Barriers to malaria prevention and chemoprophylaxis use among travelers who visit friends and relatives in Sub-Saharan Africa: A cross-sectional, multi-setting survey addressing behaviors, systems, and comparator populations

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Abstract

Despite achievements in the reduction of malaria morbidity and mortality globally, imported malaria cases to the US by travelers continue to grow. Imported malaria occurs disproportionately among individuals who travel to visit friends and relatives (VFRs) in malarious countries. This dissertation examines behavioral and structural barriers to chemoprophylaxis use and malaria prevention among VFR travelers to the African continent.

This survey-based study is one component of a broader, multi-methodologic project aimed to reduce malaria in VFR travelers. Barriers are identified through a cross-sectional, three-setting survey of knowledge, attitudes and practices of diagnosed malaria cases, community VFRs, and patients at a specialty travel clinic. Subgroup analyses are performed comparing VFRs traveling to different regions and across survey settings, as well as to non-VFR travelers to generate a deeper understanding of the heterogeneity and breadth of barriers.

In all, 489 surveys were completed, 351 among VFRs. VFRs face significant barriers between intending and actualizing malaria prevention; while 95.2% of VFRs planned to take an antimalarial, just 59.4% reported using chemoprophylaxis. Having a primary care provider is strongly positively associated with seeking pre-travel care and improved perceptions of the health care system among VFRs. Compared to VFRs, non-VFR travelers are more successful at preventive approaches including antimalarial use, wearing long clothing, and bed net use. Yet travel clinic VFRs more commonly report certain prevention approaches than VFRs in the community; heterogeneity exists both among VFRs and across traveler populations.

A novel conceptual framework is proposed to explain correlations between predictors of malaria illness, integrating concern for malaria, malaria prevention, and travel frequency. Engaging policy leaders in travel medicine is necessary for a deeper understanding of structural barriers to malaria prevention. These findings and call for future partnerships will be central to the development of targeted, evidence-based barrier reduction interventions and policies which may reduce imported malaria over time. A reduction in malaria among VFRs would not only lessen morbidity among the nearly 1,500 travelers with malaria in the US each year, but also decrease health care costs to payers, and reduce risk of local malaria transmission and the subsequent intensive public health response.

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List of abbreviations and symbols

α= – alpha, significance level for type I error, set at 0.05

'*A.*' prefix – *Anopheles* genus

ANOVA – analysis of variance

aOR – adjusted odds ratio

CA – California

CAB – community advisory board

CBO – community-based organization

CBPR – community-based participatory research

CDC – Centers for Disease Control and Prevention

CI – confidence interval

Δ – delta, difference between two values

DALY – disability-adjusted life year

Dx – malaria diagnosis

ED – emergency department

e.g. – for example

et al. – and others

GA – Georgia

GBD – Global Burden of Disease study

gen – generation

GIS – geographic information system

GSN – GeoSentinel Surveillance Network

HCMC – Hennepin County Medical Center

HIPAA – Health Insurance Portability and Accountability Act

i.e. – in other words

IRB – institutional review board

KAP – knowledge attitudes and practices

log – decadic logarithm (log base 10) unless otherwise specified

MD – Maryland

MDH – Minnesota Department of Health

MeSH – medical subject heading

MN – Minnesota

MOU – memorandum of understanding

MPP – Malaria Prevention Project

MSP – Minneapolis-St. Paul international airport

NC – North Carolina

n/a – not applicable

NY – New York

OR – odds ratio

p= – p value

'*P.*' prefix – *Plasmodium* genus

PCP – primary care provider

PHI – protected health information

QT – quantitative data

QL – qualitative data

REDCap – Research Electronic Data Capture, web-based software for developing HIPAA-compliant databases and collecting data

RDT – rapid diagnostic test

Rx – malaria chemoprophylaxis prescription

SES – socio-economic status

SSA – Sub-Saharan Africa

VFR, VFRs, VFR traveler – An individual who travels for the purpose of visiting friends and relatives. See Chapter 1 for formal definition.

UK – United Kingdom

UN – United Nations

US – United States

WA – Washington (state)

WHO – World Health Organization

$\overline{x}$ – mean

$\tilde{x}$ – median

χ^2 – chi square value (most commonly Wald's statistic)

ZCTA – ZIP code tabulation area

Chapter 1: Introduction

This chapter explores imported malaria, its impact on VFR travelers, and public health impacts of malaria in returned travelers. Preliminary research and activities performed by the Malaria Prevention Project (MPP) are summarized in the context of their impact on survey development. Lastly, research questions developed to examine barriers to malaria prevention in VFR travelers through multi-setting multi-population surveys are presented. An examination of the current state of the literature and an exploration of key findings on VFR knowledge, attitudes, and practices around malaria prevention is presented separately in Chapter 2.

Malaria illness

Malaria illness is caused by the infection of a single-celled protozoan parasite of multiple species within the *Plasmodium* genus.[1] Malaria is transmitted to humans through the bite of a female mosquito of the *Anopheles* genus infected with the parasite, or rarely though blood transfusion, organ transplantation, laboratory exposure, or congenitally from mother to child.[1,2] Malaria is not directly transmissible from person to person.

After infection, clinical symptoms of malaria take as little as one week, but normally between two weeks to several months to develop.[1] This delay in clinical illness is particularly relevant to travelers, who may return to a nonendemic country prior to the development of malaria symptoms where health care providers may be less familiar with the clinical manifestations of malaria. Common clinical symptoms of malaria include fever, influenza-like symptoms, body aches, headaches, and chills.[1] Uncomplicated malaria is a virulent illness that often requires hospital treatment. Severe malaria can cause seizures, kidney failure, or death,[1] especially among those exposed to malaria for the first time.

Curative chemotherapeutic and preventive chemoprophylactic medicines exist to kill the parasite or prevent its maturation respectively.[1] However, infection with *P. ovale* and *P. vivax* species of malaria can cause relapsing illness event after a malaria chemotherapy treatment regimen.[1] Despite the existence of both curative and preventive medicines, the malaria parasite has evolved broad resistance to many antimalarial drugs; the malaria parasite differs by region in its susceptibility and resistance to malaria medicines.[1] Health care providers prescribing of preventive chemoprophylaxis for a patient before travel must take into account region of travel when choosing an effective regimen.[1] Rapid diagnostic tests (RDTs) exist to diagnose malaria in

lower resource or unspecialized settings, but smear microscopy is the laboratory gold standard for malaria diagnosis as it can identify the parasite species, its life cycle stage, and can quantify the number of parasites circulating in the blood stream.[1]

Global malaria morbidity and mortality

According to the 2016 World Malaria Report published by the World Health Organization (WHO), in the past decade, global malaria incidence has decreased by 20% from 266 million cases in 2005 to 212 million in 2015.[3] This decrease can be attributed to investments in malaria prevention efforts on local, national and international scales. Over the same time period, global malaria mortality has decreased from 741,000 to 429,000 deaths per year, a decrease of 41% due to rising economic development and improved access to antimalarials and health care in endemic areas.[3]

In areas of Sub-Saharan Africa (SSA) with active malaria transmission in 2015, 114 million people, or 13% of the population, were estimated to be infected with the malaria parasite at any given time, down from 131 million people, or 17% of the population in 2010.[3] Ninety percent of the world's malaria cases in 2015 occurred in the African continent.[3] The WHO target for malaria reduction between 2010 and 2015 was 40% fewer incident cases; fewer than 44% of countries with endemic malaria achieved this goal.[3] Despite significant achievements in malaria reduction and improvements in malaria mortality in recent years, malaria remains a highly endemic and severe illness affecting many parts of Sub-Saharan Africa.

Malaria epidemiology and incidence in the US

Malaria morbidity and mortality among US resident travelers is likely highly underreported. The passive reporting surveillance system, self-treatment without seeing a health care provider among less acute cases, misdiagnosis of a disease rarely seen by US providers, and the opportunity for malaria illnesses and deaths to occur while still traveling abroad each contribute to an underestimate of the malaria burden in US travelers. Hospital discharge records from the Nationwide Inpatient Sample found that estimated 22,029 cases of malaria and 182 fatalities occurred from 2000-2014 in the US and occurred disproportionately in males and individuals reporting their race as black.[4] On average, malaria patients were hospitalized for more than four days and incurred $25,789 in health care charges.[4]

The Centers for Disease Control and Prevention (CDC) produces a yearly report summarizing US malaria surveillance;[2] key findings from the 2015 report are summarized here. Throughout the same decade as the observed reductions in global malaria incidence and death – 2005 to 2015 – cases of malaria imported to the US by civilian travelers have increased to 1,494 cases in 2015 at a rate of 27.8 additional cases per year.[2] This follows a forty-year trend of increasing imported malaria cases and aligns closely with the increasing trend of civilian travel to the African continent.[2,5] Alarmingly, eleven fatalities due to malaria were reported in the US in 2015, up from a 2010-2014 average of 6.1 deaths per year.[2] There is a strong seasonality of imported malaria in the US, aligning with increased travel in summer months, and a smaller spike over the winter holidays.[2]

Among cases of imported malaria, 26.5% of cases reported taking an antimalarial chemoprophylactic medicine, but most who took chemoprophylaxis poorly adhered to their regimens.[2] States with the greatest numbers of cases of imported malaria in 2015 were New York (276), Maryland (127), California (106), Texas (100) and New Jersey (86).[2] Minnesota reported 43 cases in 2015.[2,6]

Eighty five percent of imported malaria cases resulted from travel to the African continent in 2015;[2] consistently more than 80% of imported malaria cases are acquired in Africa.[7–10] More than half of all imported malaria cases (55%) originated from travel to the West African region in 2015, despite a decrease in cases and travel to the region due to the Ebola epidemic ongoing at the time.[2] Among reported cases with a known reason for travel, travelers who visit friends and relatives (VFRs) comprised 70% of cases among US civilians.[2] This group is consistently observed to experience a disproportionate burden of imported malaria. In the 2015 Malaria Surveillance Report, the CDC concludes, "evidence-based prevention strategies that effectively target travelers who are visiting friends and relatives need to be developed and implemented to reduce the numbers of imported malaria cases in the United States."[2]

VFR travelers and malaria

Travelers who visit friends and relatives (VFRs) are a commonly studied population in travel medicine due to their unique travel experiences, behaviors, and barriers to healthy travel.[11,12] Some disagreement exists in the travel medicine field around who should be considered a VFR traveler.[13,14] This study uses the more classical CDC definition of a VFR published in the 2018 Yellow Book:

> A traveler categorized as a VFR is an immigrant, ethnically and racially distinct from the majority population of the country of residence (a higher-income country), who returns to his or her home country (lower-income country) to visit friends or relatives. Included in the VFR category are family members, such as the spouse or children, who were born in the country of residence. Some experts have recommended that the term VFR refer to all those visiting friends and relatives regardless of the traveler's country of origin; however, this proposed definition may be too broad and not take into consideration cultural, economic, and attitudinal issues.[12]

VFR travel

Over the past fifteen years, international VFR travel has growing globally, both in number of trips taken, and in proportion of all travel.[15,16] A UN World Tourism Organization report estimated 27% of international travel in 2015 was attributable to a broad category encompassing visiting friends and relatives, health and religion,[15] an increase from 20% in the year 2000.[16] VFR travel is expected to continue to grow. Socio-economically disadvantaged migrants do participate in VFR travel, but as immigrant groups become more established in their new place of residence, they build wealth and can better afford to travel back to their place of origin to visit family and friends.[17] In the United States in 2015, visiting friends and relatives was cited as one of the reasons for travel in 38% of international outbound trips and was cited as the primary reason in 27% of trips abroad.[18] The discrepancy between the proportion of US imported malaria cases in US residents occurring in VFRs, 70%,[2] and the proportion of US outbound travel for VFR purposes, 38%,[18] shows a greatly increased risk for imported malaria among VFRs when compared to other traveler types.

VFRs tend to travel to more remote locations than other travelers,[19] for longer duration, and to areas of greater malaria risk than other travelers.[20] VFRs also may overestimate the partial protection to malaria acquired from repeated exposures to malaria prior to immigration and do not recognize malaria immunity disappears over time.[20] Characteristics of the trips taken by VFR travelers contribute to increased risk of malaria infection as exposures in high-risk areas are prolonged.

The GeoSentinel Surveillance Network findings on malaria and VFRs

The GeoSentinel Surveillance Network (GSN) is a global collaboration of travel and tropical medicine specialty clinics that collectively report data on pre-travel care, post-travel illnesses, and tropical diseases.[21] A broad body of epidemiologic research employing robust sample sizes has been published on VFRs and malaria through this international collaboration. Among a GSN study of ill returned travelers, 16% of immigrant VFRs and 58% of second generation VFRs had sought pre-travel care, compared to 71% of tourists.[22] A GSN study comparing adults and children found no difference in the proportionate morbidity of malaria and other febrile illnesses among sick travelers.[23] Among a large group of ill returned US-resident travelers studied within GSN, 16% of travelers across all illnesses were VFRs.[24] VFRs were less likely to have sought pre-travel care and were more likely to be admitted for their travel illnesses.[24] The relative morbidity due to malaria was greater among VFRs than other traveler types; VFRs comprised 63% of all malaria diagnoses.[24] Malaria was the most common diagnosis among febrile returned travelers.[25] In a GSN study of all post-travel malaria diagnoses in the network from 2003-2016, 53% of travelers with malaria were VFRs and 83% of all travelers acquired malaria in Sub-Saharan Africa.[26] Twenty seven percent of malaria cases in GSN from 2007 to 2011 had received pre-travel care; 62% of malaria cases in this shorter timeframe occurred in VFRs.[27] The GSN collaboration has provided a remarkable quantitative perspective on malaria illness in travelers broadly and VFRs specifically. It provides a continued opportunity to measure the impact of future interventions designed to reduce imported malaria in VFR travelers.

VFRs and primary care

VFRs commonly visit or prefer to visit primary care providers (PCPs) when seeking pre-travel care. The attitudes and practices around this topic are discussed in more detail in Chapter 2. In a study of VFRs to India, PCPs were more likely to prescribe an inadequate chemoprophylaxis regimen than providers from travel specialty clinics.[28] Inappropriate prescribing among PCPs has been observed in other studies as well.[29] A separate study of PCPs found a higher perceived overall health risk for VFR travelers compared to vacation travelers.[30] Structural and systems-level barriers to pre-travel specialty care exist for VFRs and include poor insurance coverage for travel medicine, seeking care at a separate specialty clinic may not align with VFR understanding of health systems, and the continuity of medical records across clinic settings.[29] Together, the preference to seek care with primary providers among VFRs and the recognition by PCPs that

VFRs face distinct challenges to healthy travel suggests work to provide PCPs with traveler health resources may be impactful.

Pediatric VFRs

Children are a population of concern for malaria within the VFR subgroup but their specific risk has been studied in less detail.[31] VFRs are more likely than other travelers to travel with children or send children to stay with relatives during school breaks.[20] Pediatric malaria accounts for an estimated 15 to 20% of all imported malaria cases to nonendemic countries around the globe.[32] In a study of immigrant parents traveling with children, 83% of parents recognized malaria as a risk during travel, but only 20% of children received chemoprophylaxis when traveling.[33] A Greek survey found VFR adolescents were more likely than other adolescents to stay in local residences and to stay for longer duration.[34] No differences were observed between VFRs and non-VFR adolescents in chemoprophylaxis prescription.[35] A US mapping study found pediatric malaria cases in the are strongly clustered in areas with larger Sub-Saharan Africa immigrant populations.[36] A survey of immigrant parents from endemic countries at a pediatric clinic with their children found that 36% planned to travel to VFR with their children in the next one year, suggesting family care clinicians could be proactive in discussing malaria and travel care with immigrant parents who may travel with their children.[37] Examining clinical characteristics of pediatric malaria, one study of patients diagnosed with malaria in a large hospital, 23% received a misdiagnosis for their illness; among children misdiagnosis was 43%.[38] When compared to recently resettled immigrant children, VFR children had higher parasitemia and more severe clinical manifestations.[39] As a result of this recognition of VFR children as a group of concern for malaria, MPP included questions in the surveys around travel with children and their preventive behaviors.

VFR travelers are disparately affected by malaria when compared to other travelers. Certain VFR subgroups, such as children and those traveling at short notice face distinct challenges and risks. Due to the large proportion of imported malaria cases occurring among VFRs and specifically those traveling to Sub-Saharan Africa,[2] effective interventions targeted to improve malaria prevention in this group will subsequently lead to substantial reductions in imported malaria, reducing subsequent costs to the health care and public health systems. The body of literature on VFR knowledge, attitudes and practices around malaria prevention are explored in more detail in

Chapter 2; Chapters 4, 5 and 6 seek to quantify VFR barriers to malaria prevention in greater detail.

Relevance beyond burden of disease

Although the burden of malaria morbidity, mortality, and disability adjusted life years (DALY) lost are negligible relative to other diseases in the United States,[40] imported malaria and its downstream health care costs are nearly completely preventable. For example, pre-departure presumptive treatment was implemented in 1999 for refugees arriving to the US from Sub-Saharan Africa. Prior to the policy change, one in twelve African refugees had symptomatic malaria upon arrival.[41] By 2005, the intervention was shown to be cost-effective in any departure country where malaria prevalence is greater than one percent.[41] Predeparture presumptive treatment during resettlement has virtually eliminated imported malaria in this group.[41] However, similar systems for presumptive treatment do not exist for foreign visitors traveling to the US or non-refugee migrant populations who comprised 28% of the total imported malaria cases in 2015.[2] Predeparture presumptive treatment in resettling refugees provides some evidence that interventions developed around increasing the accessibility and use of chemoprophylaxis among US-resident travelers and VFRs may be quite impactful on imported malaria illnesses. However, refugee resettlement is a highly structured process in which nearly every arrival is seen by a health care provider prior to travel and upon resettlement. This level of systematic health care provision for an at-risk group is not replicable in the US-resident traveler population short of the creation of a universal health care system closely integrated with international travel systems.

In 2015, 72% of civilian malaria cases in the US occurred in US residents; 28% of civilian malaria occurred in foreign residents.[2] The high proportion of imported malaria by US residents suggests it is possible to prevent most current imported malaria cases through interventions targeted at US residents around improved use of chemoprophylaxis and preventive behaviors while traveling.

<u>The cost of malaria illness and prevention</u>

Malaria has been shown to be the most likely cause for post-travel hospitalization among ill travelers.[42] It is estimated that a single case of malaria hospitalization costs payers on average $25,789 (2017 dollars).[4] Chemoprophylaxis use is highly effective in preventing malaria and has been shown to be cost-effective for payers at any duration of client travel to malaria endemic areas.[43] Malaria prevention is greatly cost-effective to the health care system, yet VFRs

consistently cite the cost of chemoprophylaxis and pre-travel care as key reasons they travel unprotected.[11,44,45] Interventions that subsidize the cost of malaria chemoprophylaxis have been shown to marginally reduce the number of imported malaria cases.[46] Further research is necessary to explore ways in which malaria prevention cost reduction strategies can be applied in resonant populations to encourage use of chemoprophylaxis and pre-travel care and subsequently reduce imported malaria.

Reintroduced malaria: increasing risk of local outbreaks

Autochthonous transmission of malaria in the United States has occurred as recently as 2003, causing eight locally acquired cases of vivax malaria and a massive public health response to stop the outbreak.[47–49] *Anopheles freeborni* and *A. quadrimaculatus* are competent mosquito vectors for malaria transmission and are present over much of the United States, including *A. quadrimaculatus* throughout the southern two thirds of Minnesota.[50]

Climate change is expected to lengthen the season of ideal temperature conditions for mosquito activity in much of the United States and may expand vector range,[50] increasing the risk for future autochthonous outbreaks when travelers import malaria into the United States. Furthermore, the consistently observed summer seasonality of imported malaria cases in the US[2] aligns with the seasonal activity of local competent vectors, further increasing the risk for local transmission.[50] Although local outbreaks of malaria are not expected to reintroduce malaria as an endemic disease in the US, the public health response to such outbreaks is expensive, time-intensive, and requires strategic community engagement to reduce the risk of public concern and unintended negative impacts on affected communities.[47]

Other public health impacts of reducing malaria in VFRs

Reducing imported malaria has broad impacts for public health. Unnecessary, preventable morbidity and mortality from malaria in travelers would be reduced.[2,7] Fewer imported malaria cases would directly reduce the growing risk[50] of autochthonous outbreaks in the US, which has historically led to massive emergency response to stop.[47–49] A downstream effect of successfully increasing pre-travel care among VFRs for malaria reduction could be the reduction of other imported, travel-associated, tropical, and vaccine-preventable illnesses important to public health.[24,27]

Recent outbreaks of vaccine-preventable diseases in Minnesota have been traced to international travel.[51] Some immigrant VFRs may be under-immunized due to incomplete childhood vaccine administration and the loss of immunization records.[29] In a large GSN study of febrile illness in returned travelers, VFRs had greater odds of being diagnosed with a vaccine-preventable illness.[25] Travel medicine providers are cognizant of under-immunization in the VFR population. Successful barrier reduction interventions that effectively allow a greater proportion of VFR travelers to receive specialized pre-travel care for malaria could also lead to increased immunization in this population. This would lead to reduced risk of imported vaccine preventable infectious diseases,[29] subsequently reducing the need for broad, expensive public health emergency action.[51] Health care costs associated with the treatment of individuals ill with malaria would be reduced for payers and health systems.[4,43] Finally, sustained intervention and partnership with communities at risk for malaria could build stronger public health-community relationships. These relationships could establish better pathways for communication through which other public health interventions could be initiated in the future.

The Malaria Prevention Project

The surveys used in this dissertation to examine Sub-Saharan African VFR knowledge, attitudes and practices (KAP) around malaria prevention and chemoprophylaxis use are one component of a broader study, The Malaria Prevention Project (MPP). MPP is a multi-site cooperative agreement funded by the Centers for Disease Control and Prevention. Led by co-primary investigators at the University of Minnesota (Minneapolis, MN) and Hennepin Healthcare System (Minneapolis, MN), the MPP study team also includes researchers and clinicians from the Minnesota Department of Health (St. Paul, MN), HealthPartners Institute (Bloomington, MN), Uniformed Services University of the Health Sciences (Bethesda, MD), and Albert Einstein College of Medicine (New York City, NY), with technical support from the Division of Global Migration and Quarantine at the Centers for Disease Control and Prevention (Atlanta, GA). Each site serves unique patient populations or contributes malaria expertise spanning clinical disease management, epidemiology and surveillance, geospatial analytics, pharmacology, and community-based participatory research.

The surveys designed to quantify and identify barriers to malaria prevention in Sub-Saharan African VFRs and other travelers are one specific arm within this broader MPP study (Figure 1). The surveys were designed as standardized, community vetted questionnaires which were applied

through a multi-site, multi-population approach. Preliminary research, community engagement, and epidemiologic analysis informed the development of the survey content and sampling methodologies described in Chapter 3. As depicted in Figure 1, the preliminary activities in the MPP study revealed data and perspectives that informed hypothesis development and questionnaire content to address key barriers to malaria prevention, including some that were previously undiscussed or dismissed in the literature.

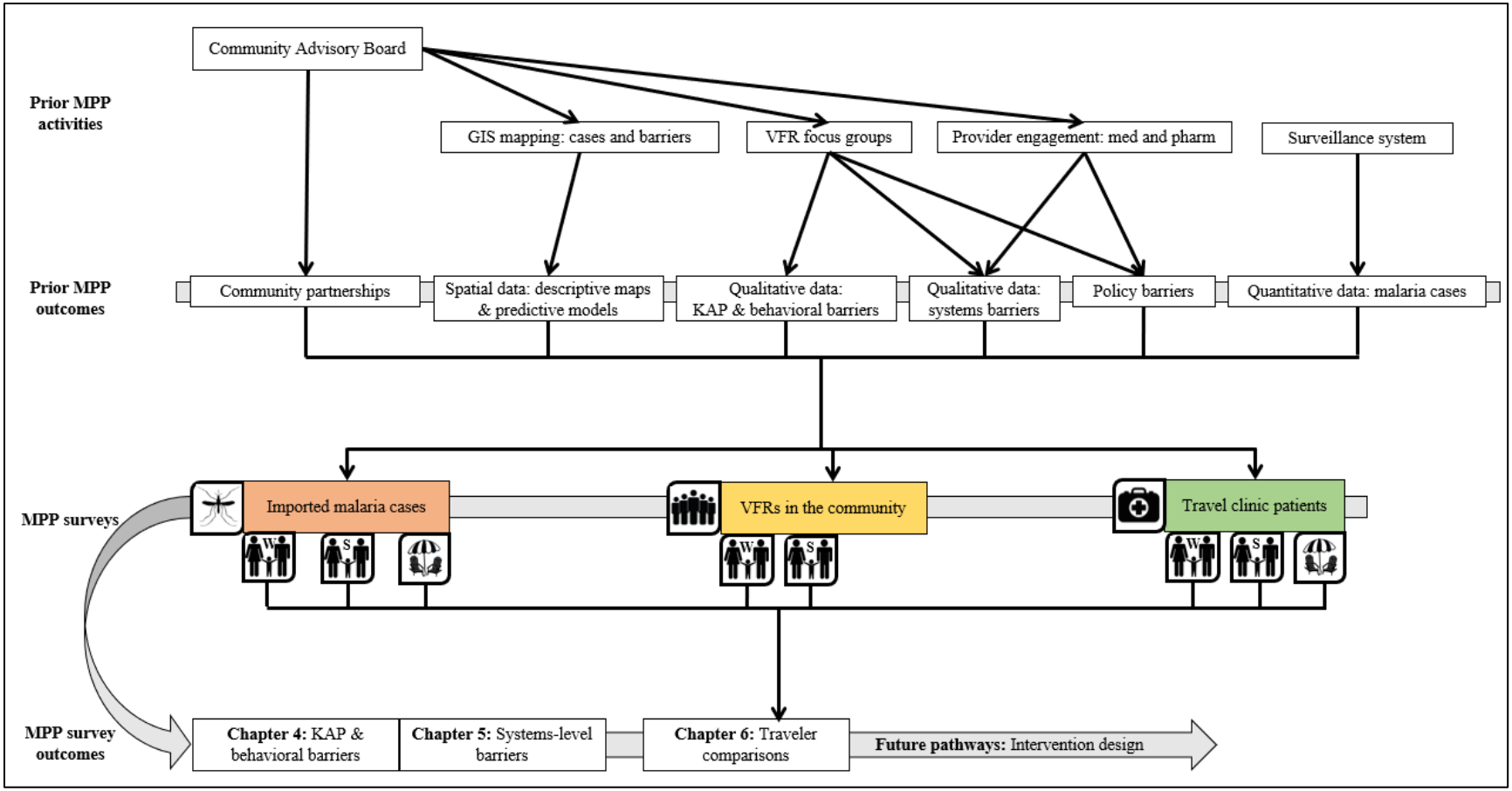


Figure 1: MPP activities informed the development of surveys intended to understand barriers to malaria prevention from multiple perspectives

Preliminary findings from the MPP

The MPP study preliminary activities and outcomes depicted in Figure 1 are summarized below as they relate to hypothesis development and survey construction to understand barriers to malaria prevention. Publications resulting from these preliminary activities may be referenced for a deeper understanding and discussion of key outcomes.

Community Advisory Board Development and CBPR in travel medicine

Community-based participatory research (CBPR) is designed to engage target communities directly in the development and dissemination of research, as well as to collaborate in subsequent intervention development. Although increasingly common in public health, CBPR is rarely used in travel medicine[52] despite the frequent discordance between study team and study population backgrounds.

Community Advisory Boards (CAB) are an important component of CBPR whenever the study research team and community differ in culture, lived experience, or understanding of health and health care. CAB members can speak to whether and to what degree a health issue identified by researchers is relevant or resonates with a community of focus, as well as whether it is a stigmatizing subject that must be navigated delicately.[53] From study design to completion, CABs provide a structured, lasting environment for community engagement and feedback, and ensure the study is conducted using methods that are resonant, acceptable, and respectful to the community.[53] CAB engagement early in study design also leads to better quality data and more impactful or sustainable interventions.[54]

The MPP study created Community Advisory Boards at study sites where VFR communities would be directly engaged, one in the Minneapolis-St. Paul metropolitan area of Minnesota, and another in the Bronx, New York City using techniques that create a transformative partnership.[52] Techniques used to establish and sustain a meaningful, equitable, bi-directional partnership included the co-development of a memorandum of understanding (MOU) to set clear expectations, monthly honoraria provided to all CAB members, ongoing collaborative capacity-building activities for members and the MPP team around CBPR, and partnership in the publication and presentation of findings.[52,55]

CAB members were recruited by MPP study team members experienced in CBPR who already had developed partnerships in the West African community through prior health-related

collaboration and engagement with community-based organizations (CBOs). The two Community Advisory Boards (CAB) were comprised of gender-balanced West African VFRs individuals hailing from a broad range of nations and working either in the health field or at West African CBOs.[52] Due to their dual background of traveling as VFRs themselves, and being well-immersed in health or community engagement, CAB members provided first-hand experiences with malaria and travel, as well as direct access and insight on engaging the study population.

CAB members worked shoulder-to-shoulder with the MPP study team on a broad range of activities, including serving in a central role in the development and vetting of survey materials, discussed in further detail in Chapter 3. In many cases CAB members were well-respected voices in their communities, especially around heath and responsible community-engaged research.[52] Due to this preexisting engagement in their communities, CAB members successfully disseminated surveys and promoted participation in the survey to reach participants and populations that would not have been accessible by the MPP study team alone.

Focus group study[56]

Building off the CBPR approach described above, focus groups were designed in Minnesota and New York through with input from CAB members and partnering community-based organizations (CBOs).[56] The goal of these focus groups was to engage a broad range of West African VFR travelers on their knowledge, attitudes, and practices around malaria prevention during travel. The focus groups were designed using robust qualitative methodology that sought to continue holding focus groups until information saturation was met on the topic, i.e. no new themes were being brought up by participants in subsequent focus group sessions.[56]

CAB members and CBO representatives were trained on focus group methodology during a capacity-building session and in addition to facilitating the focus groups, these community partners led participant recruitment as well.[56] Relying on community partners to lead focus groups was intended to encourage open communication on the topic of malaria where the facilitator would be someone who better understands participants' experiences.

In all, sixteen focus groups were conducted, half in Minnesota and half in New York and information saturation was achieved.[56] Qualitative data was analyzed using a grounded theory analysis to reveal common themes and heterogeneity in experiences.[56] Participants reflected a range of nationalities and ages, and both genders were well-represented. Key findings are discussed in more detail in Chapter 2. Barriers to malaria prevention that were not previously

identified in the literature were expressed by participants; other themes were directly discrepant with findings published in the literature.[56] The cost of chemoprophylaxis, cultural challenges, and difficulty navigating pre-travel care were identified as key barriers to be explored in quantitative detail through the survey component of the MPP study.

Geospatial analysis and predictive spatial modeling[57]

Geographic information system (GIS) is a tool used to visualize and map epidemiologic data, overlay factors and outcomes, conduct epidemiologic spatial-temporal analyses, and construct mathematical models that factor in location to better understand health issues.[58] The Uniformed Services University site of the MPP study is well-trained in using GIS to better understand malaria and traveler health issues. The team developed maps that visualized malaria cases reported to the Minnesota Department of Health from 2010-2014. This information was overlaid with American Community Survey data on reported counts of place of birth in Sub-Saharan Africa. It shows a positive statistical relationship between Minnesota ZCTAs with higher counts of individuals born in SSA and higher counts of malaria cases, further supporting epidemiologic data that suggests a large proportion of imported malaria cases occur among VFRs. Refer to Appendix 1 for a copy of this map.[57]

The team also developed a geostatistical model and found that certain sociodemographic factors are positively associated with an increased risk of imported malaria cases in ZCTAs.[57] After adjustment, a positive relationship with increased malaria burden was observed with increased education level, increased size of SSA-born population, increased size of Asian-born population, and increased proportion of a language other than English spoken at home.[57] These predictors suggest immigrant travelers play a role in imported malaria in Minnesota. As a result of these findings, the MPP team discussed whether to include Asian VFRs in malaria surveys. After an examination of imported malaria cases to Minnesota originating from travel to Asian countries found few cases, it was determined to not expand the scope of surveying to include Asian VFRs. In addition to these formal mapping activities included in the publication, the mapping team also developed maps that overlaid community assets and study activities to assist in the survey dissemination plan to better reach VFRs eligible to participate in surveys.

Prescription drug dispensing limits[59]

Common barriers reported in the focus groups were the cost of chemoprophylaxis broadly, and specifically, limitations of insurance leading to incomplete coverage of a full chemoprophylactic regimen.[56] VFRs are observed to travel for longer duration than other traveler groups,[60] and sometimes these trips exceed beyond the length of pharmaceutical dispensing limits dictated by private and public payers.[59] The MPP study team reviewed policies around prescription dispensing limits and found Minnesota Medicaid policy limits dispensing non-maintenance medicines to a maximum of a 34-day supply.[59] Even if a provider writes a prescription for malaria chemoprophylaxis for a longer regimen, pharmacies cannot dispense more than a 34-day supply and individuals covered by Medicaid are not allowed to pay out-of-pocket for the remainder of the medicine.[59] In addition to malaria chemoprophylaxis, some VFRs also have chronic diseases that require other non-maintenance medicines that are challenging to extend beyond the length of a normal prescription.[19]

Vacation overrides are rare and challenging for travelers to navigate; a vacation override cannot be approved until more than half of the 34-day supply has been used.[59] This means a traveler would need to be in communication with their pharmacy remotely while on their trip and someone would then need to ship the newly dispensed medicine abroad to the patient. Especially when considering cost and shipping delays to African destinations, 17 days would likely be insufficient for the traveler to receive the medicine before their regimen has lapsed, putting him or her at risk for malaria infection.

Despite evidence that chemoprophylaxis is highly cost-effective for payers compared to the risk and cost of treating a malaria illness,[43] this Medicaid dispensing policy is common across most states in the US and creates a severe structural barrier to malaria prevention for Medicaid-insured travelers.[59] Without policy change, few effective work-arounds exist for providers and travelers facing this medicine dispensing dilemma. Numerous questions about malaria chemoprophylactic regimens, adherence, and prescriptions were included in the questionnaire to better quantify this issue.

