -1.53   0.127    -.7787292    .0970109
_Iavmax_TL8_2 |   -.174498   .1003355    -1.74   0.082    -.3711519    .0221559
_Iavmax_TL8_3 |  -.3579086   .1353822    -2.64   0.008    -.6232528   -.0925645
_Iavmax_TL8_4 |  -.5006435   .2081295    -2.41   0.016    -.9085699   -.0927172
_Iavmax_TL1_2 |  -.1541594   .1042466    -1.48   0.139    -.3584789    .0501602
_Iavmax_TL1_3 |   -.339997   .1417405    -2.40   0.016    -.6178033   -.0621906
_Iavmax_TL1_4 |  -.6598278   .2156161    -3.06   0.002    -1.082428   -.2372281
_Iavmax_TL2_2 |  -.0841715   .1051291    -0.80   0.423    -.2902207    .1218777
_Iavmax_TL2_3 |  -.1427483   .1398255    -1.02   0.307    -.4168012    .1313046
_Iavmax_TL2_4 |  -.3467545   .2163728    -1.60   0.109    -.7708374    .0773283
        Prrfe |   .0045971   .0060839     0.76   0.450    -.0073271    .0165214
    avP_TL0_3 |  -.0129577   .0160067    -0.81   0.418    -.0443302    .0184148
    avP_TL0_7 |   .0651502   .0205831     3.17   0.002     .0248082    .1054923
   avP_TL8_14 |   .0099359   .0143149     0.69   0.488    -.0181207    .0379925
  avP_TL15_21 |  -.0169136   .0141562    -1.19   0.232    -.0446591    .0108319
  avP_TL22_28 |   .0060086   .0138209     0.43   0.664    -.0210798    .0330971
        _cons |   2.722444   .2089315    13.03   0.000     2.312945    3.131942
-------------------------------------------------------------------------------

. est store A

. *BIC=4080.631
. estat ic

Akaike's information criterion and Bayesian information criterion

-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           A |        995 -2378.967  -1977.316      63    4080.631   4389.504
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.
```

```
*Final negative binomial time-series model outputs:

. ***FINAL NEGATIVE BINOMIAL MODEL - AGI no sex considerations***
. xi: nbreg agi cos* sin* i.avmean_TL0_3 i.avmean_TL15_21 i.avmean_TL22_28 i.avmax_TL0_7
i.avmax_TL8_14 avP_TL0_7
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL1~21   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL2~28   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmax_TL0_7     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -2001.2659
Iteration 1:   log likelihood = -2000.9381
Iteration 2:   log likelihood = -2000.9379
Iteration 3:   log likelihood = -2000.9379

Fitting constant-only model:

Iteration 0:   log likelihood = -1971.5256
Iteration 1:   log likelihood = -1968.2809
Iteration 2:   log likelihood = -1968.2712
Iteration 3:   log likelihood = -1968.2712

Fitting full model:
```

```
Iteration 0:   log likelihood = -1854.0726
Iteration 1:   log likelihood =  -1820.432
Iteration 2:   log likelihood = -1810.7485
Iteration 3:   log likelihood = -1810.6585
Iteration 4:   log likelihood = -1810.6585

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(36)       =     315.23
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -1810.6585                       Pseudo R2         =     0.0801

------------------------------------------------------------------------------
         agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       cos_1 |  -.8136342   .0968361    -8.40   0.000    -1.003429    -.623839
       cos_2 |  -.1343574   .0717295    -1.87   0.061    -.2749447    .0062299
       cos_3 |  -.4643576   .0605982    -7.66   0.000    -.5831279   -.3455872
       cos_4 |  -.1665303   .0570325    -2.92   0.004     -.278312   -.0547487
       cos_5 |   .0262311   .0528802     0.50   0.620    -.0774122    .1298744
       cos_6 |  -.1164184   .0540379    -2.15   0.031    -.2223307   -.0105062
       cos_7 |  -.1257173   .0552345    -2.28   0.023    -.2339749   -.0174597
       cos_8 |   .0127369   .0550955     0.23   0.817    -.0952482     .120722
       cos_9 |   .0414705   .0544751     0.76   0.446    -.0652987    .1482397
      cos_10 |  -.0947283   .0526109    -1.80   0.072    -.1978437    .0083871
       sin_1 |   .7726899   .0718334    10.76   0.000      .631899    .9134807
       sin_2 |   .6839508   .0672044    10.18   0.000     .5522325    .8156691
       sin_3 |   .0922413   .0562478     1.64   0.101    -.0180024    .2024851
       sin_4 |   .1208107   .0553856     2.18   0.029     .0122569    .2293646
       sin_5 |   .0619643   .0517801     1.20   0.231    -.0395229    .1634515
       sin_6 |  -.2391189   .0578172    -4.14   0.000    -.3524386   -.1257993
       sin_7 |   .0204747   .0580305     0.35   0.724     -.093263    .1342124
       sin_8 |  -.0329124   .0543208    -0.61   0.545    -.1393792    .0735545
       sin_9 |   .1214587   .0549101     2.21   0.027     .0138369    .2290805
      sin_10 |   .0432582   .0519581     0.83   0.405    -.0585778    .1450943
_Iavmean_TL_2 |  -.1861741   .1296893    -1.44   0.151    -.4403605    .0680123
_Iavmean_TL_3 |  -.2886474     .15431    -1.87   0.061    -.5910895    .0137947
_Iavmean_TL_4 |  -.7291857   .2096518    -3.48   0.001    -1.140096   -.3182758
_Iavmean_TLa2 |  -.5499396   .1305826    -4.21   0.000    -.8058768   -.2940025
_Iavmean_TLa3 |  -.8934534   .1502692    -5.95   0.000    -1.187976   -.5989311
_Iavmean_TLa4 |  -1.286392   .1764462    -7.29   0.000     -1.63222   -.9405635
_Iavmean_TLb2 |  -.6878725   .1334293    -5.16   0.000    -.9493892   -.4263559
_Iavmean_TLb3 |  -.8821385   .1514975    -5.82   0.000    -1.179068   -.5852089
_Iavmean_TLb4 |  -1.519852   .1841275    -8.25   0.000    -1.880736   -1.158969
_Iavmax_TL0_2 |  -.5913302   .1599342    -3.70   0.000    -.9047955   -.2778649
_Iavmax_TL0_3 |  -.7114035   .1972007    -3.61   0.000     -1.09791   -.3248972
_Iavmax_TL0_4 |  -.5827625     .25578    -2.28   0.023    -1.084082   -.0814429
_Iavmax_TL8_2 |  -.3751677   .1330188    -2.82   0.005    -.6358799   -.1144556
_Iavmax_TL8_3 |  -.7440609   .1543565    -4.82   0.000    -1.046594   -.4415276
_Iavmax_TL8_4 |  -1.079049   .1874773    -5.76   0.000    -1.446498   -.7116003
    avP_TL0_7 |    .057645   .0245616     2.35   0.019     .0095052    .1057847
        _cons |   3.072322   .2492518    12.33   0.000     2.583797    3.560846
-------------+----------------------------------------------------------------
    /lnalpha |    -.42295   .0953902                     -.6099114   -.2359886
-------------+----------------------------------------------------------------
       alpha |   .6551114   .0624912                       .543399    .7897897
------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 380.56              Prob >= chibar2 = 0.000