MPP research questions around barriers to malaria prevention to be explored in surveys

Based on this preliminary research by the MPP study team, an examination of the literature (Chapter 2), and through engagement with the Community Advisory Board, three research questions were developed to better understand barriers to malaria prevention among VFR travelers. Surveys were designed to collect quantitative and qualitative data to answer these research questions and inform the development of barrier reduction interventions that may help to reduce imported malaria among VFRs.

The three central research questions seeking to better understand barriers to malaria prevention among VFRs are as follows:

What behavioral barriers exist to successful malaria prevention among VFR travelers, and to what extent do VFR's knowledge, attitudes and practices impact malaria prevention? This research question will be explored in Chapter 4.

What structural and health systems-level barriers exist to malaria prevention among VFRs, and to what extent does primary care relate to pre- and post- travel care experiences? This research question will be explored in Chapter 5.

How do barriers to malaria prevention differ between VFRs and other types of travelers, and how do barriers to malaria prevention differ within VFR subgroups? This research question will be explored in Chapter 6.

Chapter 2: Review of the literature

Introduction

A broad range of epidemiologic and medical research has been conducted to understand VFR travel and root causes of the disproportionate burden of travel-associated malaria in this population. Despite a robust body of research by quantity addressing malaria in VFRs, few interventions to reduce this disparity have been identified and imported malaria cases continue to increase in high-income countries.[2,61] This increase appears to be driven by increasing gross number and market share of VFR travel[15,16] alongside only mild improvements in preventive behaviors over time.[62] Distinct knowledge, attitudes and practices of VFRs are frequently cited, but some of the most widely-cited statements are hypotheses unsubstantiated with data,[11] or rely on problematic methodologies.[63]

Within the body of research on malaria in VFRs, case series examining demographic and clinical characteristics of imported malaria are particularly common,[4,20,22–24,26,64–66] as are cross-sectional pre-travel airport surveys seeking to understand chemoprophylaxis use in travelers.[62,67–74] Less common, however, are studies that seek to understand behavioral and systems-level barriers to malaria prevention through the examination of knowledge, attitudes, and practices specifically among African VFR travelers, either alone or in comparison with other traveler groups. This gap in understanding is likely related to a scarcity of behavioral and community-based research methods used in the travel medicine field.[52]

Understanding the unique and intersecting barriers to malaria prevention among African VFR travelers is central to developing targeted, evidence-based interventions, barrier reduction strategies, and policy changes that have the potential to reduce imported malaria in this high-risk population. There appears to be some dissonance between malaria prevention guidance and VFR population knowledge. For example, there is some suggestion that VFR travelers are as knowledgeable as other travelers about malaria,[62] yet VFR-specific guidelines for providers first suggest educating about malaria illness and transmission.[11,44] The extent and degree of this dissonance will be explored more formally in the following systematic review.

The goal of this systematic review is to determine the breadth, scope, content, and quality of primary and secondary research addressing malaria knowledge, attitudes, and practices among VFR travelers to the African continent. Additionally, this review seeks to understand the

constraints of closely-related but ineligible literature to identify gaps in the ways in which VFR KAP is reported and opportunities for future research.

Literature review methods

An Ovid (Ovid Technologies Inc., New York, NY) search was constructed to generate a comprehensive list of peer-reviewed literature in the MEDLINE database (US National Library of Medicine, Bethesda, MD). Medical Subject Heading (MeSH) terms were identified around malaria, travel, and knowledge attitudes and practices, and were exploded in searches. The malaria MeSH term was used in an 'OR' function with malaria as a keyword to broaden result lists. MeSH terms within the Persons/ category were explored but no term was determined to align with the target study population (VFR travelers). Multiple keywords using field-standard phrases for travelers who visit friends and relatives were used in an 'OR' function to generate a population grouping. Articles generated in a search on February 16, 2019 were included in the review.

Search syntax

The following search was used to evaluate article abstracts for their inclusion in the review: ((exp MALARIA/ OR malaria.mp.) AND ("visiting friends and relatives".mp. OR "visit friends and relatives".mp. OR VFR travel*".mp.)) OR ((exp MALARIA/ OR malaria.mp.) AND (exp TRAVEL/ OR exp Travel Medicine/) AND (exp Health Knowledge Attitudes, Practice/)) A complete list of the Ovid search parameters and the resulting cascade of paper counts is presented in Appendix 2.

Paper eligibility

Original research articles, literature reviews, and meta-analyses using observational, experimental, and qualitative study designs were eligible for inclusion in the review. Eligible papers are available in full in MEDLINE, published in 1990 or later in English or Spanish and must address four central criteria: 1) malaria, 2) knowledge attitudes and practices, 3) travel to Sub-Saharan Africa (SSA), and 4) travelers who visit friends and relatives. In other words, eligible papers must include or summarize findings about malaria knowledge attitudes and practices of VFRs traveling to endemic destinations in the African continent. Studies that address KAP of travelers and include a VFR category in their population description, but do not provide VFR-specific subgroup analyses are ineligible for inclusion. Basic assessments of

chemoprophylaxis use, or a clinic visit prior to travel were not considered sufficient practices alone to fulfil the KAP criterion.

Potentially relevant papers not generated by literature review search terms

A focus group study of West African VFRs around malaria KAP and prevention was recently conducted by the MPP study team, led by Walz.[56] The authors included a comprehensive comparison of assertions made about VFR KAP published in the literature to the findings in their qualitative analysis. This comparison sought to include anecdotes and statements unsupported by data about VFR knowledge, attitudes and practices that are published in the literature, some of which are frequently cited. In addition to Ovid search results, these cited papers were separately evaluated for eligibility an inclusion in the literature review and are denoted in review Tables 1-3 with an asterisk (*).

Paper review

All papers generated from the initial Ovid search were compiled and abstracts were evaluated for eligibility (Figure 2). Full-text review was performed on articles in which abstracts addressed malaria and KAP, and at least one of the two additional central criteria. Additionally, VFR KAP articles cited by Walz[56] that were not generated from the database search were each reviewed in full. Eligible articles addressed each of the four central criteria. Analyses and data presented in the publications were reviewed; no supplementary datasets or findings were solicited from authors.

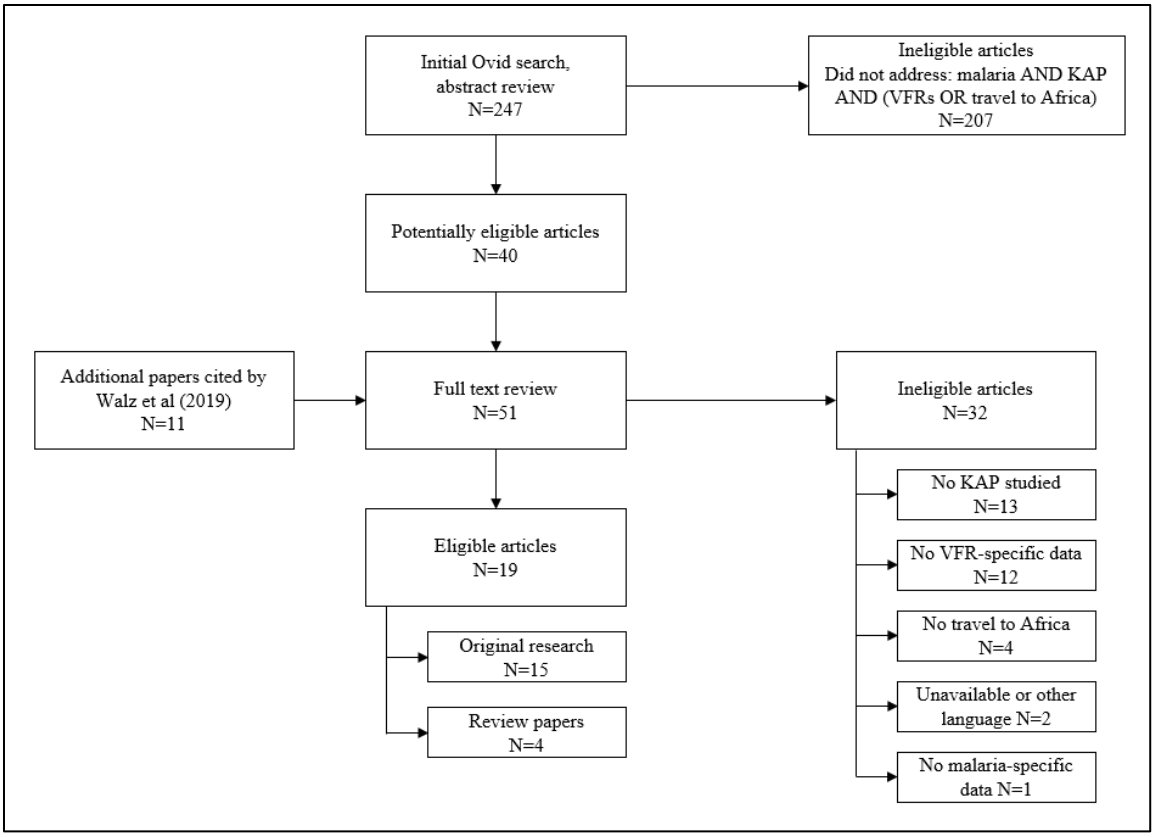


Figure 2: Article review cascade

Table 1: Inclusion and exclusion categorization of potentially eligible articles reviewed in full after abstract evaluation

	Count	Studies
Eligible	**19**	
Review papers	4	11,44,45 ∗75
Original research	15	56,62,72–74,76–82 ∗63 ∗83 ∗60
Ineligible	**32**	
No KAP studied	13	19,20,22,29,35,52,66,84 ∗4 ∗23 ∗24 ∗64 ∗65
No VFR-specific data	12	67–71,85–91
No travel to Africa	4	28,34,92 ∗93
Unavailable or other language	2	94,95
No malaria-specific data	1	∗30
Total	**51**	

Results

Two hundred forty-seven papers were generated from the initial Ovid search (Figure 2). Forty articles in which abstracts addressed malaria and KAP and at least one of the two additional central criteria were identified. After the full-text review of potentially eligible papers generated by the Ovid search, fifteen articles were determined to meet all eligibility criteria and were included in the literature review. Eleven additional articles[4,23,24,30,60,63–65,75,83,93] addressing VFR KAP cited by Walz[56] did not appear in search results. Four of these additional articles were eligible for inclusion in the literature review after evaluation, bringing the total number of eligible papers to nineteen (Table 1). Four reviews (Table 2) and fifteen original research articles (Table 3) comprise the literature review.

Reviews of malaria knowledge, attitudes and practices among African VFR travelers

Four reviews have been published that synthesize research on barriers to malaria prevention (and other traveler health issues) among travelers who visit friends and relatives and are summarized in Table 2. Three of these reviews use non-systematic approaches, fail to disclose methods, and cite literature on VFRs globally.[11,44,75] One systematic review of malaria knowledge attitudes and practices among African VFRs living in Europe was published in 2010 by Neave and colleagues, but yielded only three eligible pieces of original research.[45] Each of these publications were also eligible for the present literature review; findings are reported in detail in the following section. Neave et al. make compelling calls for the need for additional qualitative research employing robust study design, consistent definitions of VFR study populations, and research that works to disentangle the heterogeneity of barriers faced by African VFR travelers of varying ethnicities and backgrounds.[45]

Perhaps the most widely-referenced article on VFR traveler health is the 2004 review by Bacaner and colleagues,[11] cited more than 260 times according to Google Scholar. Addressing a broad range of VFR-specific traveler health issues, the review devotes a significant portion to malaria. Although the quantity of available research on VFR KAP was an order of magnitude less in 2004 according to Ovid search results, the review was not effective in communicating gaps in understanding. Rather, the review proposed a series of hypotheses around VFR knowledge, attitudes, and practices,[11] which were subsequently cited by many as evidence-based findings. These hypotheses were developed by travel medicine experts and were likely well-informed, but

still were based upon anecdotal experiences or observations, and may contain considerable bias and assumptions.

Behrens and colleagues published a review of VFR knowledge attitudes and practices for the purposes of comparing the findings to current malaria prevention guidelines in the UK.[44] Although employing an informal methodologic approach, the review highlights the dissonance between guidelines focusing on improving knowledge among travelers and findings that even VFRs who are more knowledgeable about malaria prevention are no more likely to use chemoprophylaxis and prevention methods.[44] Cost concerns, difficulties acquiring prescriptions, and the perception that malaria is easier to treat than prevent are key barriers for VFR travers that should be addressed in future evidence-based guidelines.[44]

The most recent review, performed by Heywood and colleagues in 2018 focuses on access to pre-travel care and its impact on VFR travelers.[75] The non-systematic review cites multiple studies that have found VFRs prefer to seek pre-travel care from their primary care providers. PCPs must be engaged and informed in VFR-specific travel needs and connected to resources for determining appropriate chemoprophylactic regimens.[75] The review also highlights the need for the development and formal evaluation of interventions using community-based participatory research methods designed to engage communities and connect VFRs with pre-travel care.[75] Although mostly lacking in formalized review methodologies, these papers draw consensus around the broad spectrum of VFR experiences and barriers to malaria prevention. They highlight the need for the detailed exploration of VFR KAP and the development of interventions that address the range of socioeconomic, interpersonal, and structural barriers to malaria prevention VFRs face.

Original research on malaria knowledge, attitudes and practices among African VFR travelers

Fifteen original research articles were identified that address malaria KAP in African VFRs (Table 1). Study design, key findings, and limitations of these articles are summarized in Table 3. Research around a broad range of knowledge, attitudes, practices and barriers to malaria prevention will be discussed, with notes on alignment and discrepancies between original research results. Findings from literature employing airport survey methodologies to understand traveler and VFR KAP are summarized separately in a subsequent subheading below. Only three of the eleven identified airport studies fulfilled the inclusion criteria of this review.[62,72,73] Airport

studies and other ineligible articles are also briefly discussed to highlight gaps and propose future approaches to quantifying VFR KAP.

Malaria knowledge

VFRs are knowledgeable that mosquitoes are the source of malaria and that steps can be taken to prevent illness.[76,78,79,82] Similar to other traveler groups, the depth of VFR malaria knowledge is limited. For example, most VFRs are unfamiliar with mosquito biting times,[79] and there is some confusion on the existence of a malaria vaccine.[82,83] Some VFRs discussed poor sanitation among in-country neighbors as a contributor to their risk of malaria,[56,78] although *Anopheles* mosquitoes breed productively in vegetation and poor sanitation is more correlated with diseases vectored by *Aedes* mosquitoes. Chloroquine is cited by some VFRs as an effective chemoprophylaxis,[79,81,82] despite dearly universal chloroquine resistance in Sub-Saharan Africa. Multiple studies found no association between malaria knowledge and use of pre-travel health care, chemoprophylaxis, or malaria prevention broadly,[62,81] suggesting that educational campaigns alone may be ineffective at improving preventive behaviors.

Risk perception and attitudes around malaria treatment

Malaria, and one's health more broadly, is just one of the many competing factors VFRs must consider when preparing for travel.[56] Although most VFRs recognize there is risk of acquiring malaria during travel, many were unconcerned about contracting malaria, view it as an inevitable part of travel, or perceive it as an easily treatable illness.[63,76,78,83] A considerable group within the VFR community feels that malaria is easier to treat than it is to prevent.[78,83] Others are especially concerned about malaria causing debilitating illness or ruining an expensive trip.[56] In an airport study described in greater detail below, the more respondents felt that malaria was easier to treat than prevent, the less likely they were to have purchased or started chemoprophylaxis, or to have sought pre-travel care.[73] However, another airport study found increased knowledge of the risks of malaria among VFRs did not predict chemoprophylaxis use,[72] suggesting that risk communication-based interventions alone may not reduce malaria or eliminate barriers.

Even when recognizing that malaria illness could ruin a trip, some VFRs weren't willing to sacrifice partaking in certain activities where mosquito bites could occur such as socializing outdoors at night.[56,83] Some VFRs feel that treatments and clinical care available in destination countries are better than those available in their countries of residence.[63,78] Furthermore, fears of

becoming symptomatic and being quarantined in a Western hospital were expressed by some.[56,63,78]

In one study, VFRs that had attended a travel clinic had lower perception of malaria risk than those who attended a travel agency,[82] perhaps due to effective communication of malaria prevention techniques and chemoprophylaxis effectiveness during the clinic visit. Understanding that malaria immunity wanes over time was varied; some recognized an increased severity in travel-related malaria as compared to illness experienced as a child, but others understood themselves to be still immune.[78,79,83] Although clear communication that malaria is a serious illness to which VFRs are likely not immune is an important message, increased risk perception alone appears at best to be only loosely correlated with improved preventive behaviors.

Pre-travel health care acquisition and provider knowledge

Pre-travel preventive care was reported between 18% and 70% of VFR travelers;[76,81] this range exemplifies the limitations of usefulness of summary-level analyses that do not correlate exposures and outcomes. Despite this range, it is commonly observed that VFRs are less likely to seek pre-travel care than other travelers.[62] Even when VFRs are not observed to be less likely to have received pre-travel care, foreign-born travelers have statistically higher odds of not having received pre-travel advice than US-born travelers.[80] Aligned with knowledge and attitude findings discussed above, attendance at a pre-travel clinic was not associated with increased malaria knowledge.[81]

A finding observed across multiple studies was the impression among VFRs that health care providers in high-income countries may not be sufficiently trained on malaria to provide adequate pre-travel care.[56,63,78,83] However at the same time, many VFRs prefer to seek care with their primary care physicians than at a travel clinic.[56,79,83] Both in preventive and clinical care settings, VFRs feel the quality of provider care around malaria may be limited. Better communication of the training of specialty travel and tropical medicine providers, and the availability of culturally relevant services is necessary to encourage increased preventive care in VFR travelers and decreased fear around clinical treatment of malaria illness.

Costs of chemoprophylaxis and preventive care

The cost of pre-travel care and the challenge of scheduling an appointment for last-minute visits were commonly expressed by VFRs.[56,81] Self-advocacy issues in pre-travel health care have been

expressed by some West African VFRs, including not receiving clear information on insurance coverage from navigators, past experiences with unexpected high costs, and appointment scheduling.[56,83] Perceived or actual lack of insurance coverage for visits at travel specialty clinics was expressed as a cost barrier to pre-travel care.[56] Despite these barriers, some VFRs had successful visits at travel clinics and were able to navigate the process easily.[56] Cost and structural barriers to accessing pre-travel care appear to be a key driver in the disparity of pre-travel care in the VFR population.

The cost of chemoprophylaxis was cited as a primary barrier in many studies,[56,63,83] especially when VFRs were travelling as family units.[78] In one study, among VFRs at a travel clinic, 17% refused a chemoprophylaxis prescription, overwhelmingly due to the cost of the medication.[60] VFRs recognize the cost of malaria medication and treatment is much more affordable in designation country.[78] Some recognize the chance of reduced quality or counterfeit medicines, but would rely on hosts for guidance on trustworthy pharmacies.[78] If increasing chemoprophylaxis use and adherence is a key method to decreasing imported malaria in VFR travelers, it must be paired with the development and dissemination of cost-reduction strategies for travelers.

Chemoprophylaxis use and adherence

Studies quantifying the proportion of VFR travelers using chemoprophylaxis range widely from to 14 to 60%.[73,76] It appears that VFRs overestimate their likelihood of chemoprophylaxis use, perhaps due to unknown barriers or social desirability bias, as two-thirds of focus group participants stated that they plan to use preventive medicines.[83] The need to begin chemoprophylactic regimens prior to commencing travel and after returning from travel is not well known among VFRs.[79]

Adherence to chemoprophylaxis has been reported as challenge for VFRs due to poor understanding of regimens, side effects, and justification for completing the full prescription.[83] Poor adherence has been observed in the variety of traveler populations;[87] a study comparing chemoprophylaxis adherence between tourists and VFRs, there was no statistically significant difference adherence observed.[77] A French study comparing VFRs at travel clinics and at travel agencies found better chemoprophylaxis adherence among those who had visited a travel clinic, but that still only 41% of travel clinic participants completed their medicine correctly.[82]

Adherence was observed to be reduced in travelers on longer trips,[77] which is a relevant observation as VFRs tend to travel for longer duration than non-VFRs.[60] VFRs traveling for

longer periods of time may face payer dispensing limits that will fail to provide chemoprophylactic coverage for the entire trip.[56] Interventions designed to get VFRs to seek pre-travel care alone may not be an effective solution for improving chemoprophylaxis adherence. Other barriers, including dispensing limits, managing side effects, and the cost of complete regimens must be considered.

Trip characteristics and perceived attitudes among hosting family and friends

VFRs tend to travel for longer periods of time than non-VFRs[60] and travel to countries and regions of greater malaria risk than non-VFRs.[60,62] Many VFRs are navigating a dual identity, identifying both with their places of birth and residence.[56] When staying with hosting family and friends, some VFRs desire to follow local norms and are concerned to come off as too Westernized or to require accommodations that may seem excessive or inconvenient to their hosts.[56,78,83] These culturally-specific barriers to malaria prevention may be challenging to navigate in intervention development but are central to the VFR experience. The communication to VFRs that some malaria prevention strategies are less visible to or intrusive on hosts, such as the use of insecticide treated clothing, chemoprophylaxis, and repellent lotions may be particularly resonant in this population.

Repellents, bed nets, and other preventive practices

VFRs generally recognize bite prevention measures as prudent and intend to use repellents, but also express that mosquito bites are inevitable and that limiting socializing outside in the evenings was not an option.[56] Bed nets are generally an unacceptable form of bite prevention for VFRs due to the added heat and discomfort of sleeping under a net, inconvenience of hanging nets, sense of otherness if hosts do not use them as well, and perception that more modern prevention methods exist.[78,83] Spraying bedrooms with repellent was a more acceptable prevention method among VFRs with many host families partaking in this method prior to bedtime.[78] Although knowledge of preventive practices beyond chemoprophylaxis is strong among VFRs, social and environmental barriers to their realization exist.

Limitations of original research on African VFR malaria KAP

Qualitative methodologies are relatively uncommon in the travel medicine field despite their effectiveness in understanding the nuance of the VFR experience. Most eligible qualitative studies included small sample sizes and did not report information saturation,[63,78,83] or used problematic methodologies of questionable ethical support.[63] Two focus groups reported information saturation,[56,83] and two called for the more systematic application of qualitative methods in travel medicine.[52,56]

Cross-sectional questionnaires are the most common method of quantifying African VFR malaria KAP. Most are conducted prior to travel, and a small number are performed after travel or both before and after. While airport settings create the opportunity for a more representative sample of travelers to specific malarious destinations, other settings, including travel agencies, travel clinics and migrant clinics may have a more biased sample of respondents and may not reflect the full scope of the underlying VFR traveler community. Few quantitative studies were identified that take place within the general VFR community;[79,81] a transition to the use of more well-developed community-based research methods will be necessary to more deeply understand the within-population nuances of barriers to malaria prevention.

Definitions of VFR study populations varied widely across qualitative and quantitative studies and is cited as a key limitation of research on VFRs.[19] Some limited participation to only those who had or intended to travel as a VFR, whereas others included expatriate participants born in malarious regions of Africa even if they had no plans of travel back to their home country, or even if they traveled for business. This, combined with disagreements on the proper definition of a VFR in the broader travel medicine community[13,14] create the conditions for an ambiguous study population and subsequently the potential for misaligned interventions.

Most of the eligible original research about African VFR malaria KAP pointed to chemoprophylaxis acquisition and use as key outcomes. Adequate chemoprophylaxis use is perhaps the most effective single method to prevent malaria during travel, however, chemoprophylaxis use alone does not guarantee full protection from malaria illness in travelers.[2,90] Some eligible studies, and many of the additional ineligible publications limited their VFR-specific results or more advanced analyses to chemoprophylaxis use. This outcome alone misses the multiple upstream and intersecting barriers to chemoprophylaxis acquisition and proper use VFRs face. Additionally, the use of and barriers to other preventive measures,

especially those that are unobtrusive to host family and friends, need to be studied in further detail for a more comprehensive understanding of opportunities to improve prevention in VFRs.

Airport surveys

A cross-sectional, standardized airport survey was piloted in 2003,[85] and subsequently replicated across the United States, Europe, South Africa, and Australasia. An identical questionnaire was given to all types of international travelers to destinations with endemic malaria. Although individually robust in sample size, six of seven identified publications resulting from these surveys failed to report comparative or sub-group analyses on VFRs despite most noting VFRs as a population of concern. Combined, these six malaria studies surveyed approximately 517 VFRs among 2,814 total international travelers. Among these six studies, VFRs comprised 43% of the traveler pool in the US,[71] 8% in South Africa,[70] 20% in Australasia,[69] 9% in Sweden,[68] 21.8 in the Netherlands,[67] 21 to 25% in the multisite European studies.[74,85] Although identical methodology was used across all sites, data presented in these articles were only summary level and comparative or subgroup analyses on VFRs were not performed.

The single study using the uniform instrument and methodology described above that did include VFR comparative analyses was performed at an airport in the Netherlands from 2003 to 2009 and was comprised of a traveler population to areas of high and low malaria risk.[62] Seventeen percent of respondents (521) were VFR travelers, 29.6% of whom (390) traveled to a destination with a high risk of malaria.[62] Key findings included that VFRs were less likely to seek pre-travel care than non-VFRs when destined for either high or low-risk areas and that VFRs were more likely to travel to high-risk destinations.[62] VFRs scored no different than non-VFRs on the assessment of malaria knowledge, but VFRs were less likely to report planned protective practices.[62] This dissonance between knowledge and practice may show that education-based interventions alone may not affect preventive behaviors in VFRs. Finally, this study found that planned preventive practices and risk avoidance attitude improved in the overall traveler population over time.[62] Although a subgroup analysis was not performed to observe this trend among VFRs alone, it suggests that travelers may be receptive to interventions that aid them in preventing malaria during travel. This is the most robust study identified in the literature review quantifying KAP differences between VFRs and other travelers, as well as differences within the VFR population.

Two additional studies using different questionnaires and methodologies were performed in airports and did not disclose VFR-specific results. The first used a post-travel design for

surveying travelers exiting Zimbabwe and found that three quarters of travelers used chemoprophylaxis, but nearly one in five did not achieve correct adherence.[91] The second included very few VFR travelers; 65% of all travelers to SSA brought chemoprophylaxis and 27% had incorrect ideas about how malaria is transmitted.[86] Without access to move advanced analyses or supplemental data from these publications, it is impossible to determine whether disparities in pre-travel care and chemoprophylaxis exist between VFRs and other traveler types, or to measure heterogeneity within VFR populations.

Airport surveys using separate instruments and methodology that did perform VFR-specific analyses were identified in Europe. An airport survey was deployed in the Netherlands among West African-born travelers to Ghana living outside of West Africa. The survey found 68% of travelers sought pre-travel care, 60% brought along chemoprophylaxis, and 54% had started their chemoprophylaxis regimen.[73] These estimates of pre-travel care and chemoprophylaxis still have much room for improvement, but are markedly higher than reported elsewhere in the literature.[76,82,86] The more respondents felt that malaria was easier to treat than prevent, the less likely they were to have purchased or started chemoprophylaxis, or to have sought pre-travel care.[73] Additionally, respondents who thought malaria was more easy to treat than prevent were more likely to perceive that host friends and family would discourage or disapprove of chemoprophylaxis use. These findings suggest that a nuanced range of factors contribute to VFR attitudes on malaria prevention. Although addressing attitudes around the severity of malaria illness may be a simple intervention, it may not be fully effective if not paired with messaging around navigating relationships with hosting friends or family and feelings of loss of birthplace identity.

A large UK airport study compared KAP of travelers destined for a malarious area to a represented sample of the UK population.[72] Travelers were more knowledgeable about malaria than the general UK population.[72] The traveler group included 56% VFRs and 31% of VFRs had sought pre-travel care.[72] Nigerians specifically had higher scores for knowledge and risk perception around malaria than Ghanaian or Kenyan travelers, yet were less likely to use chemoprohpylaxis.[72] Overall, increased knowledge of the risks of malaria did not predict chemoprophylaxis use, suggesting that knowledge-based interventions alone may not reduce malaria or eliminate barriers.[72] The heterogeneity observed across malarious destinations in SSA provides further support that VFRs or migrant traveler subgroups may face distinct barriers KAP barriers to malaria prevention.

Additional ineligible papers: key limitations of the description of VFR KAP

VFR subgroup-deficient studies

In addition to the eight airport studies discussed above that failed to perform VFR comparative or subgroup analyses, studies in travel clinics, among malaria cases, and in broad health cohorts have been identified that fail to examine VFR-specific KAP despite quantifying this group and noting VFRs as high-risk for malaria (Table 4). Within a retrospective cohort study including only 0.5% VFRs among its travelers, chemoprophylaxis use was 47.6% among travelers to high-risk malaria areas, but just 18.2% achieved full adherence.[87] Travelers who received malaria advice from a health care provider were significantly more likely to be compliant with chemoprophylaxis regimens.[87] In a case series of malaria diagnoses reported in Sweden, 21% were VFRs and 90% of cases had acquired malaria during travel to SSA.[90] Interestingly, 40% of cases reported taking chemoprophylaxis adequately during their travel.[90]

Two surveys were performed at travel clinics that failed to perform VFR subgroup analyses. One study employing a separate sample pretest posttest design found increased knowledge of malaria prevention and transmission among respondents who were surveyed after their travel clinic visit, although some misconceptions remained.[89] In another survey, travelers who had traveled to endemic areas before and those planning on sleeping outside were more likely than other travelers to opt to self-treat if they became ill with malaria symptoms.[88]

Collectively, these surveys (Table 4) on traveler knowledge attitudes and practices provide some insight on malaria prevention during travel but fail to perform population-specific analyses on VFRs, which many of these same papers cite as a group with increased risk of malaria. Although some studies were not powered for comparative or subgroup analyses, others included robust sample sizes and provided the potential opportunity for meta-analysis due to identical methodology, had the information been available. This highlights the need for a transition in the travel medicine field from summary-level analyses to more detailed examinations of specific populations of concern. Especially for VFRs, who are recognized in the travel medicine field as perhaps the population of greatest concern for malaria illness,[75] improvements must be made in quantifying their knowledge, attitudes and practices around malaria prevention. Frequently VFRs' barriers to prevention are reported anecdotally and are unsupported by research,[11] leading to a stall in the development of targeted barrier reduction interventions, and a continued increase in malaria morbidity.[2]

VFR studies of travelers to other malaria endemic destinations

A few studies focusing on malaria prevention among VFR travelers to non-African destinations have been performed. In an airport study among Canadian VFRs to India, fewer than a third planned to use chemoprophylaxis and only 7% carried an adequate prescription despite two thirds recognizing malaria as a moderate or severe illnesss.[28] A qualitative study of this same population found VFRs knowledgeable about malaria but generally don't plan to seek pre-travel care due to similar reasons cited in African VFR studies, including cost, short pre-travel intervals, and wanting to fit in with hosting family and friends.[93] A study of Australian travelers with reported travel diseases from travel mostly to Asia, VFRs or immigrants were no less likely to seek pre-travel care than other traveler groups.[92] These findings mirror the experiences of VFR travelers to destinations in Africa discussed above. Common experiences exist among VFRs of varying ethnicities, but more research is needed to determine the degree of generalizability of the VFR traveler experience.

Key KAP-deficient reviews

Two non-systematic global reviews of malaria illness in VFR travelers exist: one from 2010 in English[20] one from 2014 in Italian.[66] Each review original research on reported malaria illnesses that include specific counts or descriptions of VFR cases. Both conclude that compared to other travelers, VFRs less frequently use chemoprophylaxis, preventive behaviors, or pre-travel health care.[20,66] They report VFRs are disproportionately represented in malaria case counts,[20,66] although none of the cited studies quantify the proportion of VFRs in the underlying traveler populations that would prompt such a conclusion. However, based on airport studies VFRs are overrepresented in travel to high-risk malarious areas.[62] VFRs are further overrepresented among reported imported malaria cases relative other traveler groups.[2,90] While these reviews summarize a robust body of research highlighting the malaria illness burden among VFRs, they also emphasize the need to broaden the body of research in the travel medicine field to address the upstream determinants of malaria among VFR travelers.

Table 2: Summary of eligible review articles on malaria knowledge attitudes and practices of VFRs traveling to Africa, n=4

First author	Year	Review type	Study population	Key findings	Limitations
*Heywood AE[75]	2018	Non-systematic review of travel KAP	VFR travelers broadly	VFRs: disproportionately represented among malaria cases, travel for longer duration, plan trips over shorter intervals, have limited access to preventive health care, financial barriers, less likely to seek pre-travel care, lower risk perception, belief of immunity to malaria, non-use or poor adherence to chemoprophylaxis, not wanting to impose on or inconvenience hosts with their prevention.	Generalizability: many malaria citations are from studies on VFRs to India; there is no support for cross-ethnic VFR KAP homogeneity in the literature. No methods provided for literature review.
Behrens RH[44]	2015	Non-systematic review of malaria KAP; comparison to UK malaria prevention guidelines	VFR travelers to malaria endemic areas	VFRs: disproportionately represented among malaria cases, mortality and severe malaria lower, generally knowledgeable of disease risk and prevention, follow local practices and self-treat when ill with malaria abroad, chemoprophylaxis use and compliance is lower, Rx cost and access are barriers. Malaria prevention decision making integrates a complex range of socio-economic factors. Current guidelines and interventions (e.g. education) do not align with many barriers.	Mostly limited to studies on VFR travelers living in the United Kingdom. No methods provided for literature review.
Neave PE[45]	2010	Systematic review of European VFR malaria KAP	African VFR travelers in Europe	VFRs: knowledgeable about malaria transmission, knowledgeable about presence of malaria in travel destination, belief of immunity to malaria, belief malaria illness would be mild, chemoprophylaxis use high, chemoprophylaxis use greater among VFRs that go to a travel clinic, some use of ineffective medicines, Rx cost and side effects are barriers.	Only three articles with small sample sizes were eligible for systematic review.
Bacaner N[11]	2004	Non-systematic review of VFR traveler health risks	Undefined, VFR travelers broadly	Chemoprophylaxis adherence is lower among VFRs. Out-of-pocket health care and prescription costs are a financial barrier to prevention among VFRs. Recommendations on key messaging to VFRs are presented including education about malaria, bite prevention, bed net use, the need for chemoprophylaxis, and potential cost barriers.	Many VFR KAP statements are hypotheses and don't have support from original research. Hypotheses have been re-cited as factual. Review methods and study design are not included.

Table 3: Summary of eligible original research articles on malaria knowledge attitudes and practices of VFRs traveling to Africa, n=15 (4 pages)

First author	Year	Study design	Study population	Study size	Key findings	Limitations
Walz EJ[56]	2019	Focus groups, QL	West African VFRs in MN and NY	N=16 focus groups N=172 VFRs	Cost of pre-travel care and chemoprophylaxis are barriers, difficulty advocating for oneself limited quality of health care encounters, most consult primary care providers, low confidence in US provider knowledge about malaria. Some VFR KAP reported in the literature were unsupported or contradicted in focus group findings. This is the most robust qualitative study on the topic identified.	Generalizability to VFRs who travel to other parts of Sub-Saharan Africa unknown.
*Rowe K[60]	2017	Retrospective case-control of travel clinic encounters, QT	Australian travel clinic. Case: VFRs Control: Non-VFRs	N=100 VFR N=100 Non-VFR	VFRs were more likely than non-VFRs to decline any travel clinic intervention and specifically chemoprophylaxis, VFRs more likely to need chemoprophylaxis, mean time from clinic visit to departure no different between groups, mean length of stay longer among VFRs, no differences in provider advice given.	Study broadly addresses VFR travel; limited data on malaria-related outcomes.
Flaherty G[79]	2016	Cross-sectional questionnaire, QT and QL	African migrant population in Ireland	N=68 VFRs	VFRs knowledgeable of transmission, less so of mosquito biting times, low risk perception of severity, bed nets and chemoprophylaxis cited as prevention methods, little mention of repellents, low knowledge of chemoprophylactic regimen and effectiveness, pre-travel care would be sought primarily from PCP, Irish providers unknowledgeable about malaria.	Questionnaire not piloted or validated. Study among potential, not actual, VFR travelers. Small sample size.
Neave PE[78]	2014	Semi-structured interviews, QL	African VFRs in London and African VFRs with diagnosed malaria	N=20 VFRs N=6 VFR cases	It is an occasional practice of VFR-hosting families to spray bedrooms with insect repellents before bed time. Many VFRs wore repellents, especially those travelling with children. VFRs don't plan to or use bed nets when traveling due to the added heat and the notion that more modern prevention options exist. Chemoprophylaxis cost concerns were common, especially when traveling with family. VFRs felt that overt concern about malaria could make them appear as an outsider among family and friends in the designation country. VFRs had more faith in clinical malaria management in endemic countries, compared to the UK.	Small sample size; no indication of information saturation. Nigerian and Ghanaian were only nationalities eligible.

First author	Year	Study design	Study population	Study size	Key findings	Limitations
Baer A[80]	2014	Case series, questionnaire, QT	Persons with a travel-associated reportable disease in King County, WA	N=259 cases N=81 VFRs	VFRs were not statistically significantly less likely to have received pre-travel advice than other traveler types. However, foreign-born travelers had 2 times higher odds of not having received pre-travel advice than US-born travelers.	Only 19 cases in the series were from diagnosed malaria. Study population predominated by diarrheal diseases.
Behrens RH[72]	2013	Multi-group cross-sectional questionnaire, QT	Travelers destined for a malarious region and a representative sample of the UK population	N=128/500 VFRs/total travelers N= 185/1991 VFRs/ general UK pop.	VFRs are overrepresented on international flights, compared to the general UK population. Overall, 52% of travelers had received pre-travel advice, compared to 31% among only VFRs.	Few VFR-specific subgroup analyses or population comparisons are reported in this study.
Wieten RW[73]	2013	Cross-sectional questionnaire, QT	Airport travelers in Amsterdam of West African birth living outside of West Africa.	N=154 West African travelers (N=134 VFRs)	A slight majority of travelers had brought chemoprophylaxis, started their Rx and obtained pre-travel advice. Behavioral conceptual model developed for starting chemoprophylaxis. Those who hadn't started a Rx were younger, had experienced malaria before, and were traveling for longer duration.	Variable country of residence in the study population (North America & Europe). No longitudinal follow-up for chemoprophylaxis adherence.
Van Genderen PJJ[62]	2012	Cross-sectional questionnaire, QT	Airport travelers in Amsterdam destined to countries with high and low risk of malaria	N=154/708 VFRs / total to high-risk destination N=367/2337 VFRs / total to low-risk destination	VFRs less frequently sought pre-travel care than other traveler types. Knowledge and attitudes were similar between VFRs and non-VFRs to high-risk areas, but chemoprophylaxis use was significantly lower among VFRs. Over time there was an increase in protective behaviors observed.	Study robust and well-designed, but math errors observed in results.

First author	Year	Study design	Study population	Study size	Key findings	Limitations
Pistone T[82]	2007	Prospective cohort, pre- and post-travel questionnaires, QT and QL	African VFRs living in Paris who either go to a travel clinic or travel agency	N=122 travel clinic N=69 travel agency	Malaria risk perception was greater among VFRs at the travel clinic than at the agency. Forty one percent of travel clinic VFRs adhered to chemoprophylaxis regimens whereas twelve percent of travel agency VFRs adhered. Travel clinic VFRs were no more likely than agency VFRs to use anti-vector protection measures.	Relatively small study population, information saturation for qualitative responses not reported. Potential for group crossover.
Schilthuis HJ[81]	2007	Snowball cross-sectional, semi-structured interviews, QT and QL	West African immigrants to the Netherlands	N=292 West African immigrants N=142 VFRs	More than two-thirds reported taking malaria chemoprophylaxis regularly on their last trip, but once named, fewer than one-third reported a regularly prescribed prophylactic medicine. Few had 'adequate' knowledge of malaria, answering every knowledge question correctly. Travelers who did not have pre-travel care were less likely to use chemoprophylaxis.	Some questions designed around vaccination would have been useful to understand around malaria. Odds ratios were primarily only reported around predictors of vaccination.
*Morgan M[83]	2005	Focus groups, QL	African immigrants living in London	N=5 focus groups N=44 African immigrants	Health system barriers were identified, including Rx cost, appointment scheduling, and Rx uncertainty. A lack of chemoprophylaxis use was related to lower risk perception and belief malaria is easily treatable. Heterogeneity in beliefs were observed and may be linked to SES and prior experience with malaria.	Information saturation was reported, but still a relatively small sample size.
Farquharson L[77]	2004	Prospective cohort, semi-structured consultations, QL	Travel clinic patients in London going to a malarious area	N=107 total N=24 VFRs	There was no statistically significant difference in chemoprophylaxis adherence in VFRs and tourists. Adherence was reduced in travelers on longer trips.	Few VFR-specific subgroup analyses or population comparisons are reported in this study. Small VFR sub-group n.

First author	Year	Study design	Study population	Study size	Key findings	Limitations
Van Herck K[74]	2004	Cross-sectional, questionnaire, QT	Airport travelers in Europe destined for malarious areas	N=2,288 N= ~581 VFRs	Tourists were more likely than VFRs to seek pre-travel care and bring chemoprophylaxis on their trip.	Few VFR-specific or malaria-specific subgroup analyses or population comparisons are reported in this study despite robust sample size.
Scolari C[76]	2002	Cross-sectional, questionnaire, QT	Patients born in malaria endemic country attending a clinic for undocumented Italian residents	N=504 patients from malarious areas N=170 travelers	Fewer than 20% of those who have traveled back to their country of birth sought pre-travel care, 80% started chemoprophylaxis, 29% completed their regimens. Low risk perception and unawareness of malaria preventive measures were top reasons for those that did not seek pre-travel advice. Length of residence in Italy was slightly associated with receipt of pre-travel care.	Migrants are not necessarily VFRs; only a third of respondents had traveled back to their country of birth. Undocumented migrants may exhibit different KAP than legal immigrants.
*Leonard L[63]	2001	Focus groups, semi-structured interviews with travelers and physicians, QL	Travelers to their country of birth, Nigeria, living in Texas	N=3 focus groups N=2 traveler interviews N=7 provider interviews 'Numerous additional discussions'	Malaria was the most commonly reported health concern among travelers. Knowledge of transmission and symptoms are high. Impressions of malaria as a normal part of travel were shared by multiple participants, while others reported worry about malaria during travel. Cost was the most commonly cited reason barrier to following pre-travel advice.	Nonscientific, non-standardized sampling, focus group, and interview methods employed. Few focus groups and interviews; no mention of information saturation.

Table 4: Study characteristics of papers on malaria KAP that quantified VFR travelers but did not perform sub-group analyses

First author	Year	Study design	Setting	N VFR	N total	Key malaria outcomes
^van Genderen PJJ[67]	2014	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	46	373	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
Pistone T[87]	2010	Post-travel KAP questionnaire, retrospective cohort, QT	Health cohort	18 trips	3442 trips	Knowledge, mechanical protection measures used, Rx used
Lopez-Velez R[86]	2007	Pre-travel KAP questionnaire, cross-sectional, QT & QL	Airport	54	1206	Knowledge of transmission, symptoms, prevention, Rx brought
^Dahlgren AL[68]	2006	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	~33	369	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
Teodosio R[89]	2006	Pre-travel KAP questionnaire, cross-sectional separate sample pretest posttest, QT	Travel clinic	8 pre, 13 post	207 pre, 202 post	Knowledge of transmission, vector characteristics and bite times, prevention, Rx need, symptoms
Askling HH[90]	2005	Post-Dx KAP questionnaire, case series, QT	Reported cases	37	237	Trip traits, pre-travel care Rx use, Dx delay, preventive behaviors during trip
^Wilder-Smith A[69]	2004	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	~208	1041	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
^Hamer DH[71]	2004	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	~87	203	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
^Toovey Jamieson, A[70]	2004	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	~18	219	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
^Van Herck K[85]	2003	Pre-travel KAP questionnaire, cross-sectional, QT	Airport	~125	609	Risk perception, planned preventive behaviors, pre-travel care, Rx brought
Laver SM[91]	2001	Post-travel KAP questionnaire, cross-sectional, QT	Airport	120	595	Knowledge of prevention, preventive behaviors during trip, risk perception
Genton B[88]	1994	Pre-travel KAP questionnaire, cross-sectional, QT	Travel clinic	53	311	Knowledge of prevention, risk perception

^ Identical questionnaire instruments used

Discussion

Key takeaways from eligible literature

VFRs, even just those of African origin are a heterogenous group with respect to barriers to malaria prevention and travel experiences. VFRs are knowledgeable on basic malaria topics and aware of the risk during travel, but the depth of knowledge is limited; preventive action is not strongly correlated with either increased knowledge or perception of risk. This dissonance was observed both in VFR knowledge attitudes, and practices, and guidelines developed for providers to improve malaria prevention. Many guidelines promote malaria education to reduce risk of malaria in VFRs, but education alone will not reduce the disproportionate burden of malaria in VFRs.

VFRs travel for longer duration and to countries of higher risks than other types of travelers and are less likely to seek pre-travel care and use chemoprophylaxis. Adherence to chemoprophylactic regimens is a fundamental challenge to successful malaria prevention across all traveler populations, and especially VFRs. Most studies of VFR KAP address chemoprophylaxis use or adherence as a primary outcome. More robust research on other and supplemental prevention methods, paired with the identification and disentanglement of upstream barriers to malaria prevention is needed.

A broad swath of interconnected financial, structural, cultural, and behavioral barriers to pre-travel care, proper chemoprophylaxis use, and other types of prevention exist for VFR travelers. A few barriers emerged across the literature review as particularly impactful and resonant to the VFR experience. The cost of chemoprophylaxis and pre-travel care, a preference for care from PCPs despite perceptions of a lack of malaria knowledge among Western providers, the desire to follow local norms and minimize inconvenience to hosting friends and families, and personal and structural challenges to adhering to chemoprophylaxis regimens significantly impact VFRs' abilities to prevent malaria. The range of interconnected barriers and dissonance between perceptions and prevention suggest the need for the development of interventions that are intersectional and address issues at behavioral and structural levels.

Limitations of literature review

The search syntax constructed in Ovid to search the MEDLINE database addressed each of the four central criteria for article inclusion but failed to generate a small but relevant number of

known articles that fit eligibility criteria. This issue was ameliorated by the addition of full-text review of eleven additional potentially relevant articles referenced in a recent comprehensive publication,[56] yielding the classification of four as eligible for the literature review. These additional articles suggest that the search syntax may have been too narrow and other unidentified eligible articles may exist. The KAP MeSH term was used alone without any accompanying keywords. Article generation bias could exist towards studies that describe their research specifically around KAP (as opposed to more broadly as 'behavioral' or addressing 'barriers', for example). To reduce the chance of relevant articles were missed, citations in eligible review articles were cross-checked with the results of the literature review and resulted in no additional articles identified. Additionally, travel medicine leaders on the MPP team were consulted for their knowledge of the body of research on the topic and identified no missing publications.

Some eligible studies included VFR populations to malarious areas across the word and were not limited to travelers to the African continent.[11,44,60,62,72,74–77,80] Although each addressed African VFR travel in some respect, some analyses and conclusions from these papers and reviews were based on broad VFR traveler populations. The cross-ethnic generalizability of the VFR experience regarding KAP around malaria prevention is not well-researched or understood.[45] However, there is evidence that heterogeneity exists regarding behavioral and structural barriers even within the African VFR traveler population.[45,72,83]

Improving the research and reporting of VFR KAP

Although identified as perhaps the population of greatest concern for imported malaria, studies that quantify VFRs frequently fail to perform comparative or subgroup analyses on this population. Analyses specifically on VFRs, between VFRs and other types of travelers, or within groups of VFRs from different regions are lacking in scope and content while unsubstantiated hypotheses about VFRs have driven the narrative. As a result, gaps in the depth of understanding of VFR barriers to malaria prevention persist while imported cases continue to grow in this population. The application of comparative analyses and more robust sample sizes in quantitative surveys of traveler KAP are necessary to distinguish differences between types of travelers.

Qualitative and community-engaged research is relatively novel in its application to the travel medicine field,[52] but is especially effective at describing the broad range of VFR experiences and barriers to malaria prevention, even within a small and well-defined population. Future qualitative research must employ methodologically sound sampling procedures and increased sample sizes to

better reach information saturation and more accurately describe which themes were expressed most strongly. Community engagement in this work is necessary to develop ethical, culturally-appropriate and representative research studies.

A consistent definition on what kind of traveler is considered to be a VFR is necessary. Some studies in this review employed precise VFR definitions whereas others broadly sampled migrants from malaria endemic areas who may never actually travel. There is some continued disagreement in the travel medicine community about the precise definition of a VFR[13,14] Future research should clearly define its population and align it with well-recognized definitions.

Future research directions

Although many meaningful barriers have been identified across multiple studies on malaria KAP in VFRs, significant gaps in our understanding of the issue remain. Especially around non-chemoprophylactic preventive measures, consensus has not been generated around their use, acceptability, and accessibility among VFRs. Cultural barriers to malaria prevention including the desire to follow local norms are uniquely part of the VFR experience and must be explored in greater depth. Financial and structural barriers for VFRs have been clearly identified especially around pre-travel care and chemoprophylaxis, but the root source of these barriers, whether in policies, health system practices, or structural biases in not well-known. Each of these issues needs to be explored more at the VFR-community level to understand the spectrum of VFR experiences, rather than just those at a travel clinic, for example.

Comparative analyses measuring differences between VFRs and other types of travelers and within the heterogenous VFR traveler population must be expanded and should be integrated into standard reporting in the travel medicine field. Certain high-consequence barriers to effective malaria prevention, such as adequate chemoprophylaxis adherence, are experienced by travelers of all types at risk for malaria illness.[87] Perhaps interventions developed to improve VFR chemoprophylactic adherence will also be effective for other types of travelers and should be replicated more broadly, further reducing imported malaria illnesses. At the same time, significant differences within VFR population regarding malaria prevention exist. Representing 27% of all international travel in 2015,[15] travelers visiting friends and relatives are a broad, non-homogenous group. VFRs must be studied more granularly in their ethnic, socioeconomic, and locational subgroups to inform the development or application of culturally-relevant interventions that more precisely resonate with the population at risk. This must be done shoulder-to-shoulder

with engaged community partners that are already embedded in VFR communities and can anticipate, name, and mitigate dissonance between research groups and target populations.

Research that quantifies the relative or interactive effect of multiple barriers on malaria prevention is necessary to inform the development of more impactful interventions. Many barriers to malaria prevention have been identified at a range of behavioral and structural levels. Rather than simply addressing interventions that are the most straight-forward or affordable such as developing educational materials, a comparative analysis on the effect of a range of barriers and reduction strategies will yield interventions that are more impactful on malaria risk reduction.

As evidence-based interventions are developed to address well-known and emerging barriers to malaria prevention in VFRs, impact evaluations and temporal trends analyses are critical determine the effectiveness of these interventions. Some interventions have been piloted around this issue; one regarding chemoprophylaxis cost subsidy was performed and found a reduced number of imported malaria cases was associated with the subsidy, but the effect size was small, indicating cost may not be the only relevant barrier to reducing imported malaria.[46] Economic evaluations are also necessary to measure impact and provide financial justification for sustained intervention when approaches are found to be cost-effective.

Chapter 3: Methodology

This chapter describes the foundational methodology that was broadly developed and applied to examine the three research questions described in Chapters, 4, 5, and 6. Specific methodology applied to individual research questions is described in separate methods sections within each of these three chapters.

The following institutional review boards approved and monitored the survey components of the MPP study: Minnesota Department of Health (IRB#15-368), University of Minnesota (STUDY00001189), Hennepin Healthcare Research Institute, formerly Minneapolis Medical Research Foundation of Hennepin County Medical Center (HSR#17-4350), and HealthPartners Institute (IRB0#A14-011). MPP was funded by a cooperative agreement grant from the Centers for Disease Control and Prevention (CK000357-01) from fiscal year 2016 through 2019.

Through a multi-setting, multi-population design, this observational, cross-sectional study employs questionnaires to survey quantitative and qualitative KAP outcomes around malaria prevention in travelers to Sub-Saharan Africa and performs a comparative analysis of multiple groups of interest.

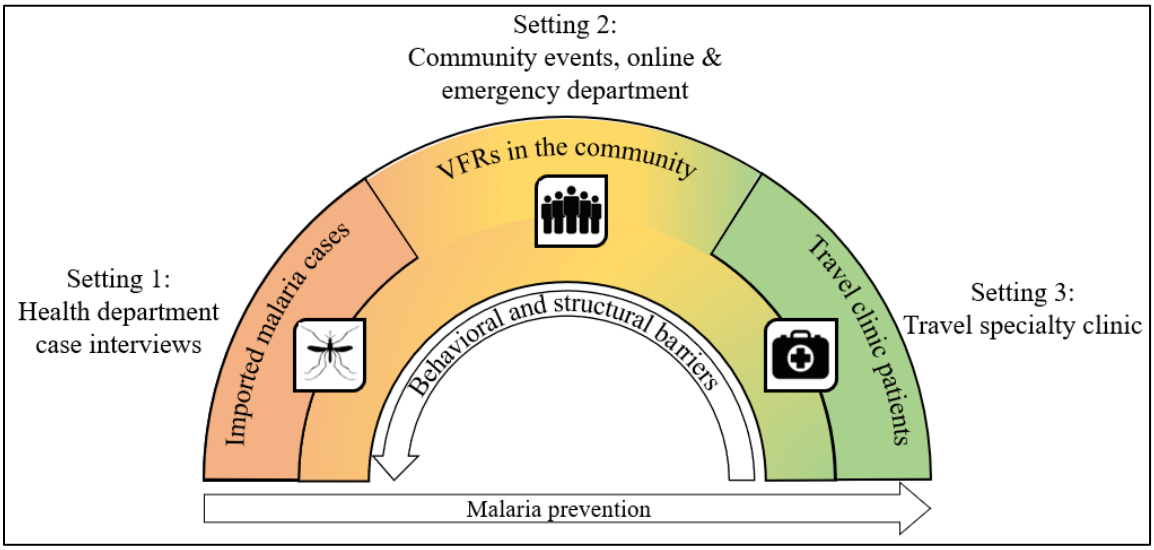
Study participants and survey settings

Questionnaires were developed for surveying populations in three settings (Figure 3): 1) Imported malaria cases reported to the state health department, 2) Travel clinic patients at a travel specialty clinic, and 3) VFRs in the community at community events, responding online, or presenting to an emergency department. Although each setting presents unique opportunities for data collection on barriers to malaria prevention, most questionnaire prompts were standardized or uniform across the three settings. This allows for the aggregation of survey data across settings and makes traveler subgroup comparisons more robust.

Broadly speaking, eligible participants include consenting, able-participating individuals in Minnesota who can communicate in English, Amharic, French, or Somali, and who have either returned from a trip to Sub-Saharan Africa in the last ten years or plan to travel to SSA in the next one year. Setting-specific eligibility criteria are described in further detail below. Questionnaires were conducted through telephone interviews, in-person interviews, online self-administered surveys, and paper self-administered surveys. Across each of these approaches, participants'

responses were self-generated for most prompts; participants were not provided with a selection of response options for most questions.

Figure 3: Study population and survey setting spectrum with hypothesized relational directionality of barriers and malaria prevention



Setting 1: Imported malaria cases – health department case interviews

In Minnesota, malaria is a reportable disease; when a health care provider or laboratory in Minnesota diagnoses a case of malaria, the illness and information about this patient must be reported to the Minnesota Department of Health (MDH) for epidemiologic surveillance purposes. Between 43 and 67 cases of malaria have been reported in Minnesota the three most recent reporting years, 2015-2017.[6,96,97] Rolling review for survey eligibility was performed on all cases of malaria reported to MDH for illnesses diagnosed from 2016 to 2018. Participants where eligibility was not certain (e.g. travel location) from available information were contacted to determine eligibility. Standing alone, this setting employs a case series study design with all eligible, consenting cases being surveyed. The case population is compared to populations surveyed in other settings through comparative analyses. A REDCap database was developed and hosted at MDH for collecting questionnaire responses.

Eligibility

All surviving, consenting, US-resident cases of non-relapsed malaria diagnosed from January 1, 2016 through December 31, 2018 in Minnesota and reported to MDH (St. Paul, MN) who

traveled for any reason to Sub-Saharan Africa were eligible for questionnaire participation. When the case patient was under 18 years of age, a parent or guardian proxy was eligible to respond on behalf of his or her child. Resettling immigrants or permanent residents of an African nation visiting Minnesota were ineligible.

Questionnaire process

Tennessen warnings were read to all participants and an informed consenting process was conducted by a trained surveyor. Interviewers conducted telephone surveys in English, Somali and French guided by translated surveys. Telephone interpreters (LanguageLine – Monterey, CA) were used and interpreted survey prompts in real-time when participants spoke other languages or proficient interviewers were unavailable. Interviewers attempted telephone contact up to six times. The questionnaire process took approximately 20 minutes to complete.

Questionnaire versions

Malaria cases diagnosed in 2016 were interviewed with a pilot version of the questionnaire. All completed interviews for cases diagnosed in calendar year 2016 through calendar year 2018 are included in analyses; data are aggregated between pilot and final versions of the questionnaire where question content and structure did not change. Refer to Appendices 3.1 and 3.2 for the 2016 pilot and final case interview survey versions.

Setting 2: VFRs in the community – community events, online, and an emergency department

The community survey was disseminated through multiple mechanisms in order to reach a broader range of VFR travelers across full the spectrum of malaria preventive behaviors (Figure 3), including those who may traditionally be missed through community-based sampling procedures alone. Patients seeking unplanned care at the Hennepin County Medical Center Emergency Department (HCMC ED) were invited to participate in the questionnaire as they waited to be seen. This setting was included for the community survey as it would reach a somewhat random sample potential participants, rather than just those who self-select to attend cultural community events. This setting may also reach travelers poorly connected to preventive health care services and pre-travel care. Due to the catchment demographics of the selected ED, this setting was also chosen to reach a broader ethnic range of African VFR travelers, especially those from and traveling to East Africa. Sampling procedures and subgroup sample size targets

directed that approximately equivalent numbers of West African travelers and Other Sub-Saharan African travelers be sampled. Therefore, nonrandom sampling by destination region was employed. A REDCap database was developed and hosted at Minnesota Department of Health for collecting emergency department questionnaire responses.

Public events, cultural community celebrations, and health fairs put on by and for immigrant African communities were identified by CAB members and through CBO partners. Events chosen for survey sampling were selected to reflect the underlying population of African immigrant groups in the Minneapolis-St. Paul area, i.e. cultural events for individuals of West and East African nationality or ethnicity. All events occurred within Minneapolis-St. Paul metropolitan area where the greatest numbers and proportions of African immigrants live as identified in earlier MPP research.[57] Study team members tabled at these events, invited attendees to participate in the questionnaire, and provided travel- and malaria-related health resources after survey completion. West African CAB members also disseminated paper surveys through their organizational and personal networks using a snowball method. Online survey participation was promoted through CAB and CBO partners. The community survey questionnaire was an abbreviated version of the ED survey to reduce time required to participate. Due to targeted sampling by travel region, respondents were nonrandom regarding this trait. A REDCap database was developed and hosted at the University of Minnesota for collecting community event and online questionnaire responses. Standing alone, these surveys in community settings employ a cross-sectional design of Sub-Saharan African VFR travelers.

Eligibility

US-resident first or second-generation immigrants from Sub-Saharan Africa, 18 years of age or older who had heard of malaria, who can communicate in English, Amharic, French, or Somali, who had traveled to SSA in the past ten years or plan to travel in the next one year, and who presented to the emergency department at HCMC (Minneapolis, MN) in stable status were eligible for participation in the ED questionnaire.

US-resident first or second-generation immigrants from Sub-Saharan Africa, 18 years of age or older who had heard of malaria, who can read and provide written responses in English, Amharic, French, or Somali, and who had traveled to SSA in the past ten years or plan to travel in the next one year were eligible for participation in the paper questionnaire.

US-resident first or second-generation immigrants from Sub-Saharan Africa, 18 years of age or older who had heard of malaria, who can read and provide written responses in English, and who had traveled to SSA in the past ten years or plan to travel in the next one year were eligible for participation in online questionnaire.

Questionnaire process

At HCMC, potential participants' charts were reviewed for demographic inclusion criteria. Potentially eligible participants were then approached by trained interviewers for final eligibility determination and were invited to participate in the questionnaire. A consent process was performed with willing participants. The questionnaire took approximately 15 minutes to complete. Participants received travel health and malaria-related informational materials upon questionnaire completion (Appendices 4.1 and 4.2).

At community events and through CAB members, paper surveys were provided to potential participants. Study team members or CAB representatives reviewed key inclusion criteria verbally and communicated the voluntary nature of the questionnaire with potential participants. Participants then reviewed the consent information and self-administered the paper survey, providing written responses. Participants were invited to keep a copy of the informational consent page. The questionnaire took fewer than 10 minutes to complete. All participants received a $5 gift card for their participation and at events also received travel health and malaria related informational materials upon questionnaire completion (Appendices 4.1 and 4.2).

Online, participants navigated through a required informed consent page and filled out questions related to inclusion criteria which prompted an early survey exit when participants were ineligible. The online questionnaire took fewer than 10 minutes to complete. Respondents were invited to provide their email address if they wished to be entered in a random drawing for one of ten $25 gift cards. Upon completion, participants were redirected to a PDF webpage on malaria and travel (Appendix 4.1)

Questionnaire versions

The ED survey was the long-form version of the master questionnaire. To account for an anticipated shorter desired participation length among event and online participants, the paper and online versions of the questionnaire were an abbreviated form of the ED questionnaire. Refer to Appendices 3.3 and 3.4 for the emergency department and community event/online surveys.

Setting 3: Travel clinic patients – travel specialty clinic

The HealthPartners Travel and Tropical Medicine Center (St. Paul, MN and Minneapolis, MN) sees a high volume of patients preparing for travel to malarious areas of the African continent. This survey setting was included to reach travelers to SSA who are traveling for any reason, to allow for comparisons between VFRs and other types of travelers. Community-based sampling of non-VFR travelers to SSA was not considered a viable study design due to exceedingly the small proportion of the MN population that travels to SSA. The first component of the travel clinic questionnaire was designed to be conducted prior to the travel clinic visit to collect baseline KAP in the study population.

The second component of the travel clinic questionnaire was designed to be conducted after the participant had returned home from their travel to collect information around actual preventive behaviors performed during travel. A REDCap database was developed and hosted at the HealthPartners Institute for collecting travel clinic questionnaire responses. Standing alone, this survey employs a cross-sectional design of travelers to SSA attending a MN travel clinic.

Eligibility

All US-resident patients with travel to Sub-Saharan Africa planned in the next one year, 18 years of age or older, who had heard of malaria, who can communicate in English, Amharic, French, or Somali, who have a pre-travel clinic visit scheduled at HealthPartners Travel and Tropical Medicine Center (St. Paul, MN and Minneapolis, MN) were eligible for participation in the travel clinic questionnaire.

Sampling procedures and subgroup sample size targets directed that approximately equivalent numbers of West African travelers and Other Sub-Saharan African travelers be sampled. Therefore, nonrandom sampling by destination region was employed in this setting in addition to the community setting.

Questionnaire process

Trained surveyors reviewed charts of patients with scheduled visits for pre-travel care for eligibility and called prospective participants by phone. Language proficient surveyors performed the survey in English or Somali; HealthPartners telephone interpreters assisted in the interpretation of the questionnaire for Amharic or French-speaking participants. A consent process was performed over the phone prior to beginning the questionnaire. The questionnaire

took approximately 15 minutes to complete. Participants were mailed a $10 gift card for their participation in the pre-travel version of the survey and received traveler health and malaria-related informational materials (Appendices 4.1 and 4.2).

Questionnaire versions

The survey designed for the pre-travel component in the travel clinic setting was the long-form version of the master questionnaire. The post-travel component was developed specifically for this setting and replicated questions in the pre-travel version to follow up on planned versus actualized preventive behaviors. Refer to Appendix 3.5 for the travel clinic survey.

Traveler populations

The three survey settings described above were designed to compile information about the knowledge, attitudes, and practices of travelers to Sub-Saharan Africa, and specifically VFR travelers, at a broad range of points across the preventive behavior spectrum (Figure 3). Embedded across this spectrum of prevention are distinct traveler populations who may face unique cultural, socioeconomic, and structural barriers to malaria prevention. In addition to reaching travelers across the risk spectrum through the three settings, these surveys sought to reach travelers across the spectrum of backgrounds to identify differences and commonalities in barriers to malaria prevention. This multi-population comparison will provide a more informed, nuanced, and precise description of the KAP of travelers at risk for malaria and should lead to better targeted interventions designed to improve malaria prevention. Combined, the spectrum of survey settings and variety of traveler backgrounds comprise a matrix of eight distinct subgroups of travelers (Figure 4).

<u>West African VFRs</u>

Travelers to West Africa consistently comprise the majority of imported malaria cases in Minnesota and across the US.[2,7,96,97] Although reporting is less robust on travel reason, VFR travel is also the most common reason for travel cited by US imported malaria cases among civilians.[2,7] The Minneapolis-St. Paul metropolitan area is home to a large West African immigrant population and anecdotally, the largest concentration of expatriate Liberians in the US.

West African VFRs are defined in this study through a combination of the CDC definition for VFRs[12] and the Global Burden of Disease (GBD) study definition for the Western Sub-Saharan Africa GBD region.[98] This region includes the following nations: Benin, Burkina Faso,

Cameroon, Cape Verde, Chad, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, and Togo.

Other Sub-Saharan African VFRs

Although the proportion of imported malaria cases in the US originating from travel outside of the West African region of Sub-Saharan Africa is fewer, case counts from this region are rising.[2,7] In Minnesota, VFR travel particularly to destinations in Eastern Africa is expected to rise in coming years due to the increasing size and affluence of East African immigrant populations in the area. Understanding this population's distinct knowledge, attitudes, and practices around malaria prevention during travel will be necessary to develop targeted interventions that work to reduce barriers for the increasingly large traveler population.

Other SSA VFRs are defined in this study through a combination of the CDC definition for VFRs[12] and the GBD study definition combining the Southern, Eastern, and Central Sub-Saharan Africa GBD regions,[98] excluding Lesotho due to malaria eradication.[1] This includes the following nations: Angola, Botswana, Burundi, Central African Republic, Comoros, Congo, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Kenya, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Other travelers

Multiple studies have observed that travelers of all types struggle to adhere to chemoprophylactic regimens during travel to malarious areas.[87] Findings from the literature review (Chapter 2) emphasize the need for more robust traveler group comparisons to identify shared barriers across traveler types and distinguish unique challenges for certain groups. A better understanding of the range of traveler experiences will inform the development and application of barrier reduction strategies to resonant populations.

In the present study, non-VFR travelers were eligible to participate in the health department case interview and travel specialty clinic settings. This 'Other traveler' group includes individuals who do not meet the CDC definition for a VFR traveler and travel for vacation, business, education or any other non-VFR purposes to the nations within the Western, Eastern, Central, and Southern GBD regions of Sub-Saharan Africa[98] listed above.

Questionnaire instrument development

Survey development and instrument design processes were informed by findings from earlier research components of the MPP study (see Chapter 1), peer-reviewed literature on the topic (see Chapter 2), contributions by subject-matter and survey design experts, and iterative review for population resonance by the Community Advisory Board. Earlier MPP study components included a multi-site focus group study of malaria knowledge attitudes and practices among West African VFR travelers, and a geospatial analysis and predictive model to identify key study population centers and groups at risk for imported malaria illness.