. ***FINAL NEGATIVE BINOMIAL MODEL - Pneumonia no sex considerations ***
. xi: nbreg pneum_any cos* sin* i.avmean_TL8_14 i.avmean_TL15_21 i.avmax_TL0_7 i.avmax_TL22_28
avP_TL0_7 avP_TL8_14
i.avmean_TL8_14   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL1~21   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmax_TL0_7     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -1188.0825
Iteration 1:   log likelihood = -1188.0622
```

```
Iteration 2:   log likelihood = -1188.0622

Fitting constant-only model:

Iteration 0:   log likelihood = -1261.4559
Iteration 1:   log likelihood = -1258.4591
Iteration 2:   log likelihood = -1258.4501
Iteration 3:   log likelihood = -1258.4501

Fitting full model:

Iteration 0:   log likelihood = -1188.4285
Iteration 1:   log likelihood = -1174.3804
Iteration 2:   log likelihood = -1173.5512
Iteration 3:   log likelihood = -1173.5448
Iteration 4:   log likelihood = -1173.5448

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(38)       =     169.81
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -1173.5448                       Pseudo R2         =     0.0675

-------------------------------------------------------------------------------
    pneum_any |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |  -.7831748   .1095585    -7.15   0.000    -.9979056   -.5684441
        cos_2 |   .0314382   .0955773     0.33   0.742    -.1558899    .2187663
        cos_3 |  -.4609743   .0706853    -6.52   0.000     -.599515   -.3224337
        cos_4 |  -.0538475   .0652669    -0.83   0.409    -.1817683    .0740733
        cos_5 |   .1238185   .0613643     2.02   0.044     .0035466    .2440904
        cos_6 |  -.0951802   .0635214    -1.50   0.134    -.2196798    .0293194
        cos_7 |   -.017815   .0636803    -0.28   0.780     -.142626     .106996
        cos_8 |  -.0025092   .0622457    -0.04   0.968    -.1245085    .1194901
        cos_9 |   .0305007   .0629828     0.48   0.628    -.0929433    .1539447
       cos_10 |  -.0074453   .0605218    -0.12   0.902    -.1260659    .1111753
       cos_11 |   .1282339   .0606214     2.12   0.034     .0094181    .2470497
       cos_12 |  -.0890904   .0598091    -1.49   0.136    -.2063141    .0281333
        sin_1 |   .6515536    .081951     7.95   0.000     .4909325    .8121746
        sin_2 |   .4688793   .0780311     6.01   0.000      .315941    .6218175
        sin_3 |    .191851   .0632092     3.04   0.002     .0679632    .3157387
        sin_4 |   .1564905   .0648281     2.41   0.016     .0294297    .2835512
        sin_5 |   .2187245   .0612936     3.57   0.000     .0985912    .3388577
        sin_6 |  -.1128694   .0638848    -1.77   0.077    -.2380814    .0123426
        sin_7 |   .0762627    .066926     1.14   0.254    -.0549097    .2074352
        sin_8 |   .1519666   .0625541     2.43   0.015     .0293629    .2745704
        sin_9 |   .0404696   .0616241     0.66   0.511    -.0803115    .1612506
       sin_10 |  -.0419334   .0615443    -0.68   0.496    -.1625581    .0786913
       sin_11 |  -.0597407   .0598995    -1.00   0.319    -.1771416    .0576603
       sin_12 |   .0632053   .0593551     1.06   0.287    -.0531285    .1795392
_Iavmean_TL_2 |  -.4702223   .1538092    -3.06   0.002    -.7716827   -.1687619
_Iavmean_TL_3 |   -.574055    .175367    -3.27   0.001     -.917768    -.230342
_Iavmean_TL_4 |  -.5303028   .2075725    -2.55   0.011    -.9371375   -.1234681
_Iavmean_TLa2 |  -.2913709   .1548112    -1.88   0.060    -.5947954    .0120535
_Iavmean_TLa3 |  -.4842511   .1692204    -2.86   0.004     -.815917   -.1525852
_Iavmean_TLa4 |   -.882762   .2043336    -4.32   0.000    -1.283249   -.4822755
_Iavmax_TL0_2 |  -.4054004   .1691142    -2.40   0.017    -.7368582   -.0739426
_Iavmax_TL0_3 |  -.6005709   .1951594    -3.08   0.002    -.9830762   -.2180656
_Iavmax_TL0_4 |  -.5822584   .2329919    -2.50   0.012    -1.038914   -.1256026
_Iavmax_TL2_2 |  -.5191103   .1530893    -3.39   0.001    -.8191597   -.2190609
_Iavmax_TL2_3 |   -.678164   .1712873    -3.96   0.000    -1.013881    -.342447
_Iavmax_TL2_4 |  -1.066223   .2115856    -5.04   0.000    -1.480923   -.6515224
    avP_TL0_7 |   .0570628   .0283041     2.02   0.044     .0015878    .1125377
   avP_TL8_14 |   .0666531   .0248818     2.68   0.007     .0178857    .1154205
        _cons |   1.024363   .3072898     3.33   0.001     .4220863     1.62664
--------------+----------------------------------------------------------------
     /lnalpha |  -1.112476   .2367268                     -1.576452   -.6485001
--------------+----------------------------------------------------------------
        alpha |   .3287439   .0778225                      .2067071    .5228294
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 29.03              Prob >= chibar2 = 0.000
```

```
. ***FINAL NEGATIVE BINOMIAL MODEL – Cardiovascular disease no sex considerations ***
. xi: nbreg cardiovas cos* sin* i.avmean_TL0_7 i.avmean_TL15_21 i.avmean_TL22_28 i.avmax_TL8_14
avP_TL0_7
i.avmean_TL0_7    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL1~21   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL2~28   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -1477.2979
Iteration 1:   log likelihood = -1477.1079
Iteration 2:   log likelihood = -1477.1077
Iteration 3:   log likelihood = -1477.1077

Fitting constant-only model:

Iteration 0:   log likelihood = -1276.3995
Iteration 1:   log likelihood = -1226.7313
Iteration 2:   log likelihood = -1203.2115
Iteration 3:   log likelihood = -1203.2075
Iteration 4:   log likelihood = -1203.2075

Fitting full model:

Iteration 0:   log likelihood = -1144.3376
Iteration 1:   log likelihood = -1131.8105
Iteration 2:   log likelihood = -1116.6278
Iteration 3:   log likelihood = -1116.5191
Iteration 4:   log likelihood =  -1116.519

Negative binomial regression                      Number of obs     =        994
                                                  LR chi2(37)       =     173.38
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood =  -1116.519                       Pseudo R2         =     0.0720

------------------------------------------------------------------------------
   cardiovas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       cos_1 |  -.7437984   .1620202    -4.59   0.000    -1.061352   -.4262447
       cos_2 |   .1387307   .1251768     1.11   0.268    -.1066113    .3840728
       cos_3 |  -.4471905    .104348    -4.29   0.000    -.6517088   -.2426722
       cos_4 |  -.1488812   .1002311    -1.49   0.137    -.3453305    .0475681
       cos_5 |  -.0444715   .0928673    -0.48   0.632    -.2264881    .1375452
       cos_6 |  -.1376526    .098667    -1.40   0.163    -.3310364    .0557312
       cos_7 |  -.0613913   .0962958    -0.64   0.524    -.2501276    .1273449
       cos_8 |  -.0033421   .0993489    -0.03   0.973    -.1980624    .1913781
       cos_9 |  -.0988056   .0989514    -1.00   0.318    -.2927467    .0951356
      cos_10 |  -.0890273   .0927059    -0.96   0.337    -.2707276     .092673
      cos_11 |  -.0294898   .0924289    -0.32   0.750     -.210647    .1516675
      cos_12 |  -.2568139   .0911851    -2.82   0.005    -.4355335   -.0780944
       sin_1 |   .6455551    .121432     5.32   0.000     .4075527    .8835574
       sin_2 |   .6071404   .1181814     5.14   0.000     .3755091    .8387718
       sin_3 |   .1281293   .0956718     1.34   0.180    -.0593839    .3156425
       sin_4 |   .1733696   .0971148     1.79   0.074    -.0169719    .3637111
       sin_5 |   .0470518   .0909565     0.52   0.605    -.1312197    .2253232
       sin_6 |  -.3710752   .0986532    -3.76   0.000    -.5644319   -.1777184
       sin_7 |   .0327372   .1011091     0.32   0.746     -.165433    .2309074
       sin_8 |  -.0753605   .0948617    -0.79   0.427    -.2612861    .1105651
       sin_9 |   .1195133   .0964927     1.24   0.216     -.069609    .3086355
      sin_10 |  -.0063068   .0908574    -0.07   0.945    -.1843841    .1717704
      sin_11 |   .0600804   .0902225     0.67   0.505    -.1167524    .2369132
      sin_12 |   .5372809   .0888609     6.05   0.000     .3631168    .7114449
_Iavmean_TL_2 |  -.5512843   .2518558    -2.19   0.029    -1.044913   -.0576559
_Iavmean_TL_3 |  -1.170737   .2899169    -4.04   0.000    -1.738964   -.6025102
_Iavmean_TL_4 |  -1.068552   .3452636    -3.09   0.002    -1.745256   -.3918476
_Iavmean_TLa2 |  -.4949593   .2203435    -2.25   0.025    -.9268247    -.063094
_Iavmean_TLa3 |  -.6485318   .2511272    -2.58   0.010    -1.140732   -.1563315
_Iavmean_TLa4 |  -1.033486   .2956536    -3.50   0.000    -1.612956   -.4540158
_Iavmean_TLb2 |  -.6344721   .2363795    -2.68   0.007    -1.097767   -.1711768
_Iavmean_TLb3 |  -.8867131   .2639444    -3.36   0.001    -1.404035   -.3693916
```