Questionnaires are a common tool in medicine to survey traveler populations in a variety of settings. Existing questionnaires addressing knowledge attitudes and practices around malaria in VFR travelers were identified in the literature[62,67–74,76,79–82,85–91] and were reviewed by the MPP study team for applicability to the present study. No single existing questionnaire was identified that addressed the breadth of barriers the MPP study team sought to explore based on the findings of preliminary activities. The multi-setting, multi-population nature of the MPP study design was also misaligned with existing instruments. The study team did seek to build upon existing findings in the literature and integrated similar questions addressing certain key barriers that would be comparable to existing findings.

Instrument piloting and validation

A master questionnaire was developed that would include questions uniformly replicable across the multiple survey settings to allow for cross-population comparison. Drafts of the master questionnaire was shared with the Community Advisory Board and reviewed for question resonance, intent interpretation, and plain language for the target VFR community. CAB members provided edits, clarifications, and suggestions intended to reduce the risk of misinterpretation or confusion by survey participants. CAB members determined that the length of the master questionnaire was too long to be appropriate in some of the survey settings and that some questions needed to be eliminated prior to dissemination.

The 2016 case interview survey served as a pilot and final refining tool for the master questionnaire. Malaria cases diagnosed in 2016 that completed the telephone survey provided informal but formative feedback on survey length and question understanding. Changes incorporated into the final master questionnaire from this pilot phase include additional question elimination and minor changes in phrasing and response structure.

Instrument length reduction

A two-round, modified Delphi method was employed to reduce the length of the master questionnaire to only the most essential questions in survey settings where participants would have less time or willingness to complete the full-length survey. MPP team members including clinical experts, epidemiologists, and community engagement coordinators first provided structured feedback on which questions were most essential. Individual reviews were aggregated and shared in separate meetings with the MPP team and CAB members. At each of these meetings, feedback was solicited on question elimination. A final individual review by both MPP team members and CAB members was conducted and findings were summarized. Consensus on question elimination was reached at a final joint review meeting and the reduced master survey was determined to be an appropriate length by the CAB.

Instrument translation and interpretation

In order to reduce participant pool bias and increase population generalizability, community and travel clinic surveys were translated into languages commonly spoken within the target study population of individuals who travel to malaria-endemic parts of Africa to visit friends and relatives. Surveys, consenting documents, and post-survey informational handouts were translated from English to French, Amharic, and Somali. Global Translator and Interpreter (Minneapolis, MN) translated, back translated, and certified all translations.

Surveys for phone interviews with diagnosed malaria cases were not translated; telephone interpreters from LanguageLine (Monterey, CA) assisted in live, bi-directional interpretation for case interviews when the participant was limited-English proficient. In the travel clinic and emergency department settings, language proficient surveyors (Somali and French) used translated study documents to conduct surveys in-person or over the phone directly in the patient's preferred language and later translated the responses back to English. In-house interpreters in the travel clinic and emergency department, guided by translated documents, assisted in in-person and telephone interview interpretation when a language proficient surveyor was unavailable. In the community setting, paper surveys translated into Amharic, French and Somali and were available for participants to self-administer the survey. The online community survey was only available in English.

Key variables

Knowledge, attitudes, and practices around malaria prevention in travelers comprise a complex web of possible measurements, especially when considering both personal and structural barriers. Identifying key outcomes was an iterative process, based in available research, preliminary research by the study team, and input from the Community Advisory Board.

Key knowledge outcomes included knowledge of malaria transmission and prevention. Attitude outcomes included level of concern about malaria for self and others, malaria severity and risk perception, and health care seeking attitudes when ill with malaria. Practice outcomes included use of chemoprophylaxis, use of other mechanical prevention methods, preventive behaviors, pre-travel care, and future planned preventive measures. Trip and experiential characteristics were also included and address destination, frequency of travel, length of stay, travel with children, and past experiences with malaria.

A demographic section was developed to better understand the study population and to allow for the adjustment of demographic sources of confounding. After recommendation from the CAB with null response impact described the methodologic literature,[99] the demographic section was positioned as the final section of each questionnaire to allow for the interviewer to develop rapport with the participant and to make demographic prompts feel less invasive. Key demographic outcomes included, age, gender, place of birth, parents' places of birth, length of residence in the US, education level, and ethnicity.

Although the CAB reported that malaria is not a stigmatizing subject for most VFR travelers, the study was designed and conducted in years immediately following the West African Ebola epidemic. Special attention was given to designing a questionnaire with non-stigmatizing prompts and engaging the community of focus in shoulder-to-shoulder partnership at every stage of survey development, vetting, dissemination, and analysis. Refer to Appendix 3 for copies of all survey instruments, including all variable prompts and prompt structure.

Database development, privacy, data monitoring, and quality assurance

REDCap databases were developed and hosted at appropriate sites per IRB stipulations and requirements. Branching logic code was written to reduce error or illogical response combinations. Databases and instruments were tested thoroughly prior to data entry or collection began. Questionnaires were constructed to contain only non-protected health information (non-

PHI) prompts and variables. Some sites added personally identifiable variables to their individual REDCap databases for internal monitoring. All data, including free-response prompts, were reviewed for PHI and completely de-identified prior to integration into a final dataset that combined data from all three settings. A single MPP team member monitored data collection at each of the three sites throughout the survey period and conducted initial and iterative training sessions with interviewers and CAB members when needed. A concern from a single participant in the ED setting was voiced and was addressed through minor protocol changes to improve communication about the nature of the questionnaire. Data entry was audited for accuracy where paper questionnaires were used. Interim analyses were performed on an ongoing basis to detect any unexpected trends, entry errors, or problems in the data.

Study sample size

Due to the broad range of outcomes of interest, limited population of eligible respondents in some settings, multiple study population subgroups and possible levels of analysis, and lack of referential data in the literature, a formal sample size calculation was not possible for each of the survey settings. Rather, three key factors contributed to the development of target sample sizes for each survey settings and eight subgroups: available resources, main aim of the survey, and the level of statistical strength needed.[100] The MPP study team determined the main aim of the survey was to broadly understand African VFR malaria KAP and that subgroup analyses would be preferred whenever possible. The mechanism funding the survey component of the MPP project also supports a range of other methodologies and activities; funding constraints did limit sample size and interviewer availability in some settings. Figure 4 depicts a matrix of the three survey settings and three sub-populations yielding eight sub-groups and presents the sample size achieved for each sub-group.

Sample size in the malaria case setting was limited to the number of reported cases of imported malaria originating from travel to Sub-Saharan Africa, and the ability to reach potential respondents through reported phone numbers. The target sample size for the case setting was to interview 75% of eligible malaria cases where a working phone number was available. Target sample size was reached in the case setting, although due to reported total cases, it still produced the smallest subgroup counts between the three settings.

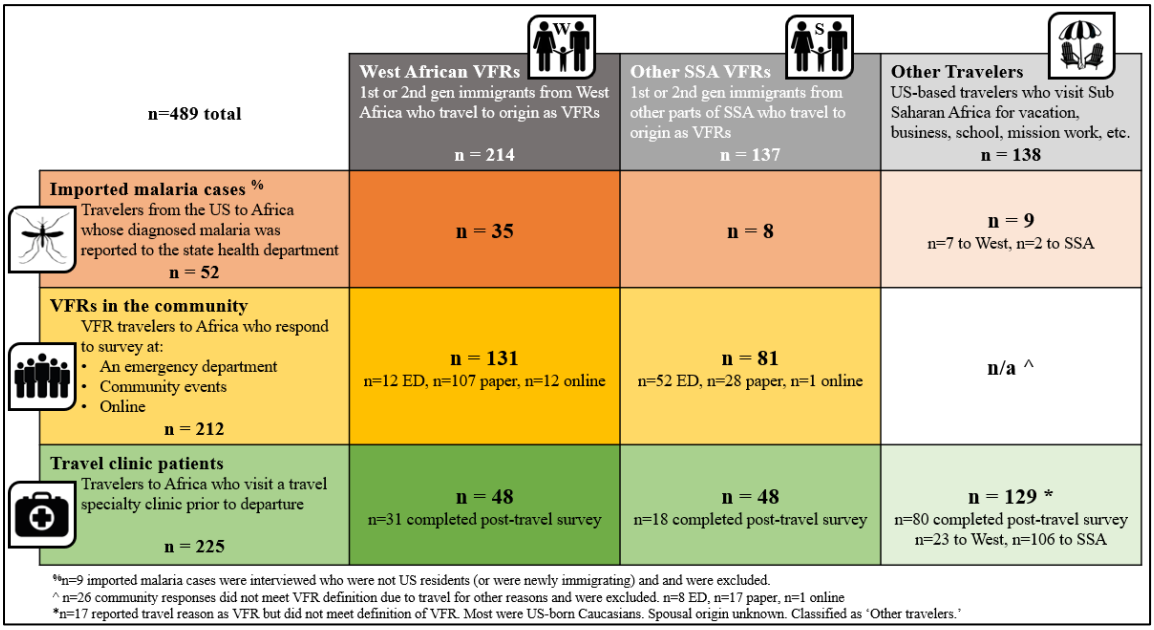
A three-pronged approach (ED, events, online) was used to solicit questionnaire responses in the community setting to reach a broader and larger VFR traveler population. Target sample size was

determined to be more than 100 West African VFRs and more than 100 Other SSA VFRs between the three prongs. Target sample size was achieved in West African VFRs and Other SSA VFRs had slightly fewer than targeted. Sampling in the ED and at community events each yielded many more responses than the online survey.

A target of more than 100 responses was established for each of the three subgroups in the travel clinic setting, West African VFRs, Other SSA VFRs, and Non-VFRs. Goal sample size was achieved in the Non-VFR group; MPP study schedule and financial restrictions prompted the conclusion of surveying prior to reaching target sample sizes for the West African and Other SSA VFR traveler groups.

Recognizing the small n of some subgroups and that target sample sizes were not reached in others, there may be decreased power and an increased risk of type II error in some subgroup analyses, which will be referenced as a limitation in when reporting results. When subgroup analyses are greatly underpowered, traveler groups are be condensed to broader categories (e.g. VFRs versus non-VFRs). It was also anticipated that statistical significance may be achieved to reject the null at the broader omnibus Chi square analysis level but not in subsequent pairwise subgroup comparisons;[101] this limitation will be noted if it occurs.

Figure 4: Setting / sub-group matrix and final sample sizes



Quantitative analysis methods, statistics and data visualization

Three specific research questions are explored in Chapters 4, 5, and 6. Each of these questions informed the survey development and study design and sampling procedures described above. Analyses are described again in methods sections of subsequent chapters as they relate to specific research questions.

Cross-sectional and case series designs from the three survey settings are integrated into a comparative analysis across levels of risk and across traveler groups. Statistical analyses were performed to compare sample means ($\bar{x}$), medians ($\tilde{x}$) and proportions (%) of relevant outcomes and characteristics between traveler setting and traveler population subgroups and are presented in tables. Figures with error bars present the 95% confidence interval around the sample statistic. Comparative analyses with resulting p values are specified in tables and include Wald's Chi square statistic (χ^2) and corresponding odds ratios (OR) for parametric comparisons, and the Mann-Whitney U statistic for non-parametric comparisons. Statistical analyses were performed in SAS version 9.4 (SAS Institute, Cary, NC).

Assumptions of linearity and goodness of fit: transformation and use of nonparametric tests

Where parametric tests are performed (e.g. Wald χ^2), normality of distributions is assumed due to robust overall and subgroup sample sizes. Logistic regression analyses also assume linearity on the log scale between predictors and outcomes. Where goodness of fit statistics identified poorly fitting continuous predictors (e.g. duration of travel), predictors were transformed to improve normality and fit. Transformations are described where performed.

Alternatively, nonparametric tests including the Mann-Whitney test were used in place of logistic regression when dependent variables where non-normal and non-continuous, such as in the case of number of trips taken and Likert scale-based variables.

Alpha

The larger a sample size, the more sensitive a statistical test becomes, i.e. large sample sizes decrease the likelihood of false negatives and increase power, or the likelihood of rejecting the null hypothesis when it is truly false. Lower sensitivity is anticipated in some analyses due to small sample size; false negatives, or type II errors may occur. However, increased sample size does not affect the likelihood of false positives, or type I errors. This instead is determined by alpha (α); alpha was set at α=0.05 for all analyses. Alpha was not adjusted downwards to be more

conservative when multiple comparisons were performed. This was due to the increasing likelihood of making a type II error that occurs as alpha is reduced, recognizing the already low power for some sub-group comparisons. Multiple comparison explorations will be designed parsimoniously and outcomes with the lowest p values will be prioritized. Effect size will also be used to make conclusions about relative importance of statistically significant outcomes.

Data visualization and maps

Data are visualized in Excel version 2016 (Microsoft, Redmond, WA). Maps were designed in ArcGIS Online (Esri, Redlands, CA). A tile layer of malaria rates in 2015 among children aged 2 to 10 years old in Sub-Saharan Africa developed by The Malaria Atlas Project (University of Oxford, Oxford, UK) was overlaid with study data to provide proxy context for malaria risk. Destinations were reported by participants at the country level and do not reflect specific location, duration, or local environmental conditions; individual malaria risk during travel cannot be estimated using Malaria Atlas Project geospatial data.

Qualitative methodology and coding

Many prompts around health system barriers to malaria prevention were structured with qualitative, free response opportunities for participants to share more nuanced and detailed responses. Based on reports in the literature and the results of the qualitative analysis of initial focus groups, a deductive coding methodology with a preestablished codebook was developed to facilitate data collections across the range of study settings. Question structure across all settings allowed participants to respond freely and unprompted, but immediate response coding structure varied by setting (See Appendix 3). Surveyor-conducted settings allowed for the selection from preestablished codes or 'other' survey response fields, whereas self-administered settings provided respondents with only free text response fields. Additional detail and opportunities for 'other' responses were provided for qualitative prompts in all settings.

Due to the quantity and brevity of responses, a formal qualitative software program was not necessary to organize codes, categories, or themes. Instead, line-by-line coding was applied to all narrative responses in Excel 2016 (Microsoft, Redmond, WA) using hand-coding techniques after data collection. Novel codes not included as a part of the deductive methodology were developed when responses captured new perspectives. Code categories were created to organize codes with shared characteristics. Finally, themes were developed that captured codes and categories, supported by the frequency by which responses fell into these themes.

Select free response quotes that reflected key themes and provided more robust detail are included below alongside results. Quotes are *italicized* and indented from each lateral margin to distinguish from sub-headings. Quotes were reviewed a second time for PHI or any characteristics that may be identifying or invasive. Quotes are published in their original form except where very minor grammatical edits improved clarity.

Methodologic limitations, bias, and mitigation

Study population

Due to the size and variety of immigrant populations living in Minnesota and the language eligibility requirements, African VFR travelers from certain areas of Africa may be underrepresented. The survey has strong representation from VFRs hailing from Liberia, Togo, Somalia, and Ethiopia. Participants traveling to Nigeria and Ghana, the countries with the two highest numbers of imported malaria cases to the US in 2015,[2] may be slightly underrepresented and may limit the generalizability of the reported barriers to the broader US population of VFRs.

According to the eligibility criteria in the community, respondents who are like VFRs in their cultural and behavioral characteristics, but who travel exclusively for other reasons, such as for business were surveyed. A question on purpose for travel was included to quantify the proportion of community respondents traveling for non-VFR reasons. A small proportion of community respondents reported non-VFR travel and were excluded from analyses.

Conversely, some travelers reported traveling to visit friends or relatives but did not fulfill the full CDC definition for a VFR traveler. In the community setting, these respondents were excluded from analysis. In case and travel clinic settings, these travelers were classified as 'Other Travelers.'

Study setting

Although identified as a key gap in the literature, it is not possible in this study to calculate relative proportions for the reasons for travel in the underlying MN or US traveler population to areas with endemic malaria. Ecological estimations exist at the global scale,[15] but more specific estimations are lacking. Airport surveys are the field-standard for capturing the underlying traveler population to malaria-endemic areas, and theoretically allow for cross-sectional, prospective cohort, or even experimental study designs. Airport surveys also provide a more representative sample of travelers and allow for VFR comparisons to other traveler groups.

However, airport surveys were beyond the scope of the MPP project and ill-fitting to the study site because MSP is not a central hub for direct travel to the African continent. Other settings, such as cases of malaria reported to the state health department provide more robust description of the factors contributing to the contraction of a rare disease.

Questionnaire content

Due to survey length limitations, some barriers to malaria prevention may be missed or nuances in these barriers may be poorly quantified. Relying on a combination of preliminary data, community partnerships, and published literature, the study team hypothesized which barriers, once better quantified, could lead to actionable interventions that may reduce imported malaria. The team employed the Delphi method to reduce the survey length and detail of certain prompts to remove unnecessary or poorly quantifiable variables. Barriers newly uncovered in preliminary analyses were given special attention in the questionnaires for qualitative support for quantitative findings.

Many cost barriers to pre-travel care and chemoprophylaxis use are identified in the literature and preliminary research by the MPP team. Insurance status is one component affecting the cost of health care and prescriptions. This variable was removed from the demographic section of the questionnaire during the Delphi method. Comparisons quantifying the relative impact of insurance status on cost barriers for VFRs and other travelers will not be possible. Other structural and systems-level barriers were maintained and are described in Chapter 5.

Sample size

Survey sample size is discussed in greater detail above but is important to note as a limitation of the methodology. Challenges were observed in the sampling for participants that limited final sample size despite interviewers approaching many potential participants. For example, at the HCMC ED, only 42% of eligible participants completed a survey due to refusal, lack of interpreter availability, or because health care providers were treating potential participants. The broader malaria study includes a variety of methodologies and the integration of results from these other activities may help generate stronger conclusions about barriers.

Sources of bias

Factors confounding the relationship between predictor and key outcomes such as travel clinic visits or chemoprophylaxis use were hypothesized by the study team through analysis of

preliminary data, expert opinion, and reviewing the literature. Many of these factors were included as variables in the master questionnaire to allow for the testing and adjustment of such factors and the reduction of bias in the interpretation of the data. Unknown unmeasured confounding factors max still exist for which the study cannot adjust. Due to the need for a survey of limited length to ensure the recruitment of subjects and survey completion, not every hypothesized confounding factor was included as a prompt in the surveys, especially those in settings where participants had limited time to participate.

Another key source of bias in the study design is recall bias. Due to the broad travel history inclusion criterion, participants may be recalling travel from long ago and may not clearly remember their experiences. This recall bias is hypothesized to be directional towards increased preventive behaviors because in most cases, participants did not report becoming ill with malaria. To mitigate this bias, the survey included prompts that guided respondents through a series of prompts to help recall specific characteristics of their travel.

Right answer bias may have caused respondents to over-report their preventive behaviors for social desirability with survey conductors. Trained survey conductors used techniques to establish rapport with respondents, received cultural guidance from the CAB, and survey conductors proficient in French, Somali or Amharic were employed at some sites. This bias is expected to be less among respondents who self-administered the survey online or on paper.

Additional bias reduction approaches employed in the study design include standardizing the three surveys, using multiple approaches to soliciting survey responses in the community for improved generalizability, partnering with the CAB and CBOs to construct prompts to ensure questions are understood and interpreted accurately by respondents, and the translation of study materials into multiple relevant languages.

Chapter 4: Behavioral barriers to malaria prevention among VFRs

Chapter abstract

Behavioral barriers to malaria prevention have been studied in VFR traveler populations but few employ robust quantitative epidemiologic study design and others fail to report VFR subgroup analyses, despite citing this group as a population of concern. This chapter seeks to quantify behavioral barriers to malaria prevention among VFRs by describing their knowledge, attitudes, and practices. Findings from a survey of VFRs traveling to Sub-Saharan Africa are reported.

Participants meeting the CDC definition of a VFR traveler were surveyed through a cross-sectional study design in three distinct settings: a state health department as reported malaria cases, in the community (through events, online or at an emergency department), and at a travel clinic prior to their visit.

Three hundred fifty-one VFRs participated. Malaria case VFRs report having taken more trips than community and travel clinic (non-case) VFRs. Malaria cases were also significantly less concerned about malaria prior to their travel and had lower impressions of malaria as a deadly disease than non-case VFRs. Taking an antimalarial or using a repellent was associated with higher concern for malaria during travel. When comparing reported and planned prevention approaches between VFRs who have recently traveled and those who plan to travel in the next year, discrepancies exist in actualizing malaria prevention. Although 95.2% of VFRs who hadn't yet traveled report planning to take an antimalarial, just 59.4% of recent travelers reported using malaria chemoprophylaxis. This discrepancy was observed across every prevention method surveyed. Among all non-case VFRs with past travel, 11.1% self-reported becoming ill with malaria during or after a trip.

Findings from this study align closely with the qualitative results of focus groups conducted earlier by the study team. When examining the discrepancies between planned and actualized prevention measures, it is evident that interventions designed to improve malaria prevention in VFRs must address barrier reduction strategies rather than simply educating VFRs to use preventive measures. A conceptual framework is proposed to explain the decrease in malaria prevention observed among frequent travelers. These findings shed light on the characteristics that distinguish case VFRs from those who experience successful malaria prevention, differences in VFRs in different regions, and highlight the extent to which barriers prevent VFRs from actualizing intended preventive measures.

Introduction

A broad range of medical and epidemiologic research has been conducted to understand VFR travel and root causes of the disproportionate burden of travel-associated malaria in this population. Despite a robust body of research by quantity addressing malaria in VFRs, few interventions to reduce this disparity have been identified and imported malaria cases continue to increase in high-income countries.[2,61] This increase appears to be driven by increasing gross number and market share of VFR travel[15,16] alongside only mild improvements in preventive behaviors over time.[62] Behavioral characteristics of malaria prevention among VFRs, including knowledge, attitudes and practices, are frequently cited, but some of the most widely-cited statements are hypotheses unsubstantiated with data,[11] or rely on problematic methodologies.[63]

This chapter seeks to quantify behavioral barriers to malaria prevention among Sub-Saharan African VFRs by describing their knowledge, attitudes and practices around malaria and travel. Through quantifying key differences between VFR subgroups, this chapter presents the first known quantitative research on VFRs' behaviors around malaria prevention distinguished across regional traveler populations and across the spectrum of preventive behavior.

State of the literature on behavioral barriers to malaria prevention

Studies on malaria prevention in travelers broadly often fail to report VFR comparative analyses, those analyses distinguishing VFRs from other types of travelers, despite frequently citing VFRs as a population of concern in their introductions and conclusions.[67–71,85–91] A transition in the travel medicine field towards more population-specific work is necessary to better identify barriers to malaria prevention in populations disproportionately burdened by the illness.

In addition to a lack of quantitative data on VFRs from large studies of travelers, definitions of VFR study populations vary widely across qualitative and quantitative studies and is cited as a key limitation of research on VFRs.[19] Some studies limit participation to only those who had or intended to travel as a VFR, whereas others included expatriate participants born in malarious regions of Africa even if they had no plans of travel back to their home country, or even if they traveled for other reasons such as business. This, combined with disagreements on the proper definition of a VFR in the broader travel medicine community[13,14] create the conditions for an ambiguous study population and subsequently the potential for misaligned interventions.

Cross-sectional questionnaires are the most common method of quantifying African VFR knowledge, attitudes and practices in the limited number of studies focusing on VFRs. Most are conducted prior to travel, and a small number are performed after travel or both before and after. While airport settings create the opportunity for a more representative sample of travelers to specific malarious destinations, other settings, including travel agencies, travel clinics, and migrant clinics likely have a more biased sample of respondents and may not reflect the full scope of the underlying VFR traveler community. Few quantitative studies were identified that take place within the general VFR community;[79,81] a transition to the use of more well-developed community-based research methods will be necessary to more deeply understand the within-population nuances of barriers to malaria prevention.

Qualitative methodologies are relatively uncommon in the travel medicine field despite their effectiveness in understanding the nuance of the VFR experience. Most qualitative studies identified around malaria prevention in VFRs prior to the Malaria Prevention Project (MPP) included small sample sizes and did not report information saturation,[63,78,83] or used problematic methodologies of questionable ethical support.[63]

Malaria knowledge and risk perception among VFRs

VFRs are generally knowledgeable that mosquitoes are the source of malaria and that steps can be taken to prevent illness.[76,78,79,82] Similar to other traveler groups, however, the depth of VFR malaria knowledge is limited. For example, most VFRs are unfamiliar with mosquito biting times,[79] and there is some confusion on the existence of a malaria vaccine.[82,83] Multiple studies found no association between malaria knowledge and use of pre-travel health care, chemoprophylaxis, or malaria prevention broadly,[62,81] suggesting that educational campaigns alone may be ineffective at improving preventive behaviors.

Although most VFRs recognize there is risk of acquiring malaria during travel, many are unconcerned about contracting malaria, view it as an inevitable part of travel, or perceive it as an easily treatable illness.[63,76,78,83] A considerable group within the VFR community feels that malaria is easier to treat than it is to prevent.[78,83] In an airport study, the more respondents felt that malaria was easier to treat than prevent, the less likely they were to have purchased or started chemoprophylaxis, or to have sought pre-travel care.[73] However, another airport study found increased knowledge of the risks of malaria among VFRs did not predict chemoprophylaxis use,[72]

suggesting that risk communication-based interventions alone may not reduce malaria or eliminate barriers.

Chemoprophylaxis use among VFRs

As the gold standard for prevention, chemoprophylaxis use and adherence is often reported in when examining malaria prevention in travelers, however, chemoprophylaxis use alone does not guarantee full protection from malaria illness in travelers.[2,90] Studies quantifying the proportion of VFR travelers using chemoprophylaxis range widely from to 14 to 60%.[73,76] The need to begin chemoprophylactic regimens prior to commencing travel and after returning from travel appears to be not well known among VFRs.[79]

Adherence to chemoprophylaxis has been reported as challenge for VFRs due to poor understanding of regimens, side effects, and justification for completing the full prescription.[83] Poor adherence has been observed in the variety of traveler populations;[87] a study comparing chemoprophylaxis adherence between tourists and VFRs, there was no statistically significant difference adherence observed.[77] A French study comparing VFRs at travel clinics and at travel agencies found better chemoprophylaxis adherence among those who had visited a travel clinic, but that still only 41% of travel clinic participants completed their medicine correctly.[82]

Other malaria prevention approaches among VFRs

Chemoprophylaxis use and adherence alone misses the multiple upstream and intersecting barriers to chemoprophylaxis acquisition and proper use VFRs face. Other malaria prevention approaches used by VFRs are less frequently and less comprehensively described in the literature. VFRs generally recognize bite prevention measures as prudent and intend to use repellents, but also express that mosquito bites are inevitable and that limiting socializing outside in the evenings was not an option.[56] Bed nets are generally an unacceptable form of bite prevention for VFRs due to the added heat and discomfort of sleeping under a net, inconvenience of hanging nets, sense of otherness if hosts do not use them as well, and perception that more modern prevention methods exist.[78,83] Spraying bedrooms with repellent was a more acceptable prevention method among VFRs with many host families partaking in this method prior to bedtime.[78]

Although knowledge of preventive practices beyond chemoprophylaxis is strong among VFRs, barriers to their realization are hypothesized to exist. The use of non-chemoprophylactic preventive measures, especially those that are unobtrusive to host family and friends, should be

studied in further detail for a more comprehensive understanding of opportunities to improve malaria prevention in VFRs.

Preceding qualitative findings by the study team

The MPP study team, led by Walz, conducted focus groups in Minnesota and New York to better understand malaria knowledge, attitudes and practices of West African VFRs and generate hypotheses about behavioral barriers to malaria prevention.[56] The focus groups were designed using robust qualitative methodology that sought to continue holding focus groups until information saturation was met on the topic, i.e. no new themes were being brought up by participants in subsequent focus group sessions.[56] Barriers to malaria prevention that were not previously identified in the literature or nuance around known barriers were expressed by participants.[56] The cost of chemoprophylaxis, cultural challenges, and difficulty navigating pre-travel care were identified as key barriers. Findings from this qualitative study informed the development and the design of the survey instrument used to quantify barriers to malaria prevention in this chapter. Building upon the qualitative findings, this chapter seeks to at quantitative support and distinguish key behavioral barriers to malaria prevention among Sub-Saharan African VFRs.

Methods

Study design

The survey used for this chapter was developed and tested through previous activities in the Malaria Prevention Project (MPP). Refer to Chapter 3 for detail on survey design, sampling methodology, and study design broadly.

Questionnaires were developed for surveying populations in three settings: 1) Imported malaria cases reported to the state health department, 2) VFRs in the community at community events, responding online, or presenting to an emergency department, and 3) Travel clinic patients at a travel specialty clinic. Although each setting presents unique opportunities for data collection on barriers to malaria prevention, most questionnaire prompts were standardized or uniform across these three settings, allowing for the aggregation of survey data across settings and making traveler subgroup comparisons more robust.

Prompt construction & instrument validation

No identified existing survey of VFR KAP was identified to quantify some hypotheses generated by the preceding focus groups and review of the literature. To evaluate key behavioral outcomes around malaria prevention, quantitative prompts were constructed around malaria knowledge, attitudes, and practices, in addition to demographic characteristics. Prompts were constructed to be categorical when classifying VFRs into specific groups; a range of categorical, dichotomous, and continuous response fields to prompts were developed around malaria prevention and behavior. Open ended qualitative responses were included to supplement quantitative findings and are summarized in later chapters.

A master questionnaire was developed that would include questions uniformly replicable across the multiple survey settings to allow for cross-population comparison. Drafts of the master questionnaire was shared with a Community Advisory Board and reviewed for question resonance, intent interpretation, and plain language for the target VFR community. CAB members provided edits, clarifications, and suggestions intended to reduce the risk of misinterpretation or confusion by survey participants.

The 2016 case interview survey served as a pilot and final refining tool for the master questionnaire. Malaria cases diagnosed in 2016 that completed the telephone survey provided informal but formative feedback on survey length and question understanding. Changes incorporated into the final master questionnaire from this pilot phase include question addition, elimination, and minor changes in phrasing and response structure.

Survey process

Eligible participants at one of the three survey settings were invited to participate in the voluntary survey. Surveys conducted with malaria cases, in the emergency department, and at the travel clinic were administered by trained surveyors. Surveys conducted at community events and online were self-administered. Surveys were administered in English, French, Amharic, and Somali either directly by language-proficient surveyors guided by translated surveys, or through the assistance of an interpreter. Elimination of qualitative pre-coding for open ended prompts and other modifications were made to the self-administered survey to ensure participants were providing unprompted responses.

Definitions and eligibility

Eligible VFRs are defined by this study as 1) meeting the CDC definition for a VFR traveler, 2) except where the CDC definition includes majority population spouses (spousal place of birth was not collected in the surveys) and 3) reporting country of destination in a Sub-Saharan African country with ongoing malaria transmission as reported by the CDC 2018 Yellow Book.[1] Additional eligibility requirements specific to each survey setting can be found in Appendix 3. The CDC definition for a VFR traveler is as follows:

> A traveler categorized as a VFR is an immigrant, ethnically and racially distinct from the majority population of the country of residence (a higher-income country), who returns to his or her home country (lower-income country) to visit friends or relatives. Included in the VFR category are family members, such as the spouse or children, who were born in the country of residence.[12]

Regional distinctions are made in subgroup analyses for VFRs traveling to two regions: West Africa and other parts of Sub-Saharan Africa. West African VFRs are defined as VFRs traveling to countries within the Global Burden of Disease West Africa region:[98] This includes the following nations: Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, and Togo.

VFR travelers to other parts of Sub-Saharan Africa, referred to as 'Other SSA VFRs', are defined as VFRs traveling to countries within the Southern, Eastern, and Central Sub-Saharan Africa GBD regions,[98] excluding Lesotho due to malaria eradication.[1] This includes the following nations: Angola, Botswana, Burundi, Central African Republic, Comoros, Congo, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Kenya, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Subgroup analyses by survey setting compare characteristics and outcomes for the three surveyed settings, malaria case VFRs, VFRs surveyed in the community, and VFRs surveyed at a travel clinic. In some analyses, setting 2 (community) and 3 (travel clinic) are combined to allow for comparison between malaria cases and the combined group, termed 'non-cases.' The study does not employ case-control sampling methodology; comparisons of cases and non-cases should not be interpreted as such.

Dataset integration and exclusions

A database was developed merging survey responses from each of the three survey settings, malaria cases, community surveys, and travel clinic surveys. Data were merged where survey prompts were identical or largely identical and would solicit the same response from participants. Some VFRs reported destinations in both West and Other Sub-Saharan Africa; these participants were coded as VFR travelers to their region of origin. Pediatric cases were eligible for analyses but were excluded from estimates of mean age due to eligibility criteria in community and travel clinic settings limiting respondents to those 18 years of age and older.

Key outcomes

Prompts were developed to address VFRs' knowledge, attitudes, and practices (collectively, behavioral characteristics), around malaria prevention and travel. Differences in behavioral characteristics were explored across survey setting and traveler population. Stratified findings distinguishing traveler populations – West African and Other SSA VFRs – are presented to better understand observed differences in VFR knowledge, attitudes, and practices by travel region.

Malaria knowledge prompts focused on respondents' knowledge of malaria transmission mechanisms and prevention methods. Participants were prompted to agree or disagree whether malaria is preventable and to list specific ways malaria is contracted, or specific ways to prevent malaria illness during travel. The group of respondents providing any incorrect method of malaria prevention were identified and classified as a group listing an incorrect method of preventing malaria. Classification was also made separately for respondents reporting an incorrect method of contracting malaria.

Prompts addressing attitudes around malaria were developed and employed a 5-point Likert scale to gauge level of agreement by respondents. Likert scale prompts were presented with a five-point scale ranging from 1=not true / disagree to 5=very true / strongly agree. VFR attitudes are explored, including around the deadliness of malaria illness and personal concern for malaria.

Malaria prevention practices were explored by asking respondents whether they used or plan to use a broad range of malaria prevention methods, including taking antimalarial chemoprophylaxis, sleeping under bed nets, educating oneself on malaria before travel, picking where to stay to avoid mosquitoes, using repellent, staying indoors when mosquitoes are out,

wearing long clothing, and using mosquito coils. Additional practices not linked to direct mosquito bite and illness prevention, such as seeking pre-travel care, are also explored.