```
_Iavmean_TLb4 |  -1.789258   .3249475    -5.51   0.000    -2.426144   -1.152373
_Iavmax_TL8_2 |   .0219641   .2344868     0.09   0.925    -.4376217    .4815498
_Iavmax_TL8_3 |  -.3996718   .2725827    -1.47   0.143    -.9339241    .1345805
_Iavmax_TL8_4 |  -.8530448   .3399838    -2.51   0.012    -1.519401   -.1866888
    avP_TL0_7 |   .1312067   .0417925     3.14   0.002     .0492949    .2131185
        _cons |   1.300533   .3987819     3.26   0.001     .5189346    2.082131
--------------+----------------------------------------------------------------
     /lnalpha |   .6788157   .0974338                      .4878489    .8697825
--------------+----------------------------------------------------------------
        alpha |   1.971541   .1920948                      1.628809    2.386392
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 721.18             Prob >= chibar2 = 0.000

. ***Final negative binomial model – AGI female model***
. xi: nbreg agi cos* sin* i.avmean_TL0_7 i.avmean_TL15_21 i.avmean_TL22_28 i.avmax_TL0_7
i.avmax_TL8_14 if Sex_combined==1
i.avmean_TL0_7    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL1~21   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL2~28   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmax_TL0_7     _Iavmax_TL0_1-4     (naturally coded; _Iavmax_TL0_1 omitted)
i.avmax_TL8_14    _Iavmax_TL8_1-4     (naturally coded; _Iavmax_TL8_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -1527.6737
Iteration 1:   log likelihood = -1527.6242
Iteration 2:   log likelihood = -1527.6241

Fitting constant-only model:

Iteration 0:   log likelihood = -1519.0905
Iteration 1:   log likelihood = -1517.3775
Iteration 2:   log likelihood =  -1517.364
Iteration 3:   log likelihood =  -1517.364

Fitting full model:

Iteration 0:   log likelihood = -1447.4649
Iteration 1:   log likelihood = -1432.1902
Iteration 2:   log likelihood = -1431.3981
Iteration 3:   log likelihood =  -1431.397
Iteration 4:   log likelihood =  -1431.397

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(35)       =     171.93
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood =  -1431.397                       Pseudo R2         =     0.0567

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |  -.2300497   .0900333    -2.56   0.011    -.4065118   -.0535876
        cos_2 |  -.0506686   .0674948    -0.75   0.453     -.182956    .0816187
        cos_3 |  -.1974106   .0641938    -3.08   0.002    -.3232282    -.071593
        cos_4 |  -.0783308   .0616786    -1.27   0.204    -.1992186     .042557
        cos_5 |  -.0003037   .0609963    -0.00   0.996    -.1198542    .1192469
        cos_6 |  -.1025639   .0644119    -1.59   0.111     -.228809    .0236811
        cos_7 |  -.0750431   .0616653    -1.22   0.224    -.1959049    .0458187
        cos_8 |   .0492443   .0622906     0.79   0.429     -.072843    .1713316
        cos_9 |   .0210392    .061984     0.34   0.734    -.1004472    .1425255
       cos_10 |  -.0816284    .060366    -1.35   0.176    -.1999435    .0366867
        sin_1 |     .52848   .0753833     7.01   0.000     .3807314    .6762286
        sin_2 |   .3662465   .0688277     5.32   0.000     .2313467    .5011463
        sin_3 |   .0167099   .0644778     0.26   0.796    -.1096644    .1430841
        sin_4 |   .1140167   .0638892     1.78   0.074    -.0112038    .2392373
        sin_5 |   .0248717   .0606529     0.41   0.682    -.0940057    .1437492
        sin_6 |  -.0937838   .0614238    -1.53   0.127    -.2141722    .0266046
        sin_7 |   .0598472   .0641599     0.93   0.351    -.0659039    .1855982
        sin_8 |  -.0719856   .0624812    -1.15   0.249    -.1944465    .0504753
        sin_9 |   .1238371   .0627551     1.97   0.048     .0008393    .2468348
       sin_10 |   .0480201   .0606673     0.79   0.429    -.0708857    .1669258
```

```
_Iavmean_TL_2 |   .0453495   .1827499     0.25   0.804    -.3128338    .4035327
_Iavmean_TL_3 |   .1753451     .23459     0.75   0.455    -.2844428     .635133
_Iavmean_TL_4 |  -.5723092    .326918    -1.75   0.080    -1.213057    .0684383
_Iavmean_TLa2 |  -.1982233   .1347824    -1.47   0.141     -.462392    .0659453
_Iavmean_TLa3 |  -.2645152   .1492648    -1.77   0.076    -.5570689    .0280385
_Iavmean_TLa4 |  -.6370769   .2014373    -3.16   0.002    -1.031887   -.2422671
_Iavmean_TLb2 |  -.3386452    .132891    -2.55   0.011    -.5991067   -.0781837
_Iavmean_TLb3 |  -.4814748   .1496457    -3.22   0.001    -.7747749   -.1881747
_Iavmean_TLb4 |  -.9513171    .188847    -5.04   0.000     -1.32145   -.5811837
_Iavmax_TL0_2 |  -.5048127     .17548    -2.88   0.004    -.8487471   -.1608784
_Iavmax_TL0_3 |  -.7198524   .2332981    -3.09   0.002    -1.177108   -.2625964
_Iavmax_TL0_4 |  -.2581578   .3092053    -0.83   0.404    -.8641891    .3478734
_Iavmax_TL8_2 |  -.3694717    .128614    -2.87   0.004    -.6215504   -.1173929
_Iavmax_TL8_3 |  -.3276295   .1538899    -2.13   0.033    -.6292482   -.0260107
_Iavmax_TL8_4 |  -.5067228   .1984923    -2.55   0.011    -.8957606    -.117685
        _cons |   1.471857   .1944151     7.57   0.000     1.090811    1.852904
--------------+----------------------------------------------------------------
     /lnalpha |  -.2782154   .1194332                     -.5123001   -.0441306
--------------+----------------------------------------------------------------
        alpha |   .7571337   .0904269                       .599116     .956829
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 192.45             Prob >= chibar2 = 0.000