Differentials between planned and actualized malaria prevention

Respondents were classified into two groups to differentiate whether they had traveled as a VFR in the past, or if they were taking their first trip. For respondents who had traveled as a VFR in the past, prompts about malaria prevention were phrased to examine whether the respondent used a given malaria prevention method (e.g. antimalarial use) on their last trip. For respondents who had not yet traveled and were planning their first trip, prompts about malaria prevention were phrased to examine whether the respondent was planning to use a given malaria prevention method. In the travel clinic setting, malaria prevention method prompts were designed for their planned use on their upcoming trip, regardless of whether the respondent reported past travel.

Subgroup analyses are performed comparing VFRs in these mutually exclusive dichotomous groups based on their report of past travel to compare planned use of malaria prevention methods and actualized use. These groups are compared to determine whether barriers exist in planned and actualizing malaria prevention. These groups are assumed to be comparable due to underlying demographic similarity; no statistically significant differences were identified between those having traveled and those planning travel in age, gender, education level (threshold greater than high school or grade school), birthplace in the US, or length of residency in the US. Travel region (West Africa versus Other SSA) and proportion with primary care were statistically different between those who have traveled and those planning travel (respectively $p<0.001$ and $p=0.030$).

Statistical analysis and data visualization

Statistical analyses were performed to compare sample means ($\bar{x}$), medians ($\tilde{x}$) and proportions (%) of relevant outcomes and characteristics between traveler setting and traveler population subgroups and are presented in tables. Figures with error bars present the 95% confidence interval around the sample statistic. Comparative analyses with resulting p values are specified in tables and include Wald's Chi square statistic (χ^2) and corresponding odds and adjusted odds ratios (OR, aOR), and the Mann-Whitney U statistic. The significance level was set for all analyses at $\alpha=0.05$. Statistical analyses were performed in SAS version 9.4 (SAS Institute, Cary, NC).

Data are visualized in Excel version 2016 (Microsoft, Redmond, WA). Maps were designed in ArcGIS Online (Esri, Redlands, CA). A tile layer of malaria rates in 2015 among children aged 2

to 10 years old in Sub-Saharan Africa developed by The Malaria Atlas Project (University of Oxford, Oxford, UK) was overlaid with study data to provide proxy context for malaria risk. Destinations were reported by participants at the country level and do not reflect specific location, duration, or local environmental conditions; individual malaria risk during travel cannot be estimated using Malaria Atlas Project geospatial data.

Assumptions of linearity and goodness of fit: transformation and use of nonparametric tests

Where parametric tests are performed (e.g. Wald χ^2), normality of distributions is assumed due to robust overall and subgroup sample sizes. Logistic regression analyses also assume linearity on the log scale between predictors and outcomes. Where goodness of fit statistics identified poorly fitting continuous predictors (e.g. duration of travel), predictors were transformed to improve normality and fit. Transformations are described where performed.

Alternatively, nonparametric tests including the Mann-Whitney test were used in place of logistic regression when dependent variables where non-normal and non-continuous, such as in the case of number of trips taken and Likert scale-based variables. The Mann-Whitney U test was used to evaluate statistical differences in Likert scale-based responses due to its noncontinuous distribution, plus evidence of skew and non-normality. Pairwise Likert scale-based comparisons were analyzed for statistical significance using the non-parametric Mann-Whitney test.

Institutional review and funding source

The following institutional review boards approved and monitored the survey: Minnesota Department of Health (IRB#15-368), University of Minnesota (STUDY00001189), Hennepin Healthcare Research Institute, formerly Minneapolis Medical Research Foundation of Hennepin County Medical Center (HSR#17-4350), and HealthPartners Institute (IRB0#A14-011). MPP was funded by a cooperative agreement grant from the Centers for Disease Control and Prevention (CK000357-01) from fiscal year 2016 through 2019.

Results

Study population

A total of 489 respondents completed surveys across the three settings; 351 participants met the study definition of a VFR traveler and are eligible for analysis in the present chapter. Figure 5 depicts participant counts categorized by study setting and traveler population. By setting, 43 VFRs (12.3%) were interviewed as malaria cases reported to the state health department, 212 VFRs (60.4%) participated in community settings including community events, online and at an emergency department, and 96 VFRs (27.4%) participated before their visits to a travel clinic. VFRs were classified into two distinct traveler populations based on region of travel and origin; 214 were VFRs to West Africa (61.0%) and 137 (39.0%) were VFRs to Other Sub-Saharan African countries.

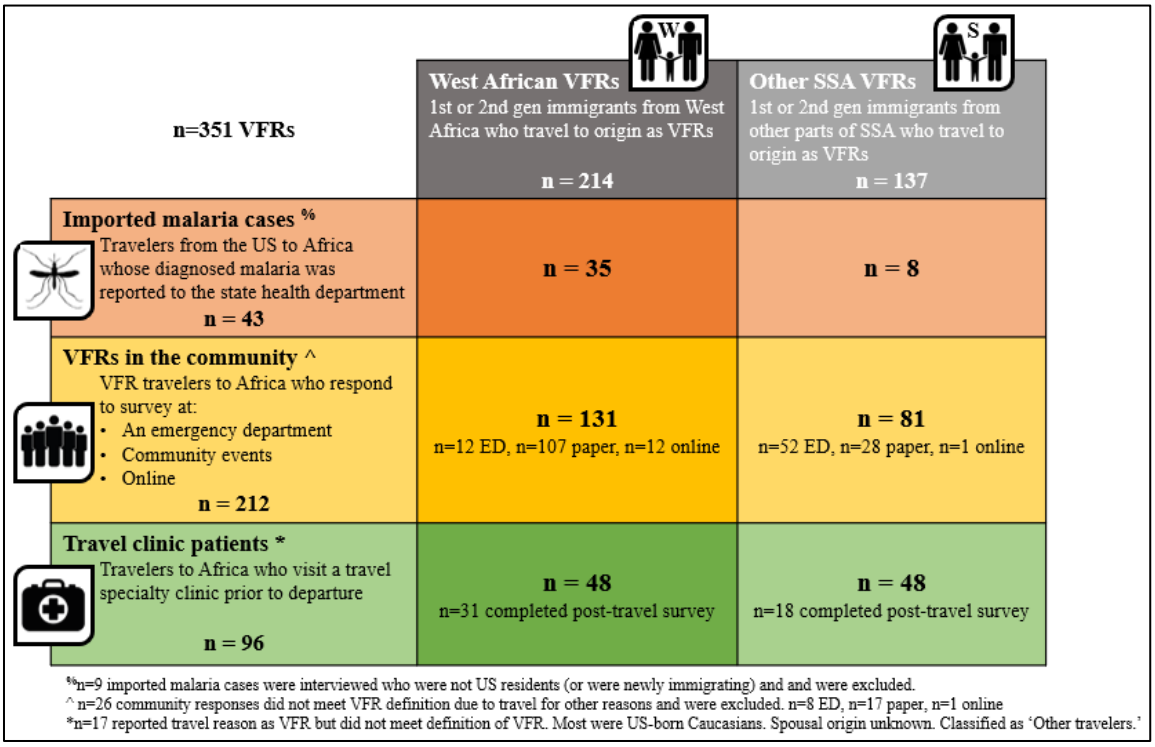


Figure 5: VFR participant matrix by survey setting (rows) and traveler population (columns)

Demographics

Demographic characteristics of the VFR study population are summarized in Table 5. The average age of VFR participants was 43.3 years; no differences were observed in mean age across settings or traveler populations. Slightly fewer than half (48.2%, 163/338) of all VFRs were male; malaria cases were disproportionately male (72.1%, 31/43) when compared to community (44.8%, 91/203, p=0.002) or travel clinic (44.6%, 41/92, p=0.004) respondents. An education level greater than high school was reported among 68.5% (224/327) of VFRs; Other SSA VFRs (46.2%, 61/132) had significantly lower proportion of postsecondary education compared to West African VFRs (83.6%, 163/195, p<0.001). The study population of VFRs was predominately first-generation immigrants with 95.6% (333/347) of participants reporting birth in a Sub-Saharan African country; no differences in foreign born proportion were observed across settings or traveler populations. Among foreign-born participants, the average length of US residency was 15.3 years. Other Sub-Saharan Africa VFRs ($\bar{x}$=14.2 years) had significantly shorter mean US residency (p=0.044) than West African VFRs ($\bar{x}$=16.1 years) and VFRs at the travel clinic (18.0 years) had significantly longer US residency than VFRs surveyed in the community (14.2 years, p=0.001). Having a primary care provider was reported among 88.3% (159/180) of VFRs; travel clinic VFRs (94.5%, 86/91) were more likely than community VFRs (82.5%, 52/63, p=0.023) or malaria cases (80.8% 21/26, p=0.038) to have a primary care provider.

Destination

Among the 351 VFR participants, 413 destinations to 31 countries in Sub Saharan Africa were reported. As depicted in Figure 6, 248 destinations were reported to West African countries; 165 destinations were reported to other countries in Sub-Saharan Africa. Most common destinations in West Africa were Liberia (55), Nigeria (43), Togo (41), Ghana (26), and Cameroon (22). Destinations in the 'Other Sub-Saharan Africa' region were predominately located in East Africa, with top counts in Kenya (55), Ethiopia (42), and Somalia (35); all remaining countries in the Other SSA region were each reported as destinations by 8 or fewer VFRs.

Trip duration

Average and median trip duration among VFRs was 7.0 and 4.0 weeks respectively (range 0.3-72 weeks). Non-normality positive skew of the mean due to multiple long-duration outliers was observed in each setting and traveler population group. After log transformation, duration of travel among Other SSA VFRs ($\bar{x}$=9.0 weeks, $\tilde{x}$=6.0 weeks) was statistically significantly longer

($p<0.001$) than West African VFRs ($\bar{x}$=5.8 weeks, $\tilde{x}$=4.0 weeks) with no differences observed in trip duration across study settings. Antimalarial use (p=0.436) or seeing a health care provider before travel (p=0.362) was not correlated with trip duration.

Travel frequency

The plurality of VFR respondents had either taken one trip or were planning to take their first trip back to their country of origin (47.5%, 151/318), fewer had taken between 2 and 4 trips (28.3%, 90/318), and 24.2% (77/318) had taken 5 or more trips back; significant differences in these proportions were observed both across the three study settings and the two traveler populations (see Table 5). The plurality of malaria cases (44.0%, 11/25) had taken 5 or more trips back, fewer (28.0% 7/25) had taken 2-4 trips or had become ill on their first trip (28.0% 7/25). Among community VFRs, 20.4% (41/201) had taken 5 or more trips back, 32.8% (66/201) had taken 2-4 trips back, and the plurality (46.8%, 94/201) were taking their first trip or had taken one trip. Among travel clinic VFRs, 27.2% (25/92) had taken 5 or more trips back, 18.5% (17/92) had taken 2-4 trips back, and the majority (54.4%, 50/92) were taking their first trip or had taken one trip. Malaria case VFRs had more 2.7 times greater odds of having taken 5 or more trips than non-case VFRs (OR=2.70 p=0.020).

Table 5: Demographic comparisons of VFR travelers across study settings and traveler populations

Characteristic	All VFRs	VFRs by Setting			VFRs by Traveler Population		M v C p	M v T p	C v T p	W v S p
	Overall n=351	Malaria Cases (M) n=43	Community (C) n=212	Travel Clinic (T) n=96	West Af VFRs (W) n=214	Other SSA VFRs (S) n=137	Pairwise Wald $\chi 2$ (*df=1*)			
Age, years #	43.3 (41.9-44.8)	45.9 (41.4-50.4)	43.1 (41.2-45.0)	42.8 (40.0-45.6)	44.1 (42.4-45.9)	42.2 (39.7-44.7)	0.222	0.235	0.868	0.197
Male	48.2 (42.9-52.6)	72.1 (58.1-86.1)	44.8 (37.9-51.7)	44.6 (34.2-54.9)	51.2 (44.3-58.1)	43.6 (35.1-52.1)	0.002	0.004	0.967	0.172
Education = grade school	9.5 (6.3-12.7)	11.1 (0.3-21.9)	11.5 (7.0-16.0)	4.4 (0.1-8.7)	4.1 (1.3-6.9)	17.4 (10.9-24.0)	0.947	0.175	0.062	<0.001
Education > high school	68.5 (63.4-73.6)	63.9 (47.4-80.4)	65.5 (58.9-72.1)	76.9 (68.1-85.7)	83.6 (78.3-88.8)	46.2 (37.6-54.8)	0.852	0.138	0.052	<0.001
Foreign born	95.6 (93.9-98.0)	97.7 (93.0-100)	96.2 (93.6-98.8)	94.6 (89.8-99.3)	94.8 (91.8-97.8)	97.7 (95.3-100)	0.642	0.428	0.513	0.184
Length of residency in US, years *	15.3 (14.4-16.2)	14.3 (11.1-17.5)	14.2 (13.1-15.3)	18.0 (16.1-19.9)	16.1 (14.9-17.4)	14.2 (12.8-15.6)	0.960	0.058	0.001	0.044
Trip duration, weeks	7.0 (6.1-8.0)	7.6 (4.1-11.6)	7.8 (6.3-9.0)	5.4 (4.4-6.3)	5.8 (4.6-6.9)	9.0 (7.4-10.6)	--	--	--	--
Trip duration, weeks, log transformed	0.68 (0.64-0.71)	0.69 (0.57-0.81)	0.70 (0.65-0.75)	0.62 (0.57-0.68)	0.59 (0.55-0.64)	0.8 (0.74-0.87)	0.873	0.288	0.092	<0.001
Has had malaria before	67.9 (62.8-72.9)	61.9 (46.6-77.2)	75.2 (69.2-81.2)	53.9 (43.4-64.5)	79.5 (73.9-85.1)	50.4 (41.8-59.0)	0.080	0.391	<0.001	<0.001
Has a primary care provider @	88.3 (83.6-93.1)	80.8 (64.5-97.0)	82.5 (72.9-92.2)	94.5 (89.7-99.3)	86.1 (78.3-93.9)	90.0 (84.2-96.0)	0.843	0.038	0.023	0.406
Destination W. Africa	^ 61.0 --	81.4 (69.3-93.5)	^ 61.8 --	^ 50.0 --	^ 100.0 --	^ 0.0 --	--	--	--	--
5 or more trips back	24.2 (19.5-28.9)	44.4 (23.1-64.9)	20.4 (14.8-26.0)	27.2 (17.9-36.4)	29.4 (22.8-36.0)	16.8 (10.3-23.3)	0.011	0.110	0.199	0.011
Number of trips back							Pairwise Wald $\chi 2$ (*df=2*)			
Will be first / 1	47.5 --	28.0 --	46.8 --	54.3 --	38.5 --	60.3 --				
2 to 4	28.3 --	28.0 --	32.8 --	18.5 --	32.1 --	22.9 --	0.034	0.075	0.040	0.001
5 or more	24.2 --	44.0 --	20.4 --	27.2 --	29.4 --	16.8 --				

n=3 pediatric cases excluded

* Foreign-born respondents only

@ Paper and online versions of the community survey omitted this prompt; community is ED exclusively

^ Noninformative; sampling protocol-determined outcome

α=0.05; p values in red are statistically significant

Table 6: Malaria knowledge, attitudes, and practices of VFR travelers across study settings and traveler populations

Characteristic	All VFRs		VFRs by Setting				VFRs by Traveler Population				M v C p	M v T p	C v T p	W v S p
	Overall n=351		Malaria Cases (M) n=43		Community (C) n=212		Travel Clinic (T) n=96		West Af VFRs (W) n=214		Other SSA VFRs (S) n=137		Mann-Whitney U two-sample test			
	$\tilde{x}$	$\bar{x}$ (95% CI)														
Concern about malaria	4	3.6 (3.4-3.7)	1	2.5 (1.9-3.1)	4	3.8 (3.6-4.0)	4	3.5 (3.2-3.8)	4	3.7 (3.5-3.9)	3	3.3 (3.0-3.6)	<0.001	0.002	0.174	0.014
Malaria is deadly	5	4.5 (4.4-4.6)	5	4.0 (3.6-4.5)	5	4.6 (4.5-4.7)	5	4.5 (4.3-4.6)	5	4.6 (4.4-4.7)	5	4.4 (4.3-4.6)	0.003	0.170	0.035	0.354
Deadly-concern differential	0	1.0 (0.8-1.1)	2	1.5 (0.8-2.3)	0	0.8 (0.6-1.0)	0	1.0 (0.6-1.4)	0	0.8 (0.6-1.1)	1	1.1 (0.8-1.4)	0.011	0.077	0.065	0.075
	%	(95% CI)											Pairwise Wald $\chi 2$ (*df=1*)			
Malaria is preventable	93.9	(91.4-96.4)	92.9	(84.7-100)	91.8	(88.0-95.6)	98.9	(96.7-100)	96.1	(93.6-98.8)	90.2	(85.2-95.4)	0.816	0.091	0.040	0.031
Listed incorrect method of preventing malaria	39.9	(34.3-45.4)	57.5	(41.5-73.5)	36.2	(29.0-43.4)	39.1	(29.0-49.3)	33.5	(26.5-40.6)	48.5	(39.8-57.2)	0.015	0.053	0.639	0.009
Listed incorrect method of contracting malaria	19.5	(15.2-23.7)	16.3	(4.8-27.8)	16.5	(11.3-21.7)	27.1	(18.0-36.1)	14.2	(9.4-19.0)	27.4	(19.8-35.0)	0.972	0.171	0.034	0.003
Had malaria on a previous trip @	11.1	(6.9-15.2)	^ 100	--	12.5	(7.3-17.7)	7.6	(1.0-14.1)	14.4	(8.3-20.5)	6.4	(1.3-11.4)	--	--	0.288	0.065
Saw health care provider before last trip *	66.8	(60.4-73.2)	41.9	(26.5-57.2)	73.2	(66.4-80.0)	^ 100	--	69.9	(62.3-77.5)	60.3	(48.4-72.2)	<0.001	--	--	0.166
On last trip…																
Took an antimalarial	59.4	(53.6-65.2)	31.7	(16.8-46.6)	61.9	(54.5-69.3)	70.1	(58.9-81.4)	66.7	(59.6-73.7)	47.1	(37.2-56.9)	0.001	<0.001	0.235	0.002
Picked where to stay to avoid mosquitos	57.2	(50.2-64.2)	19.2	(3.0-35.5)	63.1	(55.7-70.5)	--	--	62.0	(53.5-70.5)	47.7	(35.2-60.2)	<0.001	--	--	0.058
Educated oneself about malaria	57.7	(50.7-64.7)	23.1	(5.7-40.4)	63.1	(55.7-70.5)	--	--	60.5	(51.9-69.0)	52.3	(39.8-64.8)	<0.001	--	--	0.278
Used mosquito repellent	62.1	(55.5-68.7)	46.5	(31.0-62.0)	66.1	(58.8-73.3)	--	--	67.1	(59.3-74.9)	51.5	(39.3-63.7)	0.020	--	--	0.029
Stayed indoors when mosquitos were out	55.2	(48.1-62.2)	26.9	(8.7-45.2)	59.5	(52.0-67.0)	--	--	55.0	(46.3-63.7)	55.4	(43.0-67.8)	0.003	--	--	0.964
Wore long clothing	58.2	(51.2-65.2)	26.9	(8.7-45.2)	63.1	(55.7-70.5)	--	--	55.0	(46.3-63.7)	64.6	(52.7-76.6)	0.001	--	--	0.203
Used bed nets	59.7	(53.0-66.4)	44.2	(28.7-59.7)	63.7	(56.3-71.0)	--	--	57.3	(49.1-65.5)	64.7	(53.1-76.4)	0.022	--	--	0.309
Used mosquito coil	28.4	(22.0-34.7)	19.2	(3.0-35.5)	29.8	(22.8-36.7)	--	--	30.2	(22.2-38.3)	24.6	(13.9-35.4)	0.273	--	--	0.413

@ Overall, W, S, and their pairwise OR exclude malaria case participants
* Overall, W, S, and their pairwise OR exclude travel clinic participants
^ Noninformative; sampling protocol-determined outcome
α=0.05; p values in red are statistically significant

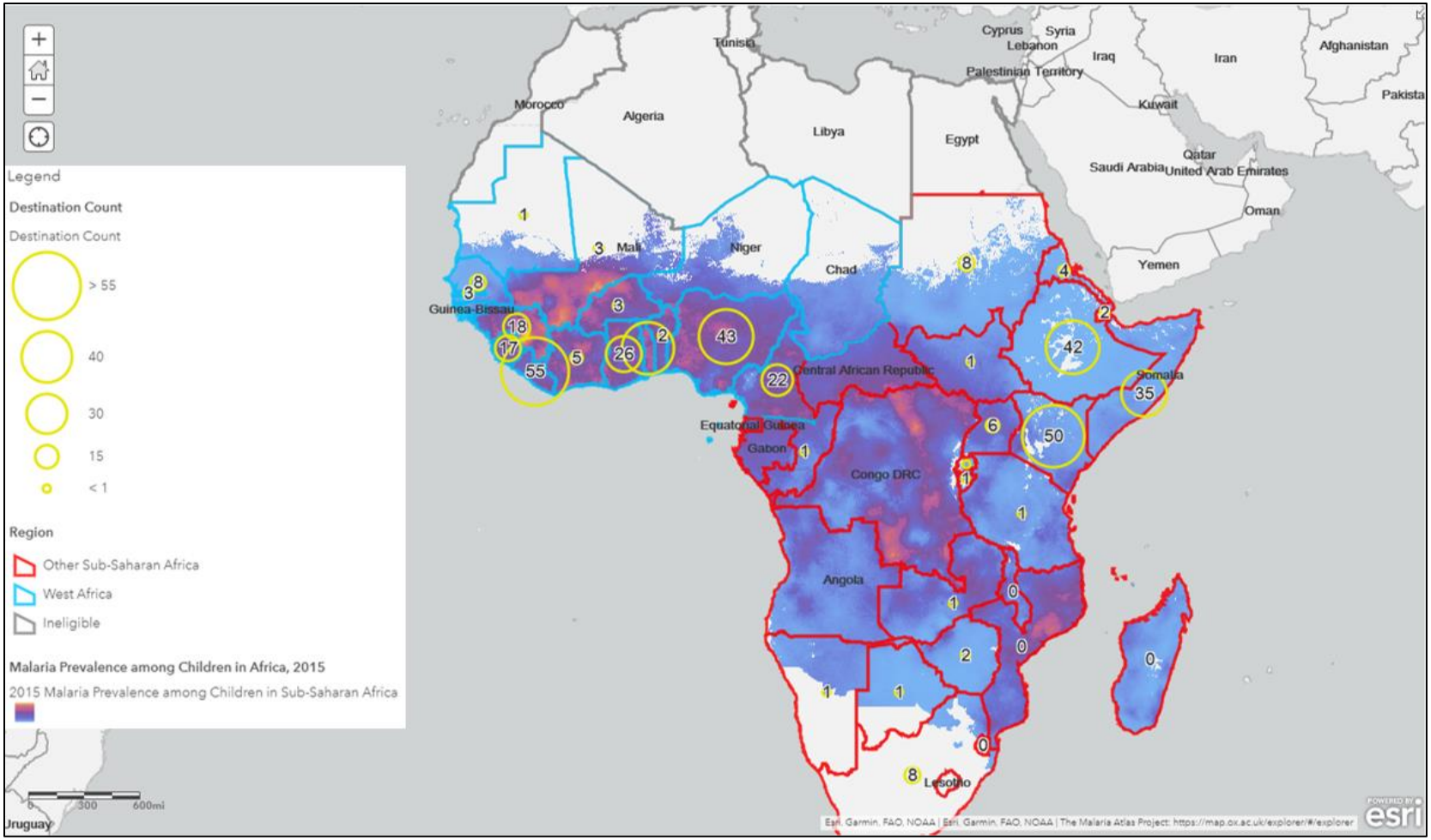


Figure 6: Map of study eligibility regions and VFR participant destination counts across the African continent, overlaid with 2015 malaria prevalence among children (Prevalence layer source: The Malaria Atlas Project, University of Oxford)

Malaria attitudes and risk perception

Differences in malaria attitudes and knowledge across setting and traveler population are summarized in Table 6. Malaria case VFRs ($\tilde{x}$=1) were significantly less concerned about malaria prior to their travel than community ($\tilde{x}$=4, p<0.001) or travel clinic VFRs ($\tilde{x}$=4, p=0.002). Although the median score for perception that malaria is deadly was equivalent across all settings and traveler groups ($\tilde{x}$=5), a significant difference in distribution of scores was observed in the Mann-Whitney two-sample nonparametric test between malaria case VFRs and community VFRs (two-sided p=0.003), and between community VFRs and travel clinic VFRs (p=0.035).

On average, VFRs rated *'malaria can be a deadly disease'* 1 point higher than their rating for *'I am concerned for myself about getting malaria when traveling'* ($\bar{x}$=1.0, $\tilde{x}$=0). This differential in scores between concern about malaria and impression of its deadliness was greater among malaria case VFRs ($\bar{x}$=1.5, $\tilde{x}$=2) than community VFRs ($\bar{x}$=0.8, $\tilde{x}$=0, p=0.011) with no significant differences observed across other setting or traveler population combinations using the Mann-Whitney two-sample test.

VFRs who reported taking an antimalarial on their last trip (59.4%, 164/276) were significantly more concerned about malaria ($\bar{x}$=3.8, $\tilde{x}$=4) than those who did not take an antimalarial ($\bar{x}$=3.1, $\tilde{x}$=3, p=0.001). Using repellent (62.1%, 131/211) also was associated with increased concern for malaria ($\bar{x}$=3.7, $\tilde{x}$=4), compared to VFRs who did not use repellent ($\bar{x}$=3.1, $\tilde{x}$=3 p=0.010). Taking an antimalarial or using repellent was not statistically associated with difference in perception of malaria deadliness.

Increased concern for malaria during travel may be independently negatively associated with number of trips taken. However, the p value in this model exceeds the established significance threshold. Each increased number of trips may be associated with a loss of 0.086 points in concern about malaria score (intercept=3.80 slope= -0.0857 f=3.58 p=0.059). This linear model estimates that a traveler who has traveled five times rated their concern about malaria 0.43 points, or 8.6%, lower on the five-point scale than a traveler who was planning their first trip.

Malaria knowledge

VFRs overwhelmingly recognize that malaria is a preventable illness (93.9%, 323/344) but some differences across groups were observed (Table 6). VFRs at the travel clinic (98.9%, 94/95) were

more likely to view malaria as preventable than VFRs in the community (91.8%, 190/207, p=0.040). Other SSA VFRs (90.3%, 121/134) were less likely than West African VFRs to perceive malaria as preventable (96.2% 202/210, p=0.031).

Although more than 9 in 10 VFRs view malaria as preventable, 39.9% (122/306) of VFR respondents listed an incorrect method of preventing malaria, with 68% (83/122) of incorrect respondents citing prevention through a malaria vaccine. VFRs who listed a malaria vaccine (55.2%, 37/67) or those who listed any incorrect method of prevention (50.5%, 48/95) were no less likely than other VFRs to have taken an antimalarial during travel (respectively, p=0.422 and p=0.071). Hygiene, handwashing, safe food and water, clean air, and avoiding contact with people with malaria were also listed by multiple respondents as ways to prevent malaria. A significantly larger proportion of malaria case VFRs (57.5% 23/40) listed an incorrect prevention approach than community VFRs (36.2%, 63/174, p=0.015). Other SSA VFRs were also more likely to list an incorrect prevention approach (48.5% 63/130) when compared to West African VFRs (33.5%, 59/176, p=0.009).

Incorrect mechanisms of contracting malaria transmission were cited among 19.5% of VFRs (66/339). Contracting malaria through water was the most commonly reported incorrect mechanism, cited by 56.1% (37/66) of incorrect respondents. Incorrect methods of contracting malaria were more commonly cited among travel clinic VFRs (27.1%, 26/96) than those in the community (16.5%, 33/200, p=0.034), and more common among Other SSA VFRs (27.4%, 37/135) than West African VFRs (14.2%, 29/204, p=0.003).

Malaria prevention approaches

Large differences were observed between malaria cases and non-cases, i.e. those VFRs surveyed in the community and travel clinic, regarding malaria prevention approaches such as taking an antimalarial on one's last trip, seeing a health care provider before one's last trip, and using a range of malaria prevention methods. Among travel clinic VFRs, 70.1% (47/67) reported taking an antimalarial on their last trip, 61.9% (104/168) of community VFRs used an antimalarial and 31.7% (13/41) of diagnosed malaria cases used an antimalarial on their last trip. Overall, non-case VFRs had 3.87 times greater odds of using an antimalarial than diagnosed malaria case VFRs (OR=3.87, p<0.001). Nearly three-quarters (73.2%, 123/168) of community VFRs saw a health care provider before their last trip, whereas 41.9% (18/43) of malaria cases saw a provider before traveling (p<0.001).

Other prevention approaches were reported more commonly among community VFRs on their most recent trip than malaria case VFRs (Table 6). Picking where to stay to avoid mosquitoes was reported by 63.1% (106/168) of community VFRs and 19.2% (5/26) of case VFRs ($p<0.001$). Educating oneself on the risks of malaria before traveling was reported 63.1% (106/108) of community VFRs and 23.1% (6/26) of case VFRs ($p<0.001$). Using mosquito repellent was reported by 66.1% (111/168) of community VFRs and 46.5% (20/43) of case VFRs ($p=0.020$). Staying indoors when mosquitoes were out was reported by 59.5% (100/168) of community VFRs and 26.9% (7/26) of case VFRs ($p=0.003$). Wearing long clothing was reported by 63.1% (106/168) of community VFRs and 26.9% (7/26) of case VFRs ($p=0.001$). Using bed nets was reported by 63.7% (107/168) of community VFRs and 44.2% (19/43) of case VFRs ($p=0.022$). Reported use of mosquito coils was not statistically different between community and case VFRs with 28.4% (55/194) overall reporting use. When comparing VFR travelers to West and Other SSA, the only significant difference in reported use among these prevention approaches was in use of mosquito repellent. Using mosquito repellent was reported by 67.1% (96/143) of West African VFRs and 51.5% (35/68) of Other SSA VFRs ($p=0.029$).

When comparing reported and planned prevention approaches between VFRs who have recently traveled and those who plan to travel in the next year, significant discrepancies exist in actualizing malaria prevention (Figure 7). Although 95.2% (60/63) of VFRs who haven't yet traveled responded that they plan to take an antimalarial, just 59.4% (164/276) of recent travelers reported using an antimalarial, a difference (Δ) of 35.8%. The differentials between planned and actualized malaria prevention methods was greatest for antimalarials, followed by picking where to stay in order to avoid mosquitoes (Planned: 92.4% [122/132], Reported: 57.2% [111/194] Δ=35.2%), educating oneself on malaria before travel (Planned: 91.7% [121/132], Reported: 57.7% [112/194] Δ=33.9%), and staying indoors when mosquitoes are out (Planned: 86.4% [114/132] Reported: 55.2% [107/194] Δ=31.2%).

Examining these differentials among traveler population subgroups, statistically significant differences exist between planned and actualized prevention reports for all techniques described in Figure 8 individually for Other SSA VFRs and West African VFRs. For Other SSA VFRs, the crude numerical differences between planning and actualizing malaria prevention were greater than those among West African VFRs for all prevention techniques except staying indoors or using bed nets (Figure 8), but these differences cannot be tested statistically in the given study design. Among Other SSA VFRs, 93.3% (28/30) planned on taking an antimalarial, but just

47.1% (48/102) reported taking an antimalarial, a difference of 46.3%. Among West African VFRs, 97.0% (32/33) planned to take antimalarials and 66.7% (116/174) reported taking antimalarials, a difference of 30.3%.

Malaria illness

Among VFR travelers surveyed in the community and travel clinic with past travel, 11.1% (25/225) self-reported becoming ill with malaria after a trip (Table 6). When comparing Other SSA VFRs (6.4%, 6/94) to West African VFRs (14.4%, 19/132), no statistically significant difference in self-reported malaria illness was observed (p=0.065). Among the 23 self-reported respondents who reported a malaria-like illness during travel that provided additional detail, 22 report seeing a health care provider after they became ill. Respondents describe severe symptoms and intention to get treated as key reasons they sought care.

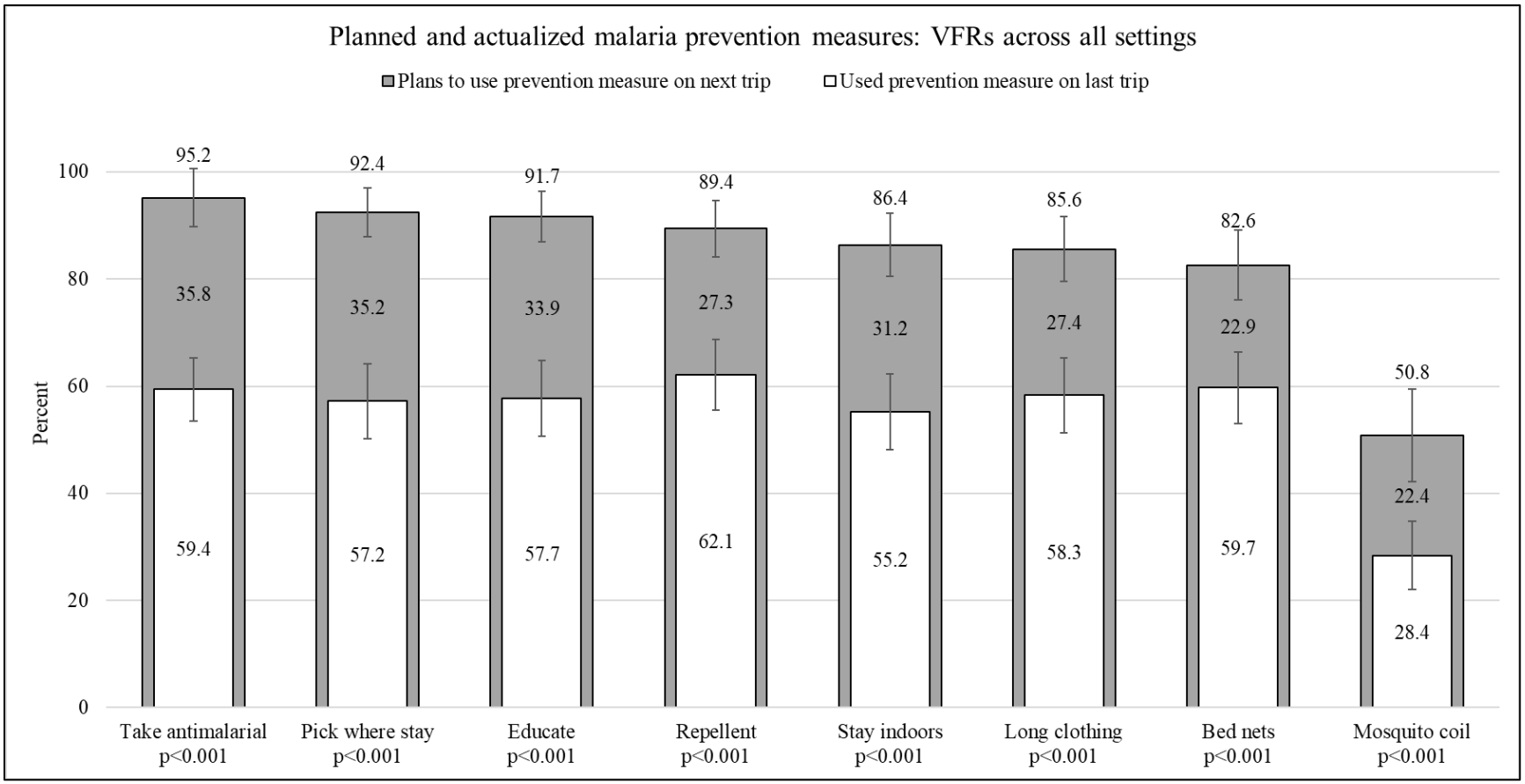


Figure 7: Planned and actualized malaria prevention measures: VFRs across all settings.

P value presents statistical significance the Wald χ^2 test of association of past/future travel on antimalarial use.

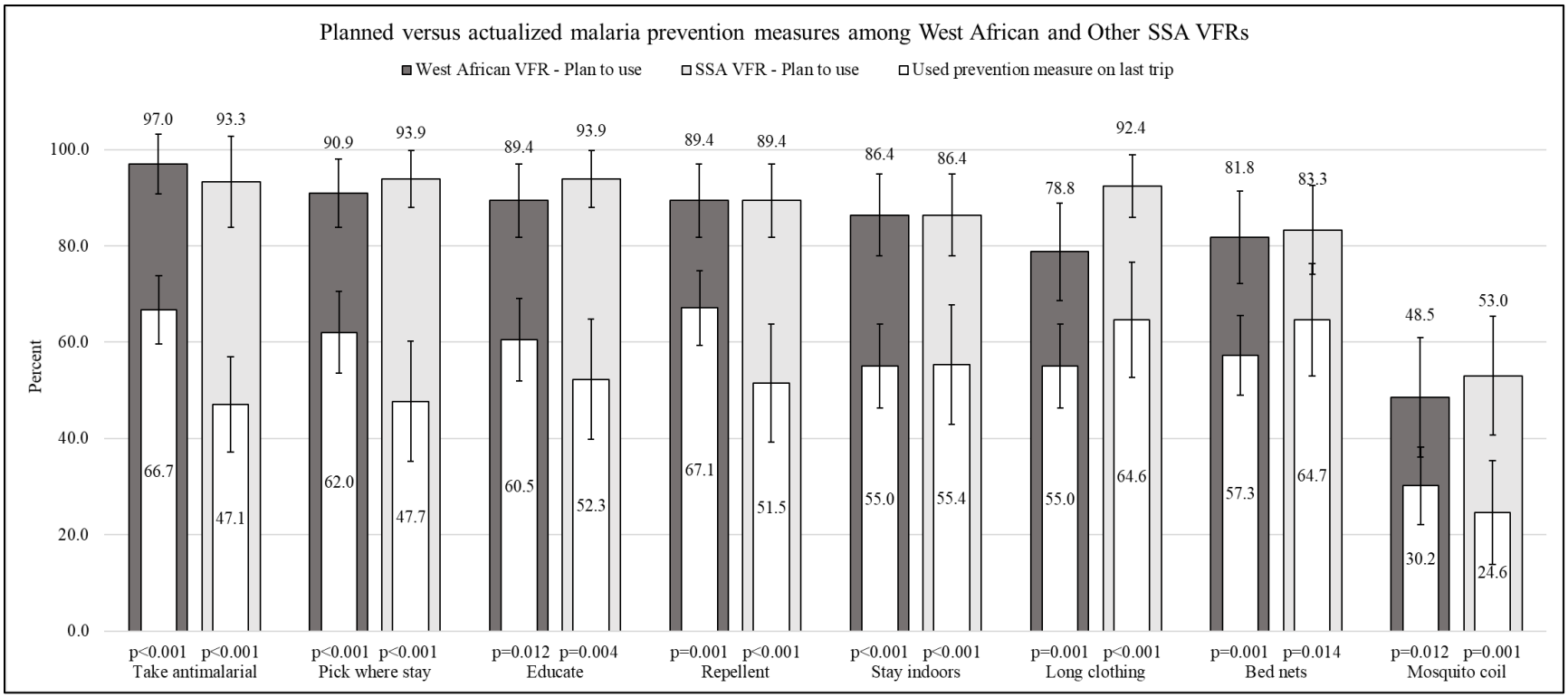


Figure 8: Planned and actualized malaria prevention measures: West African and Other SSA VFR subgroups.

P value presents statistical significance the Wald χ^2 test of association of past/future travel on antimalarial use for each specific sub-group.

Discussion

Findings from this study on behavioral barriers to malaria prevention align closely with the qualitative results of focus groups conducted earlier in the Malaria Prevention Project.[56] Especially well-aligned appears to be the recognition by VFRs that some prevention approaches work well but are a challenge to actually achieve during travel. The findings quantified in the present study convey an impactful and broad range of behavioral barriers to successful malaria prevention among VFR travelers.

Behavioral barriers to malaria prevention

Understanding the differences in demographics and behaviors of VFRs across the prevention spectrum – from those ill with malaria after a trip to those who successfully see a travel clinic provider and take an antimalarial – is critical to identifying key behavioral barriers that less successful VFRs may face. Males were greatly overrepresented among interviewed malaria cases compared to VFRs surveyed in community and travel clinic settings. This is consistent with international surveillance reports for imported malaria to nonendemic, high income countries.[102] A broad contrast was observed when comparing travel frequency among malaria cases to VFRs in the community and travel clinic settings. The plurality of malaria case VFRs had taken 5 or more trips whereas the plurality of community and travel clinic VFRs had taken one trip or were planning to take their first trip. Due to this difference in travel frequency, risk perception and preventive behaviors are hypothesized to wane among VFRs after repeated healthy trips. Healthy travel, thus, appears to be a barrier to malaria prevention among VFRs; frequent travelers may be a group of particular concern for intervention development. Trip duration also appears to be an important factor in malaria prevention; although differences across study setting were not observed, VFRs consistently report trips of long duration ($\bar{x}$ 7 weeks, $\tilde{x}$ 4 weeks). Due to these long duration trips, VFRs may face barriers to acquiring full-length antimalarial regimens, especially when Medicaid or insurance plans limit antimalarial dispensing to a 34-day supply and may not permit vacation overrides.[59]

Knowledge and attitudes

Although having largely comparable knowledge about malaria, cases were more likely than community VFRs to list an incorrect method of preventing malaria – most commonly listing a malaria vaccine. This suggests that misconceptions around being immunized to malaria could be providing some VFRs a false sense of protection, thereby decreasing their use of effective

preventive approaches. However, listing an incorrect prevention approach or method of contracting malaria alone were not statistically correlated with decreased antimalarial use. Together these findings suggest that adequate knowledge of malaria prevention is important for VFR travelers but alone may not affect chemoprophylaxis use.

While malaria knowledge may not be strongly associated with malaria prevention, attitudes and risk perception for malaria do correlate with preventive behavior in this study. Taking an antimalarial or using a mosquito repellent was associated with significantly higher concern for malaria during travel. Furthermore, malaria cases perceived significantly less risk around malaria prior to their travel than VFRs in the community or travel clinic when describing their level of concern or the deadliness of malaria. Interventions intended to increase uptake of chemoprophylaxis should work to raise the level of concern for malaria during travel and communicate its severity while also conveying the high level of effectiveness of malaria prevention when properly adhered.

Prevention practices: The planned and actualized prevention discrepancy

Broad discrepancies exist between planned and actualized malaria preventive practices when comparing VFRs considering their upcoming trips to those reporting on recent travel. These discrepancies remain significant across all prevention techniques when examining West African or Other SSA VFRs individually. The greatest discrepancies exist for using antimalarials, picking where to stay in order to avoid mosquitoes, and educating oneself on malaria prevention before travel. Barriers to using intended prevention measures have been reported in the literature,[56,78,83] but normally center on using bed nets and other measures that may inconvenience in-country hosts. Although barriers to using bed nets certainly exist, these data highlight the extent to which barriers to intentioned prevention are insurmountable for some VFRs across every method. Alarmingly, the greatest barriers to successful use of prevention appear to exist for the most effective malaria prevention techniques, such as using chemoprophylaxis and staying in lodging free from mosquitoes. These findings indicate that interventions intended to encourage malaria prevention measures, especially those with the greatest differentials in achievability, must address how to reduce barriers to their successful use (e.g. ways to improve ease-of-use, acceptability, cost, and access) rather than simply suggesting travelers use them.

East African VFRs

Compared to West African VFRs, Other SSA VFRs travel for longer duration, have shorter length of US residency, have lower likelihood of a postsecondary education, and have taken fewer trips as VFRs. More than three quarters of Other SSA VFRs in the sample travel to and hail from East African countries, consistent with the resettled immigrant populations that predominate the study area. These data suggest East African VFRs may be an emerging traveler population; future intervention development should anticipate that travel may increase within this group.

Other SSA VFRs may experience larger barriers to achieving intended malaria prevention than West African VFRs. Larger crude discrepancies between planned and actualized prevention across multiple measures were identified but statistical analysis was not possible with the given study design. Future prospective research following VFRs before and after travel is necessary to determine whether these differences between VFRs by travel region are real. Such a finding may suggest that Other SSA VFRs face added or larger barriers to successful malaria prevention than West African VFRs. Although fewer reported malaria cases in Minnesota or nationally occur among travelers to Other SSA countries than to West Africa,[2] further research is necessary to understand whether and why this group faces greater barriers to achieving malaria prevention, especially with increased future travel expected in the East African population.

Malaria illness during travel

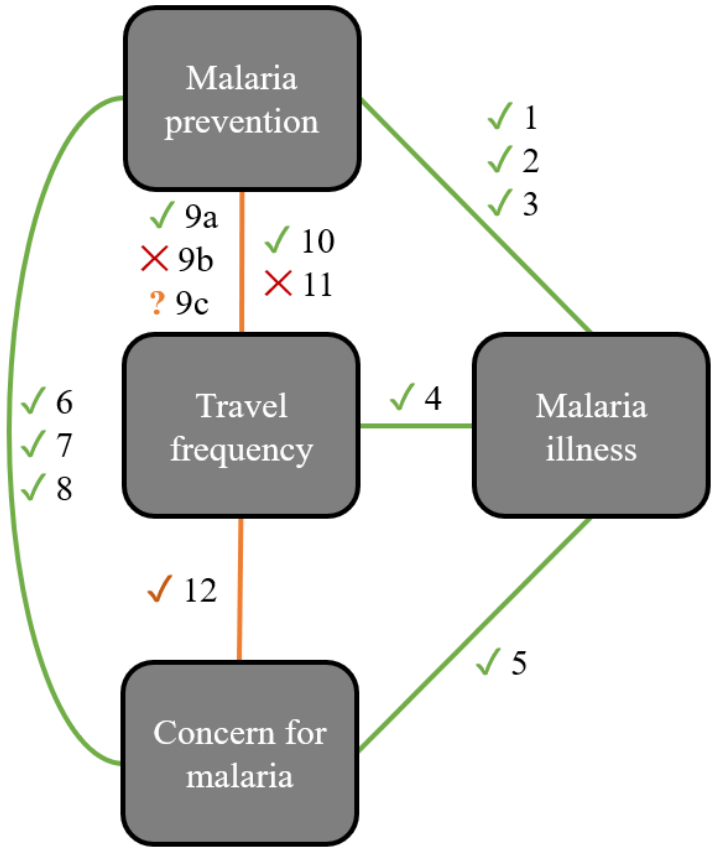
Although many travel-associated illnesses may present with similar symptoms and severity to malaria and may cause an overestimation of self-reported malaria among VFRs, 11.1% of travelers in community and travel clinic settings reported a malaria-like illness on a past trip. Even if this were a 10-fold overestimation of the malaria attack rate in the VFR traveler population, it suggests the burden of malaria among VFRs is overwhelmingly high and that many malaria cases may go unreported in this population. This is likely due to a broad range of factors, including illnesses occurring still during travel, lower acuity and symptom resolution prior to seeing a health care provider, concerns about seeing a health care provider with malaria symptoms, or self-treatment using chemoprophylaxis or chemotherapeutics purchased abroad. Prospective cohort studies following travelers and testing for malaria would better quantify the true burden of malaria in travelers but are out of the question due to the unethical design such a study would necessitate. Perhaps a retrospective cohort study design would be possible, but challenges would still exist to capture a representative traveler population and achieve a robust

sample size. Short of these challenging study designs, surveillance on diagnosed malaria cases is useful, especially in understanding which groups experience a disproportionate burden of malaria illness during travel and estimating costs to the US health care system. However, this data will remain incomplete for capturing traveler morbidity and mortality or predicting and reducing risk of autochthonous transmission.

A novel conceptual framework: The Increased Prevention – Healthy Travel – Decreased Prevention Paradigm

Four key findings from this study suggest a relationship exists between repeated travel, concern for malaria, and preventive behaviors that together impact a VFR's risk for malaria during travel. These findings are summarized together in Figure 9.

By combining these findings, a novel conceptual framework around malaria prevention in VFRs emerges (Figure 10). VFRs more concerned about malaria appear more successful at preventing malaria and less likely to become ill. Experiencing recurred healthy travel also appears to make VFRs perceive lower malaria risk, their preventive behaviors wane, and they are more likely to contract malaria. This cyclical paradigm of increased prevention leading to decreased prevention (Figure 10) is logical from a risk perception framework but presents unique challenges to maintaining adequate levels of malaria prevention in VFRs who travel frequently. Interventions targeted at first-time VFR travelers may not resonate with frequent travelers and vice versa. Due to their overrepresentation among malaria cases, frequent travelers are a subpopulation of concern and strategies that emphasize ease of malaria prevention and integration into the normal travel routine may be necessary.



✓ **1** Malaria cases less likely to take antimalarial than non-cases (RR=0.49 p<0.001)

✓ **2** Malaria cases less likely to report pre-travel care than non-cases (RR=0.52 p<0.001)

✓ **3** Malaria cases less likely to report other malaria prevention than non-cases: lodging (p<0.001), educating (p<0.001), repellent (p=0.020), indoors (p=0.003), long clothing (p=0.001), bed nets (p=0.022)

✓ **4** Plurality of malaria cases (44%) report frequent travel (5+ trips taken). Minority (22.5%) of non-cases report frequent travel (RR=1.95 p=0.016)

✓ **5** Malaria cases reported lower concern about malaria ($\tilde{x}$=1) than non-cases ($\tilde{x}$=4, p<0.001)

✓ **6** Those who did not take an antimalarial reported lower concern about malaria (OR=0.77 p<0.001)

✓ **7** Those who did not report pre-travel care reported lower concern about malaria (OR=0.77 p=0.001)

✓ **8** Those who did not use other malaria prevention reported lower concern about malaria: lodging (p<0.001), educating (p<0.001), repellent (p=0.009), indoors (p=0.046), long clothing (p=0.001)

9 Frequent travelers less likely to report taking antimalarial than less frequent travelers
- ✓ **9a** Among all (Incl. those who have not yet traveled & their planned use): p=0.017
- ✕ **9b** Among only those with past travel: p=0.375
- ? **9c** Among only malaria cases: p=0.088

✓ **10** Frequent travelers 20% less likely to report pre-travel care than less frequent travelers (RR=0.80 p=0.042, among case & community respondents)

✕ **11** Frequent travelers no less likely to report using other malaria prevention than less frequent travelers

✓ **12** Increasing number trips taken correlates with lower concern about malaria (slope = -0.086 p=0.059)

Figure 9: Quantitative evidence supporting a novel conceptual framework

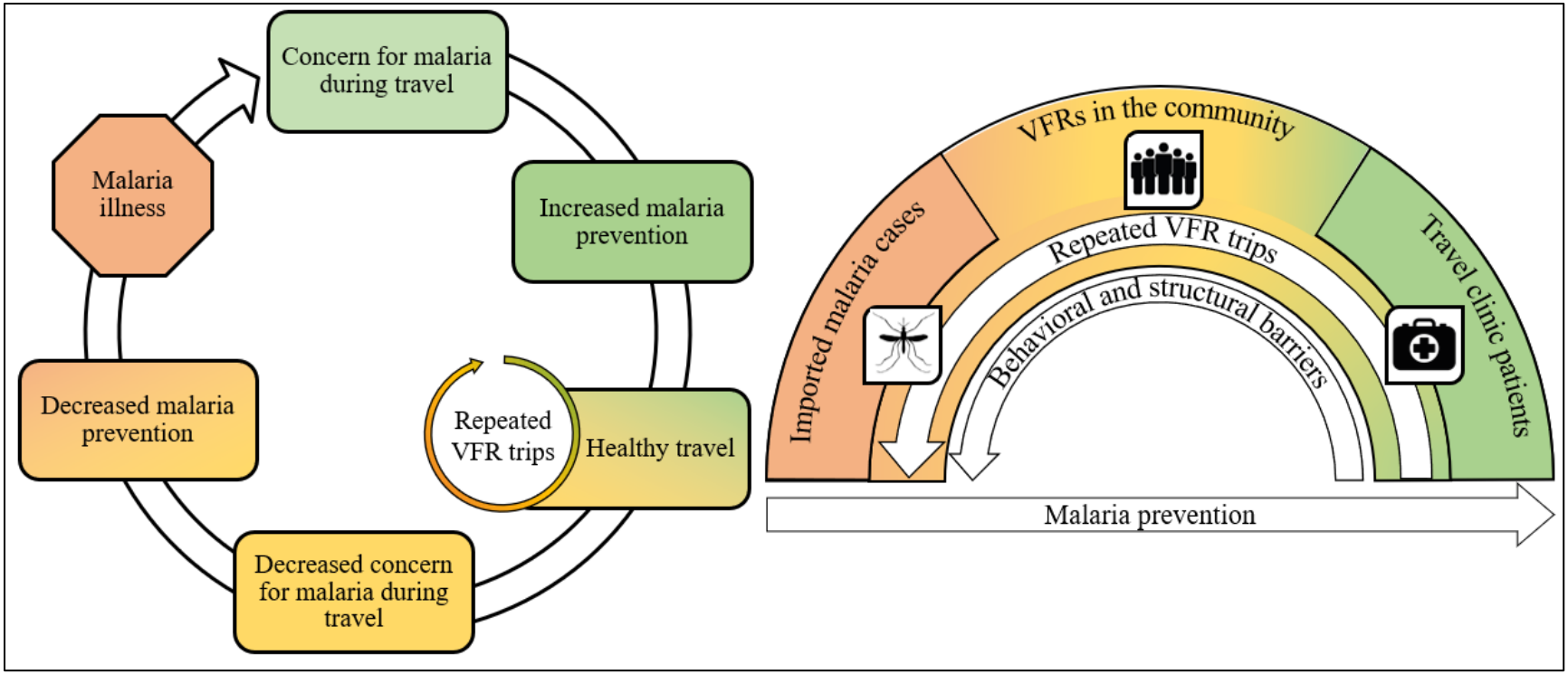


Figure 10: A novel conceptual framework: The Increased Prevention – Healthy Travel – Decreased Prevention Paradigm

Limitations

The three-setting approach to surveying VFRs provided a robust sample size with the power to detect differences in stratified subpopulations reflecting a broad range of voices from the VFR traveler population. However, due to a lack of a known, representative traveler population or reliable census data describing this group, the representativeness of the study population cannot be estimated directly. However, the representativeness of the responses can be estimated through the proxy of qualitative themes observed among respondents. Information saturation was observed in as sampling continued in the study with the emergence of no new themes after the two-thirds point of coding qualitative responses (See Chapter 5) in temporal order. This suggests that at least regarding qualitative responses based in opinion, the study may be representative of the Minneapolis-St. Paul African VFR traveler population.

More complicated and detailed questions, as well as a list of other prompts around malaria prevention behaviors were removed from the master survey used across the three study settings to ensure respondents' willingness to participate and the comprehensiveness of their answers. Some behavioral barriers identified in the literature were not explored through this study. Specifically, more detailed adherence to malaria chemoprophylaxis regimens was not solicited, nor were demographics relating to socioeconomic status. Future research should work to quantify the more impactful behavioral barriers proposed in the literature specifically in the VFR population instead of across traveler populations broadly. The detail of analysis and subgroup analysis presented in this study should be replicated in future work when examining the VFR's specific barriers to malaria prevention.

Sources of bias

Not all reported malaria cases to Sub-Saharan Africa were reachable or consented to participating in the survey. During the study period, 45% of potentially eligible cases completed a survey. Systematic and directional bias could affect case responses towards respondents more willing to talk to a state government representative, or towards those with more reliable phone accounts. Respondents were representative of malaria case reports broadly regarding age and gender.

The community survey at events, online, and through the CAB network recruited participants through a convenience sampling and snowball approaches. The inclusion of VFRs at a local emergency department was intended to broaden the community perspective by reaching VFRs that may not be as active in their community, reach individuals somewhat randomly through the

unplanned emergency care setting, and reach those with decreased access to health care services. This increased representativeness but could have also introduced bias towards VFRs with less access to health care when focusing on the community setting individually.

The Other SSA VFR subgroup is comprised of mostly travelers to East Africa. Although this is representative of the African immigrant population in the study area, the representativeness of this group's barriers to malaria prevention may be better understood as East African barriers, rather than pan-Sub-Saharan Africa.

Social desirability and right answer bias could have affected some responses reported and intended prevention behaviors. This would skew results toward the over-reporting of preventive behaviors or affirmative reporting of behaviors that were used inconsistently. Despite this risk of overreported prevention, the differential between planned and actualized preventive behaviors should theoretically remain constant and reliable, assuming prevention is overreported equally among travelers who have traveled and those planning to travel soon. Also, survey design and sampling method took this concern into account and techniques were used to develop rapport with respondents and pose the prompts without leading to a preferred answer.

Survey participants were only recruited within the metropolitan area of Minneapolis-St. Paul. Although the sampling area targeted areas with large numbers of Sub-Saharan African immigrants and appears representative of the local VFR population, the study sample may not be generalizable to other African VFR population centers in the United States or internationally. Other population groups may originate from different countries, interact with different health care systems, have differing degrees of community organization, and most broadly, have different barriers to successful malaria prevention. Focus groups performed in an earlier part of the MPP study took place both in Minneapolis-St. Paul and New York City. The themes that emerged from these focus groups do align strongly with the survey findings on behavioral barriers to malaria prevention.

Next steps

Intervention development

Consistent with recent literature, this study finds that malaria knowledge alone does not relate to successful malaria prevention. Interventions should be developed that communicate the severity of malaria illness, the importance of pre-travel health care, and taking chemoprophylaxis, but

perhaps most importantly, interventions that integrate barrier reduction strategies that make intended malaria prevention easier, more affordable, and more accessible to VFRs.

Findings from this chapter will be integrated with the structural barriers to malaria prevention VFRs face when interacting with the health care system. Together these findings can inform the development of barrier reduction approaches that address malaria prevention at personal and systems levels. Intervention development should be especially focused on sustainable mechanisms to close the gap between intended and actualized chemoprophylaxis use. Interventions should be paired with impact evaluation studies, which are exceedingly rare in the travel medicine field or in the literature on malaria prevention in travelers.

Future research

To provide more support for the hypothesis that increasing trip frequency is associated with a decrease in concern for malaria and malaria prevention, future research employing a larger sample size is necessary. A sample size calculation for linear regression using the parenthetical parameters finds that the sample size for the identified effect size, if real, would require a target of 723 responses to be detected (slope=-0.0857, trip count standard deviation=1.91, malaria concern standard deviation=1.58, significance level α=0.05, power 1-β=0.80). Because no identified research in the literature discusses trip frequency as a correlate to malaria prevention, this is a key area identified for future exploration.

Future research examining behavioral barriers to malaria prevention would benefit from explorations into how the duration of time planning a trip affects preventive behaviors. Anecdotal survey findings and conversations with cases suggest that trips with short lead time, such as those for family funerals may make malaria prevention especially hard to achieve for VFRs. Strategies that improve access to chemoprophylaxis in this subgroup may be effective for VFRs broadly, and reach travelers at heightened risk of achieving no malaria prevention.

Research broadly addressing malaria in VFRs should further explore the true burden of malaria illness in this population, including better understanding what proportion of malaria illness goes unreported or occurs prior to return to the US. Anecdotal reports from CAB members and survey participants include malaria mortalities among Minnesota VFRs while still traveling, and cases of malaria illness where patients chose to not seek health care. Understanding the breadth of malaria cases may lead to insight on ways to encourage those with symptoms to seek care and get treated

before the illness become more acute, and to reduce the opportunity for local transmission to occur.

Conclusions

These findings shed light on the characteristics that distinguish case VFRs from those who experience successful travel regarding malaria prevention, differences in VFRs to different regions of Sub-Saharan Africa, and highlight the extent to which barriers prevent VFRs from actualizing intended preventive measures. VFRs in this study are a non-homogenous group; some VFRs are particularly successful at achieving malaria prevention, while others face critical gaps in their knowledge, attitudes and practices around malaria prevention. The conceptual framework proposed above that leads a VFR across the spectrum from high preventive behaviors to low is a novel perspective on prevention in the literature on VFR traveler health. Special focus must be given to certain VFR subpopulations that face added behavioral barriers to malaria prevention to reduce the burden of malaria illness in this population.

Chapter 5: Structural barriers to malaria prevention among VFRs

Chapter abstract

Structural barriers to malaria prevention and acquiring adequate chemoprophylaxis have been reported, but not explored comprehensively in previous research on VFR travelers. These barriers include access to preventive care, pre-travel care, and perceptions of the health care system affecting health care seeking behavior. This chapter addresses these structural barriers to malaria prevention among VFRs by describing VFR experiences with the health care system before and after travel and VFR use of general primary care. Findings from a three-setting survey of VFRs traveling to Sub-Saharan Africa are reported.

A cross-sectional survey employing quantitative and qualitative sampling was used. Participants meeting the CDC definition of a VFR traveler were surveyed in three distinct settings: a state health department as reported malaria cases, in the community (through cultural events and health fairs, online or at an emergency department), and at a travel clinic prior to their visit. Outcomes analyzed are having a primary care provider, use of pre-travel care, location of pre-travel care, and experiences or perceptions of the health care system when experiencing malaria symptoms.

VFRs who reported having a primary care provider were more likely to have reported pre-travel care. Concern about seeing a health care provider when they experience malaria symptoms was less frequently reported by VFRs with a primary care provider than those without. VFRs with a PCP were also more likely seek care immediately with malaria symptoms than those without a PCP. West African VFRs were more likely to report concerns seeing a health care provider or reporting a delay in care than Other SSA VFRS. Providing additional support for the conceptual framework proposed in Chapter 4, travelers who have taken five or more trips had a decreased likelihood of reporting seeking pre-travel care than those who had taken fewer trips.

These findings emphasize the impact primary care has on traveler health and malaria prevention among VFRs. As a key setting for pre-travel care, primary care should be linked to travel medicine resources and should be encouraged to initiate conversations with potential VFRs on the availability of specialty travel clinics. Concerns about their treatment in US health care systems including low quality of care, stigma, and quarantined are expressed by VFRs, especially West African VFRs and those experiencing malaria symptoms. As evidenced by negative health care experiences reported by malaria cases, improvements within the health care system must be made around recognizing malaria illness and providing culturally competent care. Finally, travel

medicine engagement with policy analysts is needed to develop a deeper understanding of structural barriers to malaria prevention.

Introduction

Structural barriers to malaria prevention and acquiring adequate chemoprophylaxis have been reported in the travel medicine field, but not explored comprehensively in previous research on VFR travelers. These barriers exist as a result of the structure of the health care system in which VFRs interact and are hypothesized to have profound impacts on their ability to adequately take necessary steps to prevent malaria. Some of the identified and hypothesized structural barriers to malaria prevention include: access to health care services and prescriptions,[56,59,83] insurance coverage and costs of these services and medicines,[59,63,81,83] perceived and actual biases or stigma faced by patients in the health care system,[56,78] provider competence on malaria prevention and treatment,[56,78,103] and the upstream social determinants at the core of each of these barriers such as income, immigration status, and structural racism. Together these barriers likely present broad, interactive, and impactful challenges to malaria prevention for VFR travelers. Although these barriers have been identified, a deeper understanding of these barriers and their effects is necessary in order to develop solutions and targeted interventions that reduce their impact.

VFR pre-travel care and perceptions of provider training

Pre-travel care, especially that which takes places with a specialized travel health provider, is a cornerstone of malaria prevention. It provides an opportunity to discuss malaria prevention techniques and patient concerns and is usually necessary for the prescribing of antimalarial chemoprophylaxis. Pre-travel care has been reported between 18% of VFRs at an Italian immigrant clinic and 70% of VFR travelers in a small community-based survey in the Netherlands,[76,81] and 16% of first-generation VFRs with travel-acquired malaria.[22] Despite this broad range, it is commonly observed that VFRs are less likely to report pre-travel care than other types of travelers.[62] Many VFRs report seeking pre-travel care with their primary care physicians instead of at a travel clinic where specialized knowledge on travel care is more common due to familiarity with the provider or clinic and easier navigation of acquiring an appointment.[56,79,83] Evidence of challenges in acquiring pre-travel care[83] and navigating the health system[56] suggest that the failure to receive pre-travel care does not result solely from behavioral barriers, but rather that structural barriers exist that prevent VFRs from effectively accessing comprehensive pre-

travel care. To develop solutions and barrier reduction strategies, these barriers must be explored in greater detail.

VFRs' experiences in the health care system when ill with symptoms of malaria

Both in preventive and clinical care settings, VFRs report that the quality of provider care around malaria may be limited.[56] A sentiment reported frequently among VFRs is that they perceive health care providers in high-income countries may not be sufficiently trained on malaria to provide adequate pre-travel care or treatment of malaria illness.[56,63,78,83] Primary care providers themselves anecdotally report low confidence in chemoprophylactic prescribing and travel care, alongside time constraints during visits in a small qualitative study among providers in England.[103]

Focus group participants in the MPP study expressed concerns around seeing a health care provider if they had malaria symptoms.[56] Anecdotes recurred of physicians ignoring patients' statements that they suspect they had malaria and either quarantining patients or sending them home untested.[56] Others expressed concern that US health care providers may not be equipped to recognize, diagnose, treat, or prevent malaria due to their lack of experience with the disease.[56] These sentiments have been reported elsewhere in the literature as well.[63,78,83] Additional evidence of this issue may shed light on why these perceptions of poor quality health care exist among VFRs and whether physician approaches to malaria prevention and treatment could be improved.

Cost of pre-travel care and malaria prevention

The cost of pre-travel care, chemoprophylaxis, and other malaria prevention techniques can be a considerable barrier for VFR travelers, especially when an unplanned trip arises and has not been budgeted. Insurance coverage is intimately linked to these pre-travel care and prescription drug costs and can impact VFRs willingness or ability to achieve desired prevention. Cost barriers to accessing pre-travel care appear to impact the disparity of pre-travel care in the VFR population. The cost of pre-travel care itself, plus unclear information on insurance coverage and out-of-pocket costs from navigators, and unexpected high costs are concerns expressed by VFRs.[56,81,83]

The cost of chemoprophylaxis is an identified barrier to its use,[56,63,83] especially when VFRs were travelling as family units when multiple prescriptions are purchased at once.[78] In one study, among VFRs at a travel clinic in Australia, 16.7% (15/90) VFRs refused a chemoprophylaxis prescription, while slightly fewer non-VFRs (12.5% 6/48) refused chemoprophylaxis.[60] The most

commonly cited reason for refusing antimalarials was the cost of the medication.[60] Further exploration of cost and insurance impacts are necessary.

The need for increased study of upstream barriers to malaria prevention

Research on malaria prevention in VFRs is predominately focused on behavioral barriers. Knowledge and attitudes around malaria have been studied extensively in VFRs with evidence that increased knowledge or perception of risk does not strongly predict preventive behavior.[62,72,81] Chemoprophylaxis use and adherence has also been studied in detail; studies have presented a broad range of estimates of chemoprophylaxis use among VFRs, ranging 18-60%.[73,76] Adherence to chemoprophylactic regimens is poor across all types of travelers.[77,87] While these behavioral barriers are real and impactful, there is a need to also look upstream at structural barriers to malaria prevention and other traveler health issues. The small body of literature on structural barriers to malaria prevention indicates that the travel medicine field would benefit from engaging public health leaders from outside its traditional boundaries of clinical care and epidemiology, especially policy experts and those who understand health systems, the complicated aspect of immigration status and insurance coverage, and policies that improve access to needed care.

This chapter presents a step towards upstream thinking in an effort to understand structural barriers to malaria prevention among VFRs by describing VFR experiences with the health care system before and after travel. Specifically, access to primary care, use of pre-travel care, and experiences with health care after returning from travel with malaria illness are explored across VFR populations. These outcomes are also relationally explored to one another to examine how use of primary care relates to travel-related health care such as seeking pre-travel care or concerns about seeing a health care provider with malaria symptoms. Quantitative and qualitative findings from a three-setting survey of VFRs traveling to Sub-Saharan Africa are reported.