***Final negative binomial model - pneumonia female model***
. xi: nbreg pneum_any cos* sin* i.avmean_TL15_21 i.Tmax_C i.avmax_TL22_28 Prrfe if
Sex_combined==1
i.avmean_TL1~21   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.Tmax_C          _ITmax_C_1-4        (naturally coded; _ITmax_C_1 omitted)
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -803.22908
Iteration 1:   log likelihood = -803.21599
Iteration 2:   log likelihood = -803.21599

Fitting constant-only model:

Iteration 0:   log likelihood = -854.43182
Iteration 1:   log likelihood = -852.13003
Iteration 2:   log likelihood = -852.12955
Iteration 3:   log likelihood = -852.12955

Fitting full model:

Iteration 0:   log likelihood = -808.01056
Iteration 1:   log likelihood = -801.46295
Iteration 2:   log likelihood = -801.06886
Iteration 3:   log likelihood =  -801.0575
Iteration 4:   log likelihood =  -801.0575

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(34)       =     102.14
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood =  -801.0575                       Pseudo R2         =     0.0599

-------------------------------------------------------------------------------
    pneum_any |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |  -.4756673   .1033803    -4.60   0.000     -.678289   -.2730456
        cos_2 |  -.0992751   .0872678    -1.14   0.255    -.2703168    .0717667
        cos_3 |  -.2352587   .0795808    -2.96   0.003    -.3912342   -.0792832
        cos_4 |   .0138524   .0822052     0.17   0.866    -.1472669    .1749716
        cos_5 |   .0553657   .0774194     0.72   0.475    -.0963736    .2071049
        cos_6 |  -.0000293   .0819783    -0.00   1.000    -.1607039    .1606452
        cos_7 |   .0943018   .0795678     1.19   0.236    -.0616481    .2502518
        cos_8 |   -.060841   .0796044    -0.76   0.445    -.2168628    .0951808
        cos_9 |   .0335443   .0805318     0.42   0.677     -.124295    .1913836
       cos_10 |   .0442752   .0790383     0.56   0.575    -.1106371    .1991875
       cos_11 |    .205503     .07848     2.62   0.009     .0516851     .359321
       cos_12 |  -.0476766   .0769819    -0.62   0.536    -.1985584    .1032053
```

```
        sin_1 |   .4234045   .0884499     4.79   0.000      .250046     .596763
        sin_2 |   .0780726   .0846027     0.92   0.356    -.0877457    .2438908
        sin_3 |    .220822   .0839756     2.63   0.009     .0562329     .385411
        sin_4 |   .1178048   .0793928     1.48   0.138    -.0378022    .2734117
        sin_5 |   .2545928   .0822021     3.10   0.002     .0934796     .415706
        sin_6 |   .0881239   .0786035     1.12   0.262    -.0659361    .2421838
        sin_7 |   -.017256   .0807678    -0.21   0.831    -.1755579     .141046
        sin_8 |   .1498133   .0797426     1.88   0.060    -.0064793    .3061059
        sin_9 |   .0357162   .0791119     0.45   0.652    -.1193403    .1907726
       sin_10 |   .0151018   .0785645     0.19   0.848    -.1388818    .1690855
       sin_11 |  -.0859312   .0786751    -1.09   0.275    -.2401316    .0682692
       sin_12 |   .0621681   .0774718     0.80   0.422    -.0896738      .21401
_Iavmean_TL_2 |  -.6638243   .1682012    -3.95   0.000    -.9934925    -.334156
_Iavmean_TL_3 |   -.585272   .1800107    -3.25   0.001    -.9380866   -.2324574
_Iavmean_TL_4 |  -.6235464   .2167638    -2.88   0.004    -1.048396   -.1986973
   _ITmax_C_2 |  -.1766545   .1484132    -1.19   0.234    -.4675391    .1142301
   _ITmax_C_3 |  -.2739385    .155832    -1.76   0.079    -.5793636    .0314866
   _ITmax_C_4 |  -.6722132    .182096    -3.69   0.000    -1.029115   -.3153117
_Iavmax_TL2_2 |  -.3577183     .15921    -2.25   0.025    -.6697641   -.0456724
_Iavmax_TL2_3 |  -.2764869   .1805699    -1.53   0.126    -.6303975    .0774236
_Iavmax_TL2_4 |  -.6554928   .2314626    -2.83   0.005    -1.109151   -.2018344
        Prrfe |  -.0322536    .015091    -2.14   0.033    -.0618314   -.0026759
        _cons |   .1468423   .1922119     0.76   0.445     -.229886    .5235706
--------------+----------------------------------------------------------------
     /lnalpha |  -1.487798   .5481203                     -2.562094   -.4135014
--------------+----------------------------------------------------------------
        alpha |   .2258696   .1238037                      .0771431    .6613306
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 4.32                 Prob >= chibar2 = 0.019


. ***Final model - Negative Binomial - Cardiovascular disease female model***
. xi: nbreg cardiovas cos* sin* i.avmean_TL0_7 i.avmean_TL22_28 if Sex_combined==1
i.avmean_TL0_7    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL2~28   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -1099.4361
Iteration 1:   log likelihood = -1099.3624
Iteration 2:   log likelihood = -1099.3624

Fitting constant-only model:

Iteration 0:   log likelihood = -977.16341
Iteration 1:   log likelihood = -902.80564
Iteration 2:   log likelihood = -901.57555
Iteration 3:   log likelihood = -901.57543
Iteration 4:   log likelihood = -901.57543

Fitting full model:

Iteration 0:   log likelihood =  -866.5998
Iteration 1:   log likelihood = -859.56314
Iteration 2:   log likelihood = -851.06224
Iteration 3:   log likelihood = -851.02596
Iteration 4:   log likelihood = -851.02595

Negative binomial regression                      Number of obs     =        994
                                                  LR chi2(30)       =     101.10
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -851.02595                       Pseudo R2         =     0.0561

-------------------------------------------------------------------------------
    cardiovas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |  -.3381046   .1493192    -2.26   0.024    -.6307647   -.0454444
        cos_2 |   .0822765    .118081     0.70   0.486     -.149158    .3137109
        cos_3 |  -.2050585   .1147033    -1.79   0.074    -.4298728    .0197558
        cos_4 |  -.0635617   .1106224    -0.57   0.566    -.2803776    .1532541
        cos_5 |  -.0799936   .1098863    -0.73   0.467    -.2953669    .1353796
```

```
        cos_6 |  -.0782311   .1152569    -0.68   0.497    -.3041305    .1476683
        cos_7 |  -.0943673   .1106757    -0.85   0.394    -.3112877    .1225532
        cos_8 |  -.0031349   .1111564    -0.03   0.978    -.2209974    .2147276
        cos_9 |   .0221677   .1115988     0.20   0.843     -.196562    .2408973
       cos_10 |  -.0626818   .1086143    -0.58   0.564     -.275562    .1501983
       cos_11 |   .0612406   .1082284     0.57   0.571    -.1508831    .2733643
       cos_12 |  -.1730073   .1084957    -1.59   0.111    -.3856549    .0396403
        sin_1 |   .5497173   .1285516     4.28   0.000     .2977608    .8016737
        sin_2 |    .285502   .1192399     2.39   0.017     .0517961    .5192078
        sin_3 |   .1649703   .1121875     1.47   0.141    -.0549132    .3848538
        sin_4 |    .214599   .1124118     1.91   0.056     -.005724    .4349221
        sin_5 |   .1139182   .1089356     1.05   0.296    -.0995916     .327428
        sin_6 |  -.1534224   .1070638    -1.43   0.152    -.3632635    .0564188
        sin_7 |   .0228897   .1104632     0.21   0.836    -.1936142    .2393936
        sin_8 |  -.1224952   .1124844    -1.09   0.276    -.3429606    .0979702
        sin_9 |   .0127163   .1111965     0.11   0.909    -.2052249    .2306574
       sin_10 |   .0281626   .1089003     0.26   0.796    -.1852781    .2416033
       sin_11 |  -.0733347   .1091014    -0.67   0.501    -.2871695       .1405
       sin_12 |   .5639414   .1077403     5.23   0.000     .3527743    .7751086
_Iavmean_TL_2 |  -.6948781    .245207    -2.83   0.005    -1.175475   -.2142811
_Iavmean_TL_3 |  -1.179701    .280082    -4.21   0.000    -1.728652   -.6307504
_Iavmean_TL_4 |  -1.958894    .340291    -5.76   0.000    -2.625853   -1.291936
_Iavmean_TLa2 |    -.30963   .2476755    -1.25   0.211    -.7950652    .1758051
_Iavmean_TLa3 |   -.637552   .2762146    -2.31   0.021    -1.178923   -.0961814
_Iavmean_TLa4 |  -.9051251   .3234934    -2.80   0.005    -1.539161   -.2710897
        _cons |   .4115881   .2683472     1.53   0.125    -.1143626    .9375389
--------------+----------------------------------------------------------------
     /lnalpha |   1.038363   .1179224                      .8072398    1.269487
--------------+----------------------------------------------------------------
        alpha |    2.82459   .3330823                      2.241712    3.559026
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 496.67             Prob >= chibar2 = 0.000

. ***Negative binomial final model - AGI male model***
. xi: nbreg agi cos* sin* i.avmean_TL0_3 i.avmean_TL8_14 i.avmean_TL22_28 i.avmax_TL15_21
avP_TL8_14 if Sex_combined==0
i.avmean_TL0_3    _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL8_14   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)
i.avmean_TL2~28   _Iavmean_TLb1-4     (naturally coded; _Iavmean_TLb1 omitted)
i.avmax_TL15_21   _Iavmax_TL1_1-4     (naturally coded; _Iavmax_TL1_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood =  -1339.223
Iteration 1:   log likelihood = -1339.2092
Iteration 2:   log likelihood = -1339.2092

Fitting constant-only model:

Iteration 0:   log likelihood = -1355.5004
Iteration 1:   log likelihood = -1355.3676
Iteration 2:   log likelihood = -1355.3675

Fitting full model:

Iteration 0:   log likelihood = -1298.8257
Iteration 1:   log likelihood = -1289.6512
Iteration 2:   log likelihood = -1289.4542
Iteration 3:   log likelihood = -1289.4542

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(33)       =     131.83
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -1289.4542                       Pseudo R2         =     0.0486

-------------------------------------------------------------------------------
          agi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |  -.2362315   .0875593    -2.70   0.007    -.4078446   -.0646183
        cos_2 |   .0174528   .0739329     0.24   0.813     -.127453    .1623587
        cos_3 |  -.1951147   .0652164    -2.99   0.003    -.3229366   -.0672928
```