Methods

The surveys that provided data for analyses in this chapter were developed and tested through previous activities in the Malaria Prevention Project (MPP). See Chapter 3 for detail on survey design, sampling methodology, and study design broadly.

Questionnaires were developed for surveying populations in three settings: 1) Imported malaria cases reported to the state health department (surveyor-administered), 2) VFRs in the community

at select community events including population-specific cultural celebrations and health fairs (self-administered) and other miscellaneous sites including online (self-administered), or presenting to an emergency department (surveyor-administered), and 3) travel clinic patients at a travel specialty clinic (surveyor-administered). Although each setting presents unique opportunities for data collection on barriers to malaria prevention, most questionnaire prompts were standardized or uniform across these three settings, allowing for the aggregation of survey data across settings and making traveler subgroup comparisons more robust. Both quantitative and qualitative prompts were designed to understand VFRs' experiences with the health care system.

Definitions and eligibility

Eligible VFRs are defined by this study as 1) meeting the CDC definition for a VFR traveler, 2) except where the CDC definition includes majority population spouses (spousal place of birth was not collected in the surveys) and 3) reporting country of destination in a Sub-Saharan African country with ongoing malaria transmission as reported by the CDC 2018 Yellow Book.[1] Additional eligibility requirements specific to each survey setting can be found in Appendix 3. The CDC definition for a VFR traveler is as follows:

> A traveler categorized as a VFR is an immigrant, ethnically and racially distinct from the majority population of the country of residence (a higher-income country), who returns to his or her home country (lower-income country) to visit friends or relatives. Included in the VFR category are family members, such as the spouse or children, who were born in the country of residence.[12]

Regional distinctions are made in subgroup analyses for VFRs traveling to West Africa and other parts of Sub-Saharan Africa. West African VFRs are defined as VFRs traveling to countries within the Global Burden of Disease West Africa region:[98] This includes the following nations: Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, and Togo.

VFR travelers to other parts of Sub-Saharan Africa, referred to as 'Other SSA VFRs', are defined as VFRs traveling to countries within the Southern, Eastern, and Central Sub-Saharan Africa GBD regions,[98] excluding Lesotho due to malaria eradication.[1] This includes the following nations: Angola, Botswana, Burundi, Central African Republic, Comoros, Congo, Democratic

Republic of the Congo, Djibouti, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Kenya, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Subgroup analyses by survey setting compare characteristics and outcomes for the three survey settings. In some analyses, setting 2 (community) and 3 (travel clinic) respondents are combined to allow for comparison between malaria cases and the combined group, termed 'non-cases.' The study does not employ case-control sampling methodology; comparisons of cases and non-cases should not be interpreted as such.

Outcomes analyzed

The survey prompt determining whether a respondent had a primary care provider first defined primary care, *'Primary care doctors are doctors you go to for checkups and health problems that aren't emergencies,'* then asked respondents, *'Do you go to a primary care doctor?'* to establish a standard interpretation of primary care for respondents. Primary care in this study can be understood as having a usual source of care. This binary outcome was used to classify respondents by their use of primary care.

Regarding pre-travel care, malaria cases and respondents in the community setting were asked whether they saw a health care provider prior to their most recent past trip, or in the case of planning their first VFR trip, whether they plan to see a health care provider for their upcoming trip. Further detail was solicited around the type of health care provider, e.g. whether the provider was / would be a travel clinic provider, a primary care provider, or other types of providers.

Prompt differences to understand differences in concerns seeing a health care provider with symptoms of malaria across case and non-case groups

To test to what extent attitudes about malaria illness and perceptions of providers affect VFRs' willingness to seek treatment for malaria illness, hypothetical situations were posed among non-case VFRs – those surveyed in the community or at the travel clinic – and were compared with aligned questions for malaria cases' actual experiences with the health care system when they became ill. To understand whether and why VFRs may delay seeking treatment with malaria symptoms, individuals with diagnosed malaria (cases) were asked whether they went to a health care provider as soon as symptoms emerged, or if they tried to treat their illness at home first. The following aligned hypothetical situation was prompted to community and travel clinic

respondents: *Imagine you just got back to the United States from a trip to [country of travel] and started to feel symptoms of malaria such as fever and chills. Would you go to the doctor right away or try to treat it yourself at home first?*

To better understand VFR perceptions of providers and stigma in the health care system, malaria cases were asked whether they had any concerns about seeing a health care provider with their symptoms; non-cases were asked if they would have concerns seeing a health care provider if they were to have malaria symptoms. These quantitative binary outcomes for delay in seeking care and concerns about seeing a health care provider with symptoms were supplemented by qualitative free-response prompts exploring why respondents felt this way.

Adding health care system experiences to the proposed conceptual framework

Following the conceptual framework developed in Chapter 4, (Figure 10), increasing number of VFR trips taken is hypothesized to correlate with a decreased likelihood of seeking pre-travel care due to increasing familiarity with the destination and decreasing perception of risk following subsequent healthy trips. Participants reported the number (count) of previous trips they had taken as a VFR, up to a final category of '5 or more times.' This variable was examined in its relationship with whether respondents reported a travel-related health care visit before their most recent past trip. A binary outcome for frequent travel was extrapolated creating categories for '5 or more trips' and '4 or fewer trips.' In its relationship with seeking pre-travel care, trip frequency was also examined as a nonparametric ordinal variable due to nonnormality and a noncontinuous distribution using the Mann-Whitney U test.

Quantitative statistical analysis and assumptions

Quantitative statistical analyses were performed to compare sample means ($\bar{x}$), medians ($\tilde{x}$) and proportions (%) of relevant outcomes and characteristics between traveler setting and traveler population subgroups and are presented in tables. Figures with error bars present the 95% confidence interval around the sample statistic. Comparative analyses with resulting p values are specified in tables and include Wald's Chi square statistic (χ^2) and corresponding odds ratios (OR), or the Mann-Whitney U statistic. The significance level was set for all analyses at α=0.05. Statistical analyses were performed in SAS version 9.4 (SAS Institute, Cary, NC). Data are visualized in Excel version 2016 (Microsoft, Redmond, WA).

Where parametric tests are performed (e.g. Wald χ^2), normality of distributions is assumed due to robust overall and subgroup sample sizes. Logistic regression analyses also assume linearity on the log scale between predictors and outcomes. Where goodness of fit statistics identified poorly fitting continuous predictors (e.g. duration of travel), predictors were transformed to improve normality and fit. Transformations are described where performed. Alternatively, nonparametric tests including the Mann-Whitney test were used in place of logistic regression when predictors were non-normal and non-continuous, such as in the case of number of trips taken and Likert scale-based variables.

Qualitative methodology and coding

Many prompts around health system barriers to malaria prevention were structured with qualitative, free response opportunities for participants to share more nuanced and detailed responses. Based on reports in the literature and the results of the qualitative analysis of initial focus groups, a deductive coding methodology with a preestablished codebook was developed to facilitate data collections across the range of study settings. Question structure across all settings allowed participants to respond freely and unprompted, but immediate response coding structure varied by setting (See Appendix 3). Surveyor-conducted settings allowed for the selection from preestablished codes or 'other' survey response fields, whereas self-administered settings provided respondents with only free text response fields. Additional detail and opportunities for 'other' responses were provided for qualitative prompts in all settings.

Due to the quantity and brevity of responses, a formal qualitative software program was not necessary to organize codes, categories, or themes. Instead, line-by-line coding was applied to all narrative responses in Excel 2016 (Microsoft, Redmond, WA) using hand-coding techniques after data collection. Novel codes not included as a part of the deductive methodology were developed when responses captured new perspectives. Code categories were created to organize codes with shared characteristics. Finally, themes were developed that captured codes and categories, supported by the frequency by which responses fell into these themes.

Select free response quotes that reflected key themes and provided more robust detail are included below alongside results. Quotes are *italicized* and indented from each lateral margin to distinguish from sub-headings. Quotes were reviewed a second time for PHI or any characteristics that may be identifying or invasive. Quotes are published in their original form except where very minor grammatical edits improved clarity.

Institutional review and funding source

The following institutional review boards approved and monitored the survey: Minnesota Department of Health (IRB#15-368), University of Minnesota (STUDY00001189), Hennepin Healthcare Research Institute, formerly Minneapolis Medical Research Foundation of Hennepin County Medical Center (HSR#17-4350), and HealthPartners Institute (IRB0#A14-011). MPP was funded by a cooperative agreement grant from the Centers for Disease Control and Prevention (CK000357-01) from fiscal year 2016 through 2019.

Results

A total of 489 respondents completed surveys across the three settings; 351 participants met the study definition of a VFR traveler and are eligible for analysis in the present chapter.

Demographics

Refer to Chapter 4 and Table 5 for a detailed summary of VFR demographics and differences by survey setting or traveler population. Demographics that more closely relate to how VFRs interact with health care systems are summarized and in Table 7. More than two-thirds (68.5% 224/327) of VFRs across study settings reported greater than a high school education. However, a considerable group, 9.5% (31/327) of all VFRs, reported grade school education, suggesting a sub-population exists of VFRs with low general and health literacy. Differences in education level were not observed between survey settings, but education level was observed to be lower among Other SSA VFRs than West African VFRs. Grade school education was reported by 17.4% (23/132) of Other SSA VFRs and by 4.1% (8/195) of West African VFRs ($p<0.001$). Postsecondary education was reported by 46.2% (61/132) of Other SSA VFRs and by 83.6% (163/195) of West African VFRs ($p<0.001$). The study sample was predominately first-generation VFRs with 95.6% (333/347) reporting birthplace outside of the United States. No differences in foreign-born status were observed across study settings or traveler populations.

Most VFRs (88.3%, 159/180) reported having a primary care provider. The travel clinic setting had the largest proportion of VFRs reporting primary care (94.5%, 86/91) and were more likely than community (82.5%, 52/63, $p=0.038$) or case VFRs (80.8%, 21/26, $p=0.023$) to have a PCP. Having a PCP was not statistically associated with education level, gender, birthplace in the US, length of residency in the US, or number of trips taken as a VFR. A ten-year increase in age (e.g. comparing a 50-year old to a 40-year old respondent) is associated with 1.62 times greater odds of having a primary care provider (OR=1.62 $p=0.010$).

Pre-travel care and barriers to its acquisition

Due to the sampling protocol, travel clinic respondents, by definition, sought pre-travel care; these respondents were excluded from analyses in this subheading. Eligible respondents include VFRs surveyed as malaria cases or VFRs surveyed in the community who had traveled in the past. Trip characteristics such as region of travel or duration of travel were not statistically associated with reported pre-travel care. Pre-travel care was reported by 75.8% (91/120) of female respondents and 63.9% (78/122) of male respondents (p=0.007). A 10-unit increase in age (e.g. comparing a 50-year old respondent to a 40-year old respondent) was associated with increased odds of having sought pre-travel care (OR=1.38 p=0.004). Education level, birthplace in the US, and ever having malaria was each not associated with seeing a health care provider before travel. Pre-travel care was reported by 58.3% (42/72) of those with a primary care provider and 43.8% (7/16) of those without (p=0.017).

Pre-travel care and frequency of VFR travel: a link in the proposed conceptual framework

Among VFRs surveyed in community and case settings, pre-travel care was reported by 59.6% (31/52) of travelers who reported taking 5 or more trips, 76.4% (55/72) of travelers having taken 2-4 trips, and 72.9% (70/96) of VFR having taken one trip or planning their first trip. The odds of seeking pre-travel care was significantly lower among VFRs reporting taking 5 or more trips than those reporting 4 or fewer trips (OR=0.508 p=0.042). When trip count is explored as a continuous variable, a non-nonmoral distribution and positive skew is observed. Due to the noncontinuous ordinal design of the number of trips taken variable (See Appendix 3), the relationship between seeking pre-travel care and number of trips taken was explored through the nonparametric Mann-Whitney test. The difference in trip count among those who sought pre-travel care ($\bar{x}$=2.7, $\tilde{x}$=2) and those who did not ($\bar{x}$=2.2, $\tilde{x}$=2) was observed to approach but not reach statistical significance (two-sided p=0.067).

Differences in pre-travel health care provider type across survey settings

As described in Chapter 4, and available below in Table 7, nearly than three-quarters (73.2%, 123/168) of community respondents reported seeing a health care provider before their last trip, whereas 41.9% (18/43) of malaria cases saw a provider before traveling (p<0.001). When examining the type of health care provider seen, the majority of malaria cases (63.6%, 7/11) who did report pre-travel care were seen by a travel clinic provider, fewer (36.4%,4 /11) were seen by a primary care provider, and no cases were seen by both primary care and travel clinic providers.

More than one quarter (26.9%, 32/119) of community respondents who sought pre-travel care reported seeing both a primary care and travel clinic provider, perhaps due to referrals, leading to non-mutually exclusive estimates for primary care and travel clinic providers in the community. A total of 59.7% (71/119) of community respondents with pre-travel care saw their primary care provider and 66.4% (79/119) saw a travel clinic provider. There are no statistically significant differences between malaria cases and community respondents in their likelihood of seeing a primary care provider (p=0.146) or of seeing a travel clinic provider (p=0.854).

Differences in the type of pre-travel care were observed between West African VFRs and Other SSA VFRs (Table 7). Among VFRs who reported pre-travel care, seeing a primary care provider was reported by 71.8% (28/39) of Other SSA VFRs and 51.6% (47/91) of West African VFRs (p=0.036). Seeing a travel clinic provider was reported by 43.6% (17/39) of Other SSA VFRs and 75.8% (69/91) of West African VFRs (p=0.001).

Reasons for not seeking pre-travel care

Among the 75 total VFR malaria case and community respondents who did not seek pre-travel care, 56 respondents shared reasons why they did not (Table 8). Reasons were categorized into two groups by whether the reason related to underlying behavioral or health systems barriers. Respondents reported 41 total behavioral barriers to not seeking pre-travel care; top barriers were the attitude that pre-travel care was unnecessary (29), and the lack of knowledge to seek pre-travel care (7):

> *Because I did not think I need one. I am confident that I have decent knowledge on malaria and how to contract it.*
>
> *I went to Africa many times and didn't think I needed it.*
>
> *I was not informed I needed to see a doctor.*

Barriers originating from the structure of the health system in which respondents interact were reported by 13 respondents. Health system barriers included that patients did not have enough time to be seen for pre-travel care (10) including 2 that specified there was no appointment available, they were uninsured (2), and the cost of pre-travel care (1):

> *My trip was coming soon, and I didn't get a chance to get medications or vaccines.*

I couldn't find an appointment.

No health insurance.

Prompts directly inquiring about travel lead time, appointment availability or delay, insurance status, and the costs of pre-travel care were not included in the survey due to the breadth of behavioral and systems-level barriers addressed in the survey and need for brevity expressed by Community Advisory Board reviewers. These health systems barriers cannot be explored through a quantitative lens at this time, but do echo barriers reported by participants of focus groups in earlier parts of the Malaria Prevention Project.[56]

Table 7: Select demographics and VFR experiences with the health care system across study settings and traveler populations

Characteristic	All VFRs	VFRs by Setting			VFRs by Traveler Population		M v C p	M v T p	C v T p	W v S p
	Overall n=351	Malaria Cases (M) n=43	Community (C) n=212	Travel Clinic (T) n=96	West Af VFRs (W) n=214	Other SSA VFRs (S) n=137	Pairwise Wald $\chi 2$ (*df=1*)			
Foreign born	95.6 (93.9-98.0)	97.7 (93.0-100)	96.2 (93.6-98.8)	94.6 (89.8-99.3)	94.8 (91.8-97.8)	97.7 (95.3-100)	0.642	0.428	0.513	0.184
Education = grade school	9.5 (6.3-12.7)	11.1 (0.3-21.9)	11.5 (7.0-16.0)	4.4 (0.1-8.7)	4.1 (1.3-6.9)	17.4 (10.9-24.0)	0.947	0.175	0.062	<0.001
Education > high school	68.5 (63.4-73.6)	63.9 (47.4-80.4)	65.5 (58.9-72.1)	76.9 (68.1-85.7)	83.6 (78.3-88.8)	46.2 (37.6-54.8)	0.852	0.138	0.052	<0.001
Has a primary care provider @	88.3 (83.6-93.1)	80.8 (64.5-97.0)	82.5 (72.9-92.2)	94.5 (89.7-99.3)	86.1 (78.3-93.9)	90.0 (84.2-96.0)	0.843	0.038	0.023	0.406
Saw health care provider before last trip *	66.8 (60.4-73.2)	41.9 (26.5-57.2)	73.2 (66.4-80.0)	^ 100 --	69.9 (62.3-77.5)	60.3 (48.4-72.2)	<0.001	--	--	0.166
Of those who saw a HCP, PCP *	57.7 (49.1-66.3)	36.4 (2.5-70.3)	59.7 (50.7-68.6)	-- --	51.6 (41.2-62.1)	71.8 (57.0-86.6)	0.146	--	--	0.036
Of those who saw a HCP, travel clinic *	66.2 (57.9-74.4)	63.6 (29.7-97.5)	66.4 (57.8-75.0)	^ 100 --	75.8 (66.9-84.8)	43.6 (27.3-59.9)	0.854	--	--	0.001
Of those who saw a HCP, both PCP & travel *	24.6 (17.1-32.1)	0.0 --	26.9 (18.8-35.0)	-- --	28.6 (19.1-38.0)	15.4 (3.5-27.2)	n/a	--	--	0.115
If sick with malaria symptoms, would…#										
Try and treat at home before seeing HCP	14.3 (10.5-18.0)	41.9 (26.5-57.2)	13.1 (8.4-17.9)	4.2 (0.1-8.3)	19.1 (13.7-24.6)	6.8 (2.5-11.2)	<0.001	<0.001	0.025	0.003
Have concerns seeing HCP	12.8 (9.1-16.5)	33.3 (13.0-53.7)	12.9 (8.3-17.6)	7.4 (2.0-12.7)	17.4 (11.9-22.8)	6.2 (2.0-10.3)	0.012	0.002	0.161	0.005

@ Paper and online versions of the community survey omitted this prompt; community group is ED exclusively

* Overall, W, S, and their pairwise OR exclude travel clinic participants

For malaria cases, prompts were not hypothetical, i.e. *Did you try to treat at home first* and *Did you have concerns seeing a HCP*

^ Noninformative; sampling protocol-determined outcome

α=0.05; p values in red are statistically significant

Table 8: Reasons provided why respondents did not seek pre-travel care, organized into categories for behavioral and health system barriers. Respondents could provide multiple reasons; counts reflect number of different respondents who provided a given reason.

Reason did not seek pre-travel care	Count
Behavioral barriers	41
Pre-travel care is unnecessary	29
Didn't know to seek care	7
Would get antimalarial at destination	2
Thought was vaccinated	1
Had recently been to a doctor	1
Had been to a travel clinic for a prior trip	1
Health system barriers	13
Not enough time	10
No appointment available	2
Uninsured	2
Cost	1

Table 9: Case and non-case responses to prompts around interacting with the health care system with malaria symptoms. Respondents could provide multiple reasons; counts reflect number of different respondents who provided a given reason.

	Cases	Non-cases
Did you / Would you have concerns seeing a HCP with malaria symptoms…		
Yes	**33.3%**	**11.1%**
Doctors are unknowledgeable	6	19
Could be quarantined	4	6
Cost of treatment / lack of insurance	1	2
No	**66.7%**	**88.9%**
When you felt / If you were to feel symptoms of malaria…		
Did / Would go to the doctor right away	**58.1%**	**89.8%**
To get tested and treated	--	142
Malaria is a serious illness	--	90
Could be contagious	--	9
Did / Would try and treat at home first	**41.9%**	**10.2%**
Might not be malaria / wait and see if symptoms resolve	12	9
Easy to treat / already have medicine	2	15
Malaria is not a serious illness	0	6
Doctors are unknowledgeable	0	4
Treatment would be expensive	1	2
Could be quarantined	0	1

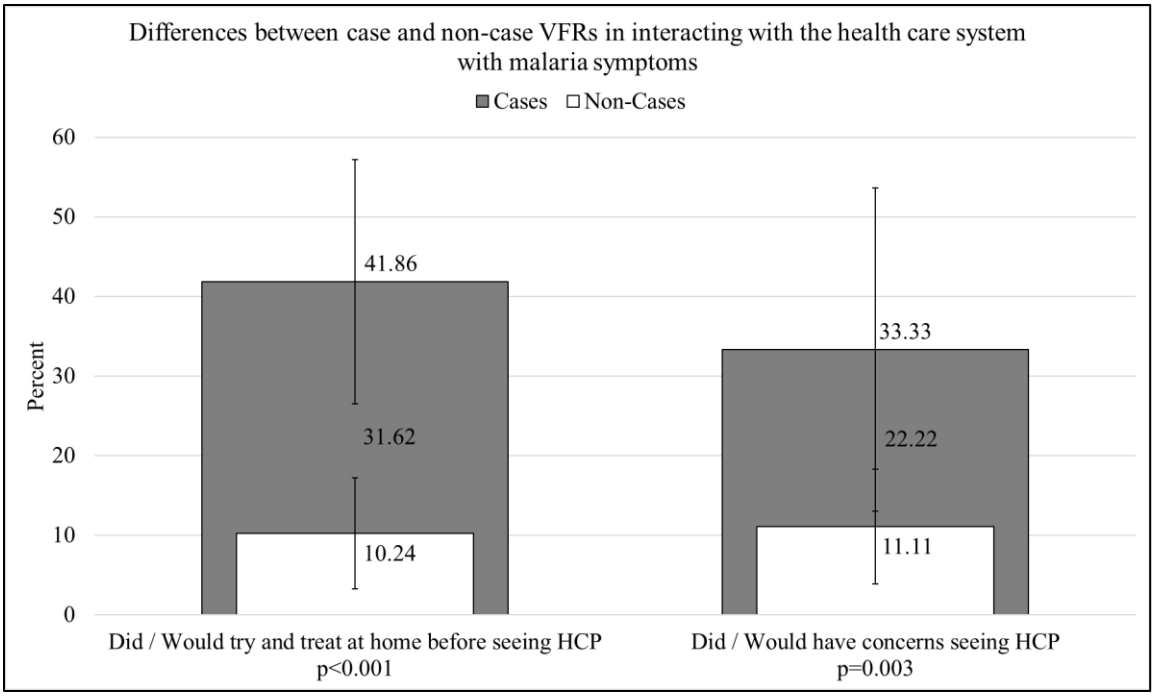


Figure 11: Differences between case and non-case VFRs in interacting with the health care system with malaria symptoms. P value presents statistical significance the Wald χ^2 test of association of case/non-case status on response outcomes.

Navigating malaria illness in the US health care system

Concerns seeing a health care provider

One-third (33.3%, 8/24) of malaria cases reported feeling concerned about seeing a health care provider with their malaria symptoms, while 11.1% (33/296) of non-cases felt they would be concerned seeing a provider if they were to have symptoms of malaria (p=0.003) (Figure 11). The most commonly expressed concerns by cases were shared by non-cases (Table 9). Top concerns were: US doctors are unknowledgeable about malaria (25 total reports), fears of being quarantined (10), and issues around the cost of treatment and insurance coverage (3):

> *I was concerned about seeing by a health care provider who doesn't know about malaria. This doctor who saw me looked at MDH website to learn more about malaria. I also told him to test me for malaria before he knew it. (Case)*
>
> *When I went to urgent care and I told the doctor I have malaria and they did not believe me. (Case)*

I thought the doctors made it a bigger deal and thought I should be quarantined. There were too many doctors asking questions and I felt like I was a guinea pig. (Case)

The doctors did not know it was malaria and was transferred 4 times. Some thought I had Ebola and was placed in quarantine and had to wear a face mask. A lot of the doctors were scared of malaria. (Case)

I might be quarantined and put into isolation. I just came from foreign country, so I was scared of isolation and stigma. (Non-case)

I was worried about health care cost and too expensive medications. (Non-case)

I've heard that some African have been put in quarantine in US hospital just because they had malaria. Malaria is not well known here. Provider will searching for other disease even if you tell them you think you have malaria you will be lucky if you find someone who hear. (Non-case)

Concern about seeing a health care provider was not found to be statistically correlated with level of concern about malaria, age, education level, birthplace in the US, or number of trips taken. Concern about seeing a health care provider with symptoms of malaria was reported by 25.0% (5/20) of VFRs without a primary care provider and 8.2% (13/158) of VFRs with primary care (OR=0.27 p=0.027). This comparison was adjusted for survey setting under the hypothesis that setting acts as a confounder, for example, travel clinic VFRs are better linked to primary care and are less concerned about provider competence as they plan to see specialists. After the adjustment, those with a primary care provider had even lower odds of being concerned to see a health care provider (aOR=0.24 p=0.031).

Try and treat at home or see a health care provider immediately for malaria symptoms

Broad differences in health care system perceptions between cases and non-cases were also observed regarding decisions around whether to seek care immediately when malaria symptoms present. Whereas 41.9% (18/43) of malaria cases reported they tried to treat their illnesses at home first, only 10.2% (30/293) of non-cases reported they would treat at home first if they became sick with malaria symptoms (OR=6.31 p<0.001) (Figure 11).

Table 9 presents reported reasons why cases and non-cases would try and treat symptoms of malaria first. Eighty percent (12/15) of case respondents who provided a reason tried to treat symptoms at home first because they thought it might not be malaria or that the symptoms might resolve. This was reported by non-cases as well, but at made up only 24% (9/37) of the reasons provided. Other reasons for treating malaria symptoms at home first included: because it is easy to treat malaria or they already have the medicine on-hand (17 overall), because malaria is not serious (6), because doctors are unknowledgeable about malaria (4), because the cost of going to the doctor was prohibitive (3), and because doctors may quarantine the patient (1):

> *I thought I could handle it.*
>
> *Because I don't think it needs a doctor visit.*
>
> *I am concerned the doctors here would not know how to treat malaria.*
>
> *Only go to the doctor if I am unable to treat. I always bring malarial medicines with me as preventive measures if incase I get sick.*

Among the 232 non-cases who reported a reason why they would see a provider right away, the leading reason was to get tested and treated (142 responses), followed by malaria being a dangerous illness (90) (Table 9). Nine respondents reported seeing a provider in case they were contagious and didn't want to spread illness to others:

> *I came from Africa. I don't know what It could be. Tylenol and ibuprofen might not help me.*
>
> *If I'm feeling any symptoms when I've travelled, I always go to the doctor right away. I wouldn't want to take any chances.*
>
> *I can't guess what it might be. Fever is the first sign and I would not minimize the possibility. We are not 100 percent protected no matter what we do. Malaria is deadly when kids have it. For adults there might be complications that open the door to other health issues.*

Seeking care immediately, as opposed to treating at home first was significantly associated with increased age. A ten-year increase in age (e.g. comparing a 50-year old respondent to a 40-year old respondent) correlates with increased odds of seeking care immediately (OR=1.46 p=0.003). Similar to concerns about seeing a health care provider with malaria symptoms, seeking care

immediately was reported more commonly by those with a primary care provider (91.8%, 146/159) than by those without primary care (76.2%, 16/21, OR=3.51, p=0.033). Survey setting does not appear to confound the relationship in this case. A one-point increase in score for general concern about malaria during travel was associated with increased odds of seeing a health care provider right away (OR=1.26 p=0.0171). Treating at home or seeking care first was not associated with gender, education, birthplace in the US, or number of trips taken.

Discussion

Primary and pre-travel care

Established primary care: a key correlate to pre-travel visits and improved perceptions of care

VFRs with a primary care provider were more likely to report pre-travel care. Additionally, having a PCP was positively associated with significantly improved perceptions of the health care system in the case of malaria symptoms. Those with a PCP had 3.51 times greater odds of seeking care immediately when malaria symptoms present and 4.17 times greater odds of not having concerns seeing a health care provider. Together, these relationships suggest that being engaged in preventive medicine is positively impactful on malaria prevention and relates to better experiences with and perceptions of the health care system. In addition to improving overall health, efforts improving immigrant access to preventive medicine services therefore may also improve pre-travel care and malaria prevention among VFRs and decrease imported malaria cases.

Primary care: an opportunity to enhance provider resources and connect VFRs to travel care

About sixty percent (59.7%, 71/119) of community respondents with pre-travel care saw their primary care provider and slightly more 66.4% (79/119) saw a travel clinic provider. Even when including VFRs who did not seek pre-travel care, overall pre-travel care in a primary care setting was reported by 42.3% (71/168) of all community respondents who have traveled in the past.

Regardless of whether primary care is equipped to provide pre-travel care, it is commonly used for this purpose by VFRs. This provides compelling evidence that interventions should be developed that target the primary care audience with information about health issues unique to VFR travelers. Alongside the preponderance of unplanned travel among VFRs, these findings also highlight the need for providers initiating discussions about travel health and pre-travel care even among immigrants who do not describe planned travel. Primary care providers should start

conversations with potential VFR travelers to share information on the availability of highly-specialized, travel care providers and their ability to provide in-network referrals.

Additionally, because such a large proportion of VFRs seek pre-travel care with their primary physician, and many VFRs have little lead time to their trips, resources should be readily available to primary care physicians on prescribing chemoprophylaxis and providing pre-travel counsel. Dissemination of existing resource guides like the CDC Yellow Book, with information on appropriate prescribing accounting for drug resistance profiles at destinations and tolerability of side effects should be targeted to primary care audiences. Additionally, new resources on common barriers VFRs face in acquiring their full prescription regimen, behavioral barriers, and provider access to consults from specialists should be shared throughout primary care networks as well. Future studies could examine differences in the confidence and knowledge of traveler health among primary care providers in a range of clinic settings commonly visited by VFRs, including those serving large immigrant populations, federally qualified health centers, and pediatric primary care clinics.

Impressions of health care quality around malaria treatment

Differences between cases and non-cases

Case respondents were significantly more likely to be concerned about seeing a health care provider with malaria symptoms than non-case respondents. Furthermore, cases were more likely to delay seeking care for their malaria illness than non-cases when thinking about the same hypothetical situation. This suggests that some of the issues VFRs face when engaging with health care providers may be unrecognized or unanticipated until they find themselves in the situation and experiencing symptoms. At which time, perhaps, subconscious concerns, assumptions, and fears surface. Anecdotes VFRs may have heard from friends and family, such as those circulated in multiple focus groups about being quarantined, may resonate more strongly and cause to a delay in care. Unanticipated concern for seeing a health care provider could cause a delay care and treatment, leading to poorer health outcomes and increased health care costs.

In fact, compared to non-cases with the hypothetical situation, cases more commonly reported actually delaying care because they wanted to wait and see if symptoms resolved on their own. When considering messaging interventions around malaria illness developed by groups serving and targeting VFRs, it appears important to prioritize information that emphasizes the severity of malaria illness. Messages should convey that seeking care immediately with malaria symptoms

leads to better treatment outcomes, a faster resolution of symptoms, and decreased health care costs.

Differences in health systems perceptions between West African and Other African VFRs

Overall, West African VFRs do not appear differently linked to the health care system than Other SSA VFRs with no statistical differences observed in report of having primary care, or in seeking pre-travel care between the traveler populations. However, West African VFRs appear to have poorer perceptions of interacting with the health care system if malaria symptoms were to present. West African VFRs have more than three times greater odds of trying to treat at home before seeing a health care provider or of reporting concerns seeing a health care provider than Other SSA VFRs. This perceived stigma or incompetence in the health system by West African VFRs may reflect undercurrents of the 2014 Ebola outbreak response, as evidenced by occasional references to Ebola provided by respondents. But due to reports in the literature prior to this event of poor impressions of provider knowledge and experiences,[63,78,83] providers could do more to engage in more culturally competent care of West African patients. Opportunities for West African cultural competence training through partnerships with community-based organizations should be considered for health systems serving large populations of West African immigrants.

Actual health care quality of malaria treatment

Although travel and tropical medicine physicians are exceedingly well-trained and competent at diagnosing and treating malaria, the findings from this chapter, supported by evidence from focus groups and in the literature, suggest that the health care system broadly faces significant room for improvement in its messaging, diagnostic approach, and soft skills (compassionate care, cultural competence) around treating malaria illness among VFRs.

Due to its rarity as an imported disease in the United States, many providers outside of travel and tropical medicine are unfamiliar with malaria. VFRs understand this issue well and expressed it through multiple prompts discussed above. However, other providers, especially those who have been trained in malaria diagnosis and treatment or see it occasionally, provide exceptional treatment and care. This nuance was not conveyed in VFRs' perceptions of provider knowledge. Messaging to VFRs around the advanced training that travel medicine physicians receive may reduce VFR concerns about seeing a health care provider with malaria symptoms and encourage them to seek pre-travel care in the first place.

Inward-facing systems interventions and messaging improving health care experiences for VFR travelers are also necessary. VFRs with malaria expressed feeling like a guinea pig or that providers made a spectacle of their illness. At the same time, providers have an obligation to ensure the safety of their clinics, patients, and colleagues. Malaria is a tropical illness that can present with nondescript symptoms. Other infectious diseases transmittable from person to person should be included on the differential diagnosis and apposite personal protective equipment and infection control procedures should be followed until those diseases are ruled out. However, multiple patients in this sample communicated to their providers '*I think I have malaria'* and were not immediately tested. Providers interfacing with travelers need to 'think malaria' in these situations and perform diagnostic tests in a timely fashion, alongside appropriate infection prevention. This would not only lead to expedited diagnosis and treatment, but improved relationships with their VFR patients as well. Interventions should be developed to train emergency and urgent care providers in travel-related illnesses, alongside training in cultural competence that makes patients feel less alienated and more likely to promptly seek care.

Adding health care system experiences to the novel conceptual framework

This chapter identified that frequent travel as a VFR was negatively associated with the likelihood of seeking pre-travel care (Figure 10, evidence point 10). Among community VFRs, pre-travel care was reported by 59.6% (31/52) of travelers who reported taking 5 or more trips, and by 76.2% (125/168) of travelers having taken 1 to 4 trips in the past (OR=0.508 p=0.042). Although this may still reflect a behavioral and not structural barrier, as frequent travelers may find it unnecessary to seek pre-travel care, this finding provides additional evidence for the conceptual framework proposed in Chapter 4: The Increased Prevention - Healthy Travel - Decreased Prevention Paradigm (Figure 10).