```
        cos_4 |   .0316222   .0629254     0.50   0.615    -.0917094    .1549537
        cos_5 |   .0757849   .0621347     1.22   0.223    -.0459968    .1975667
        cos_6 |  -.1121457   .0626607    -1.79   0.073    -.2349584     .010667
        cos_7 |   .0183436   .0619766     0.30   0.767    -.1031283    .1398155
        cos_8 |   .0096197   .0618499     0.16   0.876    -.1116039    .1308434
        cos_9 |   .0500145   .0622599     0.80   0.422    -.0720127    .1720417
       cos_10 |  -.0812323   .0609462    -1.33   0.183    -.2006848    .0382201
        sin_1 |   .4408481   .0740289     5.96   0.000     .2957543     .585942
        sin_2 |   .3541141   .0696836     5.08   0.000     .2175366    .4906915
        sin_3 |   .0932512   .0633698     1.47   0.141    -.0309514    .2174537
        sin_4 |   .0231677   .0625154     0.37   0.711    -.0993601    .1456956
        sin_5 |   .0411191   .0603563     0.68   0.496     -.077177    .1594152
        sin_6 |  -.0523045   .0626414    -0.83   0.404    -.1750795    .0704704
        sin_7 |   .0875072   .0633084     1.38   0.167    -.0365749    .2115894
        sin_8 |  -.0937243   .0631704    -1.48   0.138     -.217536    .0300875
        sin_9 |   .0310664   .0622395     0.50   0.618    -.0909209    .1530536
       sin_10 |   .0251856   .0610717     0.41   0.680    -.0945126    .1448839
_Iavmean_TL_2 |  -.3343297   .1264738    -2.64   0.008    -.5822137   -.0864457
_Iavmean_TL_3 |  -.4036346     .13841    -2.92   0.004    -.6749131   -.1323561
_Iavmean_TL_4 |  -.6525882   .1680143    -3.88   0.000    -.9818901   -.3232863
_Iavmean_TLa2 |  -.1739067    .131962    -1.32   0.188    -.4325474     .084734
_Iavmean_TLa3 |  -.4077542   .1545174    -2.64   0.008    -.7106028   -.1049056
_Iavmean_TLa4 |  -.4520223   .2010727    -2.25   0.025    -.8461176   -.0579269
_Iavmean_TLb2 |  -.0617523   .1330719    -0.46   0.643    -.3225683    .1990638
_Iavmean_TLb3 |  -.2153289   .1489844    -1.45   0.148     -.507333    .0766752
_Iavmean_TLb4 |  -.8396631   .1907095    -4.40   0.000    -1.213447   -.4658794
_Iavmax_TL1_2 |  -.3375065   .1251319    -2.70   0.007    -.5827606   -.0922523
_Iavmax_TL1_3 |  -.3535033   .1489415    -2.37   0.018    -.6454233   -.0615833
_Iavmax_TL1_4 |  -.4296049   .1941346    -2.21   0.027    -.8101018   -.0491081
   avP_TL8_14 |   .0386561   .0186463     2.07   0.038       .00211    .0752023
        _cons |   .8204095   .2025792     4.05   0.000     .4233615    1.217457
--------------+----------------------------------------------------------------
     /lnalpha |  -.4811161   .1478832                     -.7709618   -.1912705
--------------+----------------------------------------------------------------
        alpha |   .6180931   .0914056                       .462568    .8259092
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 99.51                Prob >= chibar2 = 0.000

***Negative binomial final model - Pneumonia male model***
. xi: nbreg pneum_any cos* sin* i.avmean_TL8_14 i.avmean_TL22_28 if Sex_combined==0
i.avmean_TL8_14   _Iavmean_TL_1-4     (naturally coded; _Iavmean_TL_1 omitted)
i.avmean_TL2~28   _Iavmean_TLa1-4     (naturally coded; _Iavmean_TLa1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -824.34068
Iteration 1:   log likelihood =  -824.3243
Iteration 2:   log likelihood =  -824.3243

Fitting constant-only model:

Iteration 0:   log likelihood =   -860.526
Iteration 1:   log likelihood = -857.84688
Iteration 2:   log likelihood = -857.84454
Iteration 3:   log likelihood = -857.84454

Fitting full model:

Iteration 0:   log likelihood =  -824.3154
Iteration 1:   log likelihood = -820.91846
Iteration 2:   log likelihood = -820.76061
Iteration 3:   log likelihood =  -820.7589
Iteration 4:   log likelihood = -820.75889

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(30)       =      74.17
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -820.75889                       Pseudo R2         =     0.0432

-------------------------------------------------------------------------------
    pneum_any |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

```
--------------+----------------------------------------------------------------
        cos_1 |  -.2193569   .1018016    -2.15   0.031    -.4188844   -.0198294
        cos_2 |  -.0833712   .0838997    -0.99   0.320    -.2478116    .0810693
        cos_3 |   -.166142   .0842501    -1.97   0.049    -.3312691    -.001015
        cos_4 |   .0227099   .0789028     0.29   0.773    -.1319368    .1773566
        cos_5 |   .0957763   .0781154     1.23   0.220    -.0573271    .2488798
        cos_6 |   -.158893   .0816197    -1.95   0.052    -.3188647    .0010787
        cos_7 |   -.013836   .0789947    -0.18   0.861    -.1686628    .1409907
        cos_8 |   .0121637   .0775625     0.16   0.875     -.139856    .1641834
        cos_9 |  -.0208029   .0799357    -0.26   0.795     -.177474    .1358683
       cos_10 |   .0025572   .0779797     0.03   0.974    -.1502802    .1553945
       cos_11 |   .1769375   .0783597     2.26   0.024     .0233554    .3305197
       cos_12 |   -.076936   .0771128    -1.00   0.318    -.2280743    .0742024
        sin_1 |   .4365477   .0859673     5.08   0.000     .2680549    .6050405
        sin_2 |   .2247939    .082772     2.72   0.007     .0625638    .3870239
        sin_3 |   .0846403   .0776426     1.09   0.276    -.0675364     .236817
        sin_4 |   .0325843   .0803502     0.41   0.685    -.1248991    .1900677
        sin_5 |   .0907807   .0789154     1.15   0.250    -.0638907     .245452
        sin_6 |  -.0883706   .0769137    -1.15   0.251    -.2391187    .0623776
        sin_7 |   .0751242   .0792129     0.95   0.343    -.0801303    .2303787
        sin_8 |   .1079741   .0801001     1.35   0.178    -.0490192    .2649674
        sin_9 |   .0449539    .077873     0.58   0.564    -.1076744    .1975822
       sin_10 |  -.0371423   .0783498    -0.47   0.635    -.1907051    .1164205
       sin_11 |  -.0009422   .0785621    -0.01   0.990    -.1549211    .1530368
       sin_12 |   .0837463   .0760361     1.10   0.271    -.0652818    .2327743
_Iavmean_TL_2 |   .0021088   .1637781     0.01   0.990    -.3188903    .3231079
_Iavmean_TL_3 |  -.3957484   .1863505    -2.12   0.034    -.7609886   -.0305083
_Iavmean_TL_4 |  -.4465465   .2160756    -2.07   0.039    -.8700468   -.0230461
_Iavmean_TLa2 |  -.3584705   .1621013    -2.21   0.027    -.6761832   -.0407577
_Iavmean_TLa3 |  -.6265834   .1797469    -3.49   0.000    -.9788808    -.274286
_Iavmean_TLa4 |  -.7659694   .2096399    -3.65   0.000    -1.176856   -.3550828
        _cons |  -.3447276   .1735802    -1.99   0.047    -.6849387   -.0045166
--------------+----------------------------------------------------------------
     /lnalpha |    -1.2202   .4397657                     -2.082125   -.3582755
--------------+----------------------------------------------------------------
        alpha |    .295171   .1298061                       .124665    .6988805
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 7.13                Prob >= chibar2 = 0.004

***Negative binomial final model – Cardiovascular disease male model***
. *Final model
. xi: nbreg cardiovas cos* sin* i.avmax_TL22_28 avP_TL8_14 if Sex_combined==0
i.avmax_TL22_28   _Iavmax_TL2_1-4     (naturally coded; _Iavmax_TL2_1 omitted)

Fitting Poisson model:

Iteration 0:   log likelihood = -747.46033
Iteration 1:   log likelihood = -747.43208
Iteration 2:   log likelihood = -747.43207

Fitting constant-only model:

Iteration 0:   log likelihood = -746.49326
Iteration 1:   log likelihood = -730.51472
Iteration 2:   log likelihood = -728.99812
Iteration 3:   log likelihood =  -728.9944
Iteration 4:   log likelihood =  -728.9944

Fitting full model:

Iteration 0:   log likelihood = -696.23954
Iteration 1:   log likelihood = -688.23223
Iteration 2:   log likelihood = -687.67529
Iteration 3:   log likelihood = -687.67456
Iteration 4:   log likelihood = -687.67456

Negative binomial regression                      Number of obs     =        995
                                                  LR chi2(28)       =      82.64
Dispersion     = mean                             Prob > chi2       =     0.0000
Log likelihood = -687.67456                       Pseudo R2         =     0.0567
```

```
-------------------------------------------------------------------------------
    cardiovas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        cos_1 |   .0341988   .1243096     0.28   0.783    -.2094436    .2778411
        cos_2 |   .2151239   .1303731     1.65   0.099    -.0404027    .4706505
        cos_3 |   -.167612   .1176728    -1.42   0.154    -.3982465    .0630225
        cos_4 |  -.0317903   .1099062    -0.29   0.772    -.2472026     .183622
        cos_5 |  -.0258995   .1097188    -0.24   0.813    -.2409443    .1891453
        cos_6 |  -.1622908   .1134825    -1.43   0.153    -.3847124    .0601308
        cos_7 |   .1313376    .109652     1.20   0.231    -.0835763    .3462515
        cos_8 |   .0192842   .1085475     0.18   0.859     -.193465    .2320333
        cos_9 |  -.0683213    .110827    -0.62   0.538    -.2855382    .1488957
       cos_10 |  -.0760506   .1090582    -0.70   0.486    -.2898008    .1376997
       cos_11 |  -.0322112   .1092731    -0.29   0.768    -.2463825    .1819601
       cos_12 |  -.2398743   .1077182    -2.23   0.026    -.4509981   -.0287505
        sin_1 |   .1942107   .1185117     1.64   0.101    -.0380679    .4264894
        sin_2 |   .1583268   .1169747     1.35   0.176    -.0709394    .3875929
        sin_3 |   .0874619    .108749     0.80   0.421    -.1256823    .3006061
        sin_4 |   .0710143   .1120038     0.63   0.526    -.1485091    .2905377
        sin_5 |  -.1044106   .1108402    -0.94   0.346    -.3216534    .1128322
        sin_6 |  -.2899703   .1065476    -2.72   0.006    -.4987999   -.0811408
        sin_7 |   .1328727   .1108722     1.20   0.231    -.0844329    .3501783
        sin_8 |  -.1349737    .111816    -1.21   0.227     -.354129    .0841816
        sin_9 |   .2261679   .1095748     2.06   0.039     .0114053    .4409305
       sin_10 |  -.1230285   .1102483    -1.12   0.264    -.3391111    .0930541
       sin_11 |    .188733   .1089697     1.73   0.083    -.0248437    .4023098
       sin_12 |   .4634114   .1081722     4.28   0.000     .2513977     .675425
_Iavmax_TL2_2 |  -.0633711   .2234977    -0.28   0.777    -.5014184    .3746763
_Iavmax_TL2_3 |  -.4302637   .2600399    -1.65   0.098    -.9399326    .0794053
_Iavmax_TL2_4 |  -1.302861   .3248605    -4.01   0.000    -1.939576   -.6661463
   avP_TL8_14 |   .0847089   .0300244     2.82   0.005      .025862    .1435557
        _cons |  -1.257652   .2141835    -5.87   0.000    -1.677444   -.8378604
--------------+----------------------------------------------------------------
     /lnalpha |   .5971865   .1710502                      .2619342    .9324388
--------------+----------------------------------------------------------------
        alpha |      1.817   .3107982                      1.299441    2.540698
-------------------------------------------------------------------------------
LR test of alpha=0: chibar2(01) = 119.52               Prob >= chibar2 = 0.000
```

[Note: model building process was removed for brevity. Please contact the authors for the full Stata output]