However, sample sizes limitations may have impeded the ability to explore travel frequency as a continuous variable to better understand this relationship. If real, the effect of number of trips taken as a VFR on seeking pre-travel care was too small to detect statistically at the given study sample size using parametric or nonparametric models, but the hypothesis stands and should be studied further. Future research exploring the conceptual framework in greater detail will need to account for small effect sizes in its sampling plan and study design. Assuming future studies would measure trip count continuously and normality assumptions would be met to perform logistic regression, a sample size range using Whittemore's equation and the parenthetical

parameters was estimated (effect size: OR=0.87, event proportion: P=0.3, significance level: α=0.05, and power: 1-β=0.80).[104] This estimation finds that between 672 and 2982 total participants would be necessary to detect a statistical difference at the identified effect size.

Limitations

Due to survey length reductions, some key demographics determining with how a traveler interacts with health care systems, such as socioeconomic status, insurance status, and immigration status were not included. The Delphi process used to reduce the master survey to its final length (See Chapter 3) leaned on the expertise of travel medicine physician experts and Community Advisory Board members. Had this process engaged health care policy experts or others with advanced knowledge of health systems, there is high likelihood that some of these questions would have been retained, leading to a broader understanding of health system barriers to malaria prevention among VFRs. The shortcomings of this survey serve as a powerful lesson learned that the travel medicine field needs to explore its issues from beyond its traditional clinical and epidemiological perspectives and engage a broad range of public health professionals, especially policy leaders and those who can influence systems change.

Sources of bias

The proportions of VFR travelers in the community and among diagnosed cases who reported seeing a health care provider before travel in this study are greater than the broad range of estimates reported in the literature.[22,76,81] No similar quantitative studies have been performed on VFR populations in the Minneapolis-St. Paul metropolitan study area in the past for reference. Recall and social desirability bias may have shifted responses towards positively reporting pre-travel care and this effect is theorized to be larger in community settings than among cases. However, the proportion of cases that sought pre-travel care was also higher than reported in the literature. Furthermore, primary preventive care was reported by a strong majority of participants. These findings suggest that although some information bias may have been present, the study population appears to be engaged in preventive health care services. Therefore, the population should be generally receptive to interventions developed to increase their access and reduce barriers to pre-travel care.

The study was designed to reduce sampling bias in the community by engaging respondents through a range of approaches and locations. By surveying community respondents in an emergency department, the study sought to engage VFRs with added barriers to the health care

system that may be otherwise underrepresented through traditional community sampling techniques. This purposive sampling, however, could have skewed the community population toward those less connected to health care systems. Analyses of differences between ED community respondents and those surveyed through other approaches found no significant differences in demographics besides and overrepresentation of Other African VFRs sampled through the ED approach. Due to the location of the selected ED in a neighborhood with a large population of East African immigrants, this demographic shift within the ED community subgroup is not unexpected; a lack of other differences within the subgroup makes no compelling argument for bias towards respondents poorly linked to health care services.

Future work

Researching costs and insurance: shifting travel medicine research upstream

Preliminary results on systems barriers in this chapter suggest that further research should address issues of appointment delay, insurance coverage and cost the cost of pre-travel care, chemoprophylaxis, and post-travel treatment. Anecdotal findings in the survey, supported by the citation of costs and insurance status as a barrier to adequate malaria prevention in the focus groups suggests these issues should be explored in greater detail in future work. Given the complexity of eligibility for public insurance coverage for immigrant populations,[105] more should be done to examine the role of domestic insurance coverage on travel medicine access.

In addition to engaging policy leaders, a shift in the overall focus of travel medicine towards upstream determinants of key issues, including malaria in VFR travelers, is necessary. Regarding malaria prevention, insurance status and out-of-pocket costs are known to be a barrier to adequate antimalarial use; Medicaid prescribing limits for non-maintenance drugs has been identified as a clear barrier to acquiring a full chemoprophylaxis regimen.[59] Additional nuance of the this issue remains unexplored. Research on insurance coverage for pre-travel specialty care insurance should be conducted.

A study of the varying availability and costs of chemoprophylaxis at pharmacies in VFR neighborhoods is being concurrently conducted by the Malaria Prevention Project. Findings from this study will shed light on the inequitable availability and costs of antimalarial medicines for VFR travelers and points to the need for community-level systems interventions to improve health outcomes and equitable access among immigrant groups. Additional research on malaria prevention costs, however, is warranted. Explorations into decision theory around malaria

prevention among VFRs should be explored as there is anecdotal evidence that VFRs are weighing the costs of malaria prevention alongside competing costs, such as plane tickets, lodging, and gifts and supplies for hosts.

Other research: engaging health care providers

The issues identified in this study around VFR's poor perceptions of the health care system in its management of malaria warrants further exploration. Qualitative research with VFRs, paired with impact evaluations of messaging campaigns and provider cultural competence training may identify root causes and determine whether these perceptions can be positively shifted on a population scale.

Research studying primary care physician confidence in providing pre-travel care and prescribing appropriate chemoprophylaxis is also necessary. These studies should also explore PCP knowledge of key resources for pre-travel information and to what extent primary care providers initiate conversations about traveler health with their immigrant patients. Subsequent interventions seeking to provide supplemental training on traveler health for primary care providers could be developed.

Potential intervention: Pre-travel telemedicine

Increased frequency of travel as a VFR was negatively associated with seeking pre-travel care. Considering the conceptual framework proposed to explain the relationship with increased travel on malaria prevention alongside the finding that many VFRs who failed to seek pre-travel care expressed not having enough time before departure to seek care, improved access to rapid pre-travel care may improve malaria prevention and use of chemoprophylaxis among VFRs.

A potential health system intervention to lessen the barrier to securing pre-travel care rapidly would be permitting travel clinics to provide pre-travel care through e-visits or telemedicine. This intervention assumes VFRs would be able to access telemedical services quickly and more easily than recurrent travel specialty clinic visits. To ensure travelers are up-to-date on immunizations, and so that adequate information on malaria prevention and general travel health is communicated, these e-visits could be offered only to travelers who have seen a travel specialist in clinic at least once in a set timeframe (e.g. the last two years). This intervention may be particularly impactful for frequent VFR travelers and those who travel unexpectedly, for example, due to a family member's illness or death. Careful monitoring of an impact evaluation of this

intervention comparing chemoprophylaxis adherence and preventive behavior would be necessary to ensure electronic care is as impactful as in-person care on realizing recommended malaria prevention and reducing malaria risk. Because chemoprophylaxis use is likely the best malaria prevention approach, telemedicine has the opportunity to fill a gap in VFR antimalarial coverage among frequent and last-minute travelers, a group overrepresented among cases in the study.

Conclusions

Having a primary care provider is strongly positively associated with seeking pre-travel care and improved perceptions of the health care system. The primary care setting also appears to be the preferred or first destination VFRs look to for their pre-travel care needs. These findings emphasize the need to equip primary care providers with travel medicine resources and to encourage PCPs to initiate conversations with potential VFRs on traveler health. Significant concerns are expressed by VFRs, especially those who are experiencing malaria symptoms about their treatment in the US health care system. The availability of tropical medicine specialists should be communicated to VFRs, while improvements within the health care system must be made around recognizing malaria illness and providing culturally competent care. Finally, there is significant room for improvement for the travel medicine field to engage health policy experts and transition to exploring the systemic determinants of adequate malaria prevention. Partnerships between travel medicine experts and health policy analysts are necessary and will better identify upstream barriers and opportunities for impactful barrier reduction strategies.

Chapter 6: Heterogeneity of malaria prevention among VFRs and across traveler populations

Chapter abstract

VFRs are frequently referenced as a population of concern for imported malaria and do experience a disproportionate burden of the illness compared to other travelers. Yet, comparisons in barriers to malaria prevention between VFRs and other types of travelers are exceedingly infrequent. Differences between VFRs and other types of travelers along with key differences within VFR subpopulations must be better understood to develop barrier reduction strategies resonant and effective for at-risk VFRs. This chapter seeks to understand the intra- and inter-VFR population heterogeneity of barriers to malaria prevention. Intra-VFR comparisons are made by measuring differences among VFRs best linked to pre-travel care and VFRs surveyed in community settings; inter-population comparisons measure differences between VFRs seeking pre-travel care and those traveling for other reasons.

Participants meeting the CDC definition of a VFR traveler were surveyed through a cross-sectional questionnaire in the community or prior to their pre-travel visit at a travel clinic. Non-VFRs, travelers reporting another reason for their trip to a malarious country in Sub-Saharan Africa, were also surveyed at the travel clinic to serve as a comparator population. Differences in antimalarial use, other malaria prevention, and health care experiences were explored.

Comparing VFRs and non-VFRs in the travel clinic setting, VFRs were less successful in actualizing their planned use of antimalarial chemoprophylaxis than non-VFRs (82.2% versus 98.7% p=0.001), wearing long clothing (82.9% versus 95.9% p=0.019) and using bed nets (56.8% versus 81.8% p=0.009). At the same time, travel clinic VFRs were more likely than VFR respondents from the community to report taking an antimalarial (83.0% versus 61.9% p=0.009), to report picking where they stayed to avoid mosquitos (80.9% versus 63.1% p=0.025), to educate oneself about malaria (91.5% versus 63.1% p=0.001), to stay indoors when mosquitoes were out (80.9% versus 59.5% p=0.009), or to have a primary care provider than community VFRs (94.5% versus 82.5%, p=0.023).

Greater barriers exist to actualizing certain malaria prevention approaches for VFRs than for non-VFRs, even when both groups had received pre-travel counsel. Chiefly, actualized antimalarial use is significantly lower among VFRs. As the gold-standard for malaria prevention, antimalarial chemoprophylaxis use is critical to prevent malaria illness in travelers. Although VFRs at the

travel clinic appear better engaged with preventive and pre-travel health care than their VFR peers surveyed in the community, specialized pre-travel care does not appear sufficient to ensure chemoprophylaxis use among VFRs. Future research is necessary to characterize barriers and better understand why VFRs disparately fail to achieve intended malaria prevention.

Introduction

A broad range of medical and epidemiologic research has been conducted to understand VFR travel and root causes of the disproportionate burden of travel-associated malaria in this population. Despite a large number of studies addressing malaria in VFRs, imported malaria cases continue to increase in high-income countries.[2,61] Behavioral characteristics of malaria prevention among VFRs, including knowledge, attitudes and practices, are frequently cited, but VFRs are rarely compared to other traveler populations in order to explore differences in experienced barriers to malaria prevention. Furthermore, explorations into differences in malaria prevention success within the VFR population, for example, comparing VFRs of different backgrounds or with different health seeking behaviors, are even more infrequent.

This chapter seeks to understand the intra- and inter-population heterogeneity of barriers to malaria prevention. Intra-VFR comparisons are made by measuring differences among VFRs at a travel clinic (those best linked to pre-travel care), and VFRs surveyed in community settings (unassociated with pre-travel care). Inter-population comparisons measure differences between travel clinic VFRs and those traveling for other reasons, termed ‘Other Travelers’ surveyed at the travel clinic. These findings should shed light on key differences between VFRs and other travelers, and whether VFR subgroups exist with increased success in preventing malaria.

Comparisons of VFRs and other traveler populations

Five studies have been identified that compare VFRs to other traveler populations in regards to malaria prevention.[60,62,74,77,80] Rowe et al. (2017) compared VFRs and non-VFRs at an Australian travel clinic.[60] VFRs had significantly longer mean travel duration and were more likely to decline recommended antimalarial regimens, often citing the cost of the prescription.[60] VFRs had longer intervals between travel clinic visits and their departure date than non-VFRs, contradicting some assumptions and findings published elsewhere.[60]

Van Herck et al. (2004) found that 31.4% of VFRs sought pre-travel care and were less likely to do so than tourists (60.9%) or those traveling for religious reasons (82.5%).[74] VFRs were also less

likely than other travelers to report bringing an antimalarial on their trip.[74] A study of returned ill travelers (not limited to those with just malaria) by Baer et al. (2014) found that VFRs were no less likely than other ill travelers to have sought pre-travel care.[80] A study of antimalarial adherence among travel clinic patients found no differences in adherence between VFRs and tourist travelers.[77] Together, these findings suggest that differences in trip characteristics between VFRs and non-VFRs may affect malaria prevention. Antimalarial use, even when pre-travel care is sought, appears to be a greater challenge for VFRs than for other travelers. At the same time, issues to adequate malaria prevention, such as adherence to chemoprophylactic regimens, are experienced by a broad range of travelers.

Airport studies: missed opportunity for comparing VFRs to other traveler populations

A cross-sectional, standardized airport survey was piloted in 2003,[85] and subsequently replicated across the United States, Europe, South Africa, and Australasia. An identical questionnaire was given to all types of international travelers to destinations with endemic malaria. Although individually robust in sample size, six of seven identified publications resulting from these surveys failed to report comparative analyses on VFRs and other travelers, or subgroup analyses within the VFR group, despite most noting VFRs as a population of concern. Combined, these six malaria studies surveyed approximately 517 VFRs among 2,814 total international travelers. Among these six studies, VFRs comprised 43% of the traveler pool in the US,[71] 8% in South Africa,[70] 20% in Australasia,[69] 9% in Sweden,[68] 21.8 in the Netherlands,[67] 21 to 25% in the multisite European studies.[74,85] Although identical methodology was used across all sites, data presented in these articles were only summary level and comparative analyses by traveler population were not performed to detect differences in malaria prevention between groups.

The single study using this uniform instrument and methodology described above that did include VFR comparative analyses was performed at an airport in the Netherlands from 2003 to 2009 and was comprised of a traveler population to areas of high and low malaria risk.[62] Seventeen percent of respondents (521) were VFR travelers, 29.6% of whom (390) traveled to a destination with a high risk of malaria.[62] Key findings included that VFRs were less likely to seek pre-travel care than non-VFRs when destined for either high or low-risk areas and that VFRs were more likely to travel to high-risk destinations.[62] VFRs scored no different than non-VFRs on the assessment of malaria knowledge, but VFRs were less likely to report planned protective practices.[62] This dissonance between knowledge and practice may show that education-based interventions alone

may not affect preventive behaviors in VFRs. Finally, this study found that planned preventive practices and risk avoidance attitude improved in the overall traveler population over time.[62] Although a comparative analysis was not performed to observe this trend within VFRs alone, it suggests that travelers may be increasingly receptive to interventions that aid them in preventing malaria during travel.

Comparisons of VFR subpopulations

Three research articles have been identified that compare different West African VFR subpopulations to one another.[62,72,82] Discussed above, Van Genderen et al. (2012) performed a cross-sectional survey of airport travelers in Amsterdam destined to countries with high and low risk of malaria.[62] This study included both VFRs and other types of travelers. Most analyses focus on differences between VFRs and other travelers, but it was observed that travel high-risk destinations are more common among VFRs than travel to low risk destinations.[62] Although the sample size was robust within the VFR sub-population with 154 VFRs surveyed traveling to high-risk and 367 VFRs traveling to low-risk destinations, additional subgroup analyses were not performed to understand differences of VFRs traveling to destinations across the malaria risk gradient.

Beherns et al. (2013) found in their airport study that compared to Ghanaian or Kenyan travelers, Nigerians were less likely to use chemoprophylaxis, despite similar scores for knowledge and risk perception.[72] Nigerians were also more likely to make annual visits than Ghanaian or Kenyan respondents.[72] The heterogeneity observed across malarious destinations in West Africa provides further support that VFRs from different backgrounds may face distinct barriers KAP barriers to malaria prevention.

Pistone et al. (2007) explored differences in malaria prevention of VFRs surveyed in travel agency and travel clinic settings.[82] This study found VFRs in the travel clinic had a longer length of residency in France, took longer duration trips, and a higher proportion of travel clinic VFRs were traveling to West Africa.[82] Differences were not observed in malaria knowledge or risk perception between the two VFR subpopulations.[82] Planned antimalarial use and bed net use was greater among travel clinic VFRs than those at the travel agency.[82] Adequate chemoprophylaxis use and adherence was also higher among travel clinic VFRs.[82] These findings suggest that pre-travel care has a positive impact on preventive behaviors among VFR travelers.

Outside of the African VFR population, one report has indicated assumed homogeneity of malaria prevention among VFRs is overestimated. In a study of VFRs traveling to India, adherence to pre-travel health recommendations differed significantly by ethnicity within the VFR population,[106] suggesting that barrier reduction interventions may be more important or impactful in certain VFR-sub populations. These studies in West African and Indian VFR populations suggest that barriers to malaria prevention in VFR subpopulations should be explored in more depth across behavioral and health systems determinants. This research will help to better understand the predictors of prevention success and why certain subpopulations may face increased barriers to adequate malaria prevention.

Methods

Study design

The survey used for this chapter was developed and tested through previous activities in the Malaria Prevention Project (MPP). Refer to Chapter 3 for detail on survey design, sampling methodology, and study design broadly.

Questionnaires were developed and disseminated to surveying populations in two settings 1) Patients at a travel specialty clinic ahead of their visit, and 2) VFRs at community events, responding online, or presenting to an emergency department. Although both settings present unique opportunities for data collection on barriers to malaria prevention, most questionnaire prompts were standardized or uniform across these three settings, allowing for the aggregation of survey data across settings and making traveler subgroup comparisons more robust.

Survey process

Eligible participants at one of the two survey settings, the travel clinic, or community, were invited to participate in the voluntary survey. Surveys conducted in the emergency department (community sub-setting), and at the travel clinic were administered by trained surveyors. Surveys conducted at community events and online were self-administered. Surveys were administered in English, French, Amharic, and Somali either directly by language-proficient surveyors guided by translated surveys, or through the assistance of an interpreter. Elimination of qualitative pre-coding for open ended prompts and other modifications were made to the self-administered survey to ensure participants were providing unprompted responses.

Definitions and eligibility

Eligible VFRs are defined by this study as 1) meeting the CDC definition for a VFR traveler, 2) except where the CDC defines non-immigrant spouses as VFRs (spousal place of birth was not collected in the surveys) and 3) reporting country of destination in a Sub-Saharan African country with ongoing malaria transmission as reported by the CDC 2018 Yellow Book.[1] Additional eligibility requirements specific to each survey setting can be found in Appendix 3. The CDC definition for a VFR traveler is as follows:

> A traveler categorized as a VFR is an immigrant, ethnically and racially distinct from the majority population of the country of residence (a higher-income country), who returns to his or her home country (lower-income country) to visit friends or relatives. Included in the VFR category are family members, such as the spouse or children, who were born in the country of residence.[12]

Eligible non-VFRs, termed 'Other Travelers' are defined by this study as: 1) Having made a pre-travel consultation appointment at the HealthPartners Travel Clinic (St. Paul and Minneapolis, MN), 2a) Reporting reason for travel as any other reason besides to visit friends and relatives, or 2b) Reporting travel to visit friends and relatives, but not meeting the CDC definition for a VFR traveler,[12] and 3) Reporting country of destination in a Sub-Saharan African country with ongoing malaria transmission as reported by the CDC 2018 Yellow Book.[1]

Regional distinctions are made in subgroup analyses for VFRs traveling to West Africa and other parts of Sub-Saharan Africa. West African VFRs are defined as VFRs traveling to countries within the Global Burden of Disease West Africa region:[98] This includes the following nations: Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, and Togo.

VFR travelers to other parts of Sub-Saharan Africa, referred to as 'Other SSA VFRs', are defined as VFRs traveling to countries within the Southern, Eastern, and Central Sub-Saharan Africa GBD regions,[98] excluding Lesotho due to malaria eradication.[1] This includes the following nations: Angola, Botswana, Burundi, Central African Republic, Comoros, Congo, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Kenya, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Key outcomes and prompt structure

Prompts were developed to address VFRs' knowledge, attitudes, and practices (collectively, behavioral characteristics) around malaria prevention and travel, and experiences with the health care system before and after travel. Intra-VFR differences in behavioral characteristics and health care experiences were explored by comparing VFRs across community and travel clinic survey settings. Inter-population differences were explored by comparing travel clinic VFRs to travelers at the travel clinic reporting another reason for travel.

Malaria knowledge prompts focused on respondents' knowledge of malaria transmission mechanisms and prevention methods. Participants were prompted to agree or disagree whether malaria is preventable and to list specific ways malaria is contracted, or specific ways to prevent malaria illness during travel. The group of respondents providing any incorrect method of malaria prevention were identified and classified as a group listing an incorrect method of preventing malaria. Classification was also made separately for respondents reporting an incorrect method of contracting malaria.

Prompts addressing attitudes around malaria were developed and employed a 5-point Likert scale to measure level of agreement by respondents. Likert scale prompts were presented with a five-point scale ranging from 1=not true / disagree to 5=very true / strongly agree. VFR attitudes are explored, including around the deadliness of malaria illness and personal concern for malaria.

Experiences engaging with the health care system are explored using prompts about having a primary care provider, reported use of pre-travel care before respondents' most recent trip, and hypothetical situations about engaging with health care providers when experiencing malaria symptoms to understand respondents' perceptions of health care providers or stigma in the health care system.

Malaria prevention practices were explored by asking respondents whether they used or plan to use a broad range of malaria prevention methods, including taking antimalarial chemoprophylaxis, sleeping under bed nets, educating oneself on malaria before travel, picking where to stay to avoid mosquitoes, using repellent, staying indoors when mosquitoes are out, wearing long clothing, and using mosquito coils. Additional practices not linked to direct mosquito bite and illness prevention, such as seeking pre-travel care, are also explored.

Prompt design differences measuring planned and actualized malaria prevention in community and travel clinic settings

In the travel clinic setting, prior to their pre-travel consultation, respondents were asked about planned malaria prevention approaches. The proportion of all travel clinic respondents who reported planned malaria prevention are reported in Table 10. Separately, paired analyses are performed comparing planned and actualized malaria prevention proportions for only the cohort of travel clinic respondents who completed the pre-travel and post-travel components of the survey (Tables 12-14). All reports of actualized malaria prevention among travel clinic VFRs and Other Travelers reflect only those travelers who completed post-travel component of the survey.

In the community setting, a different methodology was used to quantify planned and actualized use of malaria prevention methods. Unlike the travel clinic setting where respondents were followed and pre/post-travel reports of planned and actualized malaria prevention are both available for individuals, in the community setting, planned and actualized malaria prevention reflects two mutually exclusive groups based on whether the respondent had traveled or not. Prompts were designed to ask about malaria prevention approaches used during respondents' most recent past trip, or about planned malaria prevention in the case that respondents hadn't yet traveled as a VFR and were planning their first trip. These groups are assumed to be comparable due to underlying demographic similarity; no statistically significant differences were identified between those having traveled and those planning travel in age, gender, education level (threshold greater than high school or grade school), birthplace in the US, or length of residency in the US. Travel region (West Africa versus Other SSA) and proportion with primary care were statistically different between those who have traveled and those planning travel (respectively $p<0.001$ and $p=0.030$). Reports of planned malaria prevention in the community reflect the population of only those respondents who had not traveled and were planning their first trip. Reports of actual malaria prevention used in the community reflect the population of only those respondents who have traveled previously as a VFR.

Statistical analysis and assumptions

Statistical analyses were performed to compare sample means ($\bar{x}$), medians ($\tilde{x}$) and proportions (%) of relevant outcomes and characteristics between traveler setting and traveler population subgroups and are presented in tables. Figures with error bars present the 95% confidence interval around the sample statistic. Comparative analyses with resulting p values are specified in tables and include Wald's Chi square statistic (χ^2) and corresponding odds ratios (OR), or the Mann-Whitney U statistic. The significance level was set for all analyses at α=0.05. Statistical analyses were performed in SAS version 9.4 (SAS Institute, Cary, NC). Data are visualized in Excel version 2016 (Microsoft, Redmond, WA).

Where parametric tests are performed (e.g. Wald χ^2), normality of distributions is assumed due to robust overall and subgroup sample sizes. Logistic regression analyses also assume linearity on the log scale between predictors and outcomes. Where goodness of fit statistics identified poorly fitting continuous predictors (e.g. duration of travel), predictors were transformed to improve normality and fit. Transformations are described where performed. Alternatively, nonparametric tests including the Mann-Whitney test were used in place of logistic regression when predictors were non-normal and non-continuous, such as in the case of number of trips taken and Likert scale-based variables.

Institutional review and funding source

The following institutional review boards approved and monitored the survey: Minnesota Department of Health (IRB#15-368), University of Minnesota (STUDY00001189), Hennepin Healthcare Research Institute, formerly Minneapolis Medical Research Foundation of Hennepin County Medical Center (HSR#17-4350), and HealthPartners Institute (IRB0#A14-011). MPP was funded by a cooperative agreement grant from the Centers for Disease Control and Prevention (CK000357-01) from fiscal year 2016 through 2019.

Results

Population description

A total of 351 VFRs and 138 Other Travelers participated in surveys across the three settings (Figure 4). In the travel clinic, 96 VFRs participated prior to their clinic visit; 49 VFRs completed the post-travel follow-up component of the survey. In the travel clinic, 129 Other Travelers participated prior to their clinic visit; 80 Other Travelers completed the post-travel survey.

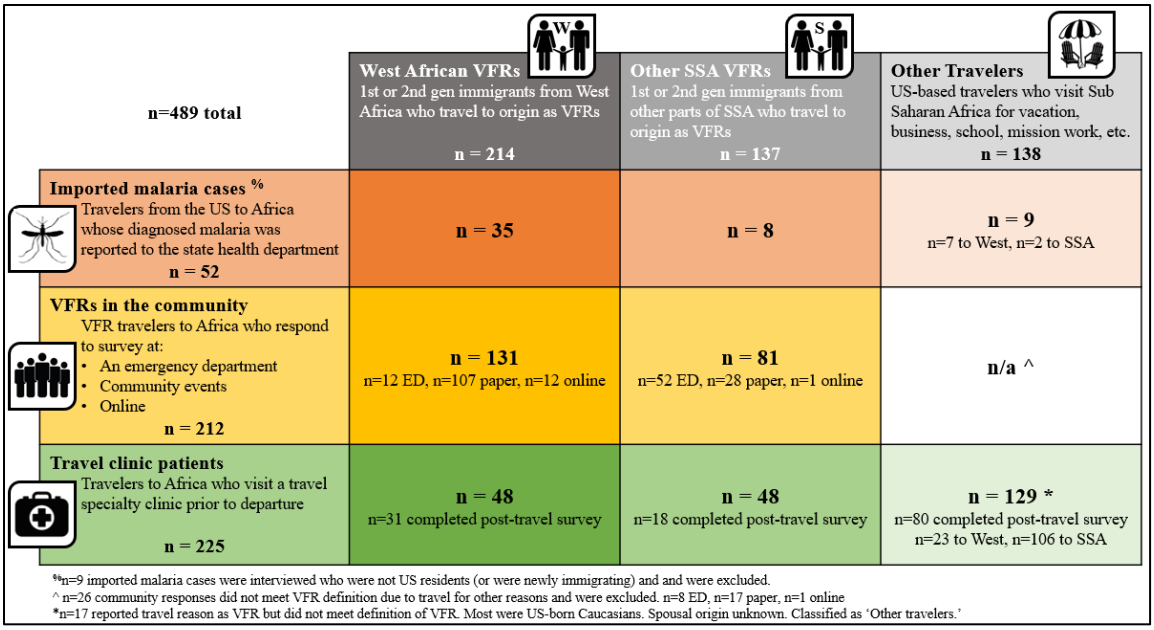


Figure 4 (Repeated): VFR participant matrix by survey setting (rows) and traveler population (columns)

Travel destinations

The sampling protocol for VFR travelers at the travel clinic sought to achieve equivalent counts of West African VFRs (48) and VFRs traveling to other Sub-Saharan African countries (48). Common destination countries among travel clinic VFRs were Ethiopia (23), Liberia (18), Kenya (16), Nigeria (8), Ghana (7), Somalia (5) and Sierra Leone (4). The sampling protocol for Other Travelers at the travel clinic did not specify travel destination and may be more representative of destinations for this group at the travel clinic of focus. A travel destination in West Africa was reported by 17.8% (23/129) of Other Travelers, 82.2% (106/129) of Other Travelers were traveling to countries in Sub-Saharan Africa outside of West Africa (Other SSA). The most commonly reported destination countries reported by Other Travelers were to Tanzania (45), Kenya (36), South Africa (25), Ghana (16), Uganda (12), and Zimbabwe (11).

Nonrandom sampling by destination was also in place for community VFRs leading to 61.8% (131/212) of community respondents reporting travel to West Africa and 38.2% (81/212) of community respondents reporting travel to other Sub-Saharan African countries. Top destinations among community VFRs include Togo (37), Kenya (31), Nigeria (28), Somalia (28), Liberia (23), Cameroon (17), Ethiopia (17), Ghana (15), Guinea (13), and Sierra Leone (9).

Reason for travel among Other Travelers

Among the group of Other Travelers at the travel clinic that did not meet the definition of a VFR, 62.0% (80/129) were traveling for vacation, 14.0% (18/129) were traveling for a mission trip, 12.4% (16/129) were traveling for business, and 7.0% were traveling to study abroad (9/129). Seventeen travelers (13.1%) reported travel to visit friends or relatives but did not meet the study definition of a VFR traveler. Among this group, nearly than three-quarters (73.3% 11/15) reported Caucasian ethnicity only, while two reported African American or 'Native Black American' ethnicity only, one reported dual African American and Caucasian ethnicity, and one reported Latino ethnicity.

Demographics

Travel clinic VFRs and Other Travelers

Table 10 presents comparisons between Other Travelers and VFRs. Other Travelers at the travel clinic were older ($\bar{x}$=51.9) than travel clinic VFRs ($\bar{x}$=42.8, p<0.001), reported more post-secondary education (95.3%, 122/128) than VFRs (76.9%, 70/91, p<0.001), were less likely to report ever having malaria before (3.9% 5/127) than VFRs (53.9% 48/89, p<0.001), and were less likely to be born outside the US (10.3% 13/126) than VFRs (94.6%, 87/92, p<0.001). Differences were not observed in the gender of Other Travelers (42.5% 54/127) and VFRs (44.6, 41/92, p=0.763) at the travel clinic with a higher proportion of travelers reporting female gender in each group.

Other Travelers reported significantly shorter duration trips to Sub-Saharan Africa ($\bar{x}$=3.8 weeks) than VFRs ($\bar{x}$=5.4 weeks, p<0.001). Differences in the number of trips previously taken were not observed between Other Travelers (First / 1 trip: 64.6% 82/127, 2-4 trips: 11.0% 14/127, 5+ trips 24.4% 31/127) and VFRs (First / 1 trip: 54.3% 50/92, 2-4 trips: 18.5% 17/92, 5+ trips 27.2%, 25/92, p=0.209).

Community VFRs and travel clinic VFRs

Survey participation in community settings does not signify that VFRs did not seek pre-travel care; community and travel clinic VFRs are not mutually exclusive in this regard. Nearly two-thirds (66.4% 79/119) of community VFRs with past travel reported visiting a travel clinic or their primary care provider (59.7% 71/119) prior to their last trip. Demographic differences were not observed between community VFRs and travel clinic VFRs regarding age, gender, or

education level. Differences were not observed in the proportion of travel clinic (94.6% 87/92) and community (96.2% 204/212, p=0.513) VFRs who report birthplace outside the US, but travel clinic VFRs had a longer mean length of residency in the US ($\bar{x}$=18.0 years) than community VFRs ($\bar{x}$=14.2 years, p=0.001). Travel clinic ($\bar{x}$=5.4 weeks) and community ($\bar{x}$=7.8 weeks, p=0.092) VFRs had similar mean trip duration, and a similar proportion of travel clinic (27.2% 25/92) and community (20.4%, 41/201, p=0.199) VFRs reported taking 5 or more trips as a VFR.

Malaria knowledge and risk perception

No differences were observed between VFRs at the travel clinic and Other Travelers regarding agreement that malaria is preventable, the frequency these groups incorrectly report ways to prevent or contract malaria, or perceptions about the deadliness of malaria (Table 10). Other Travelers at the travel clinic, however, rated their concern about malaria ($\bar{x}$=2.7, $\tilde{x}$=3) significantly lower than VFRs ($\bar{x}$=3.5, $\tilde{x}$=4 p<0.001).

Community VFRs less frequently reported malaria as a preventable disease (91.8% 190/207) than travel clinic VFRs (98.9% 94/95 p=0.040) but were less likely to list an incorrect method of contracting malaria (16.5% 33/200) than travel clinic VFRs (27.0% 26/96 p=0.034). Differences between these VFR groups were not observed in their concern about malaria, or experience with malaria on a previous VFR trip.

Table 10: Demographic, KAP, and health system experience survey outcomes of VFRs and Other Travelers: Comparisons among VFRs (Intra-VFR) and between traveler populations (Inter-Pop)

Characteristic	Community		Travel Clinic				Pairwise Comparisons	
							Intra-VFR	Inter-Pop
	Community VFRs (C) n=212		Travel Clinic VFRs (T) n=96		Other Travelers (O) n=138		C v T p	T v O p
Demographics & Trip Characteristics	**x̄**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Age, years	43.1	(41.2-45.0)	42.8	(40.0-45.6)	51.9	(48.9-55.0)	0.868	<0.001
Length of residency in US, years *	14.2	(13.1-15.3)	18.0	(16.1-19.9)	30.5	(19.8-41.2)	0.001	0.001
Trip duration, weeks	7.8	(6.3-9.0)	5.4	(4.4-6.3)	3.8	(2.1-5.6)	--	--
Trip duration, weeks, log transformed	0.70	(0.65-0.75)	0.62	(0.57-0.68)	0.37	(0.32-0.43)	0.092	<0.001
--	**%**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Male	44.8	(37.9-51.7)	44.6	(34.2-54.9)	42.5	(33.8-51.2)	0.967	0.763
Education > high school	65.5	(58.9-72.1)	76.9	(68.1-85.7)	95.3	(91.6-99.0)	0.052	<0.001
Foreign born	96.2	(93.6-98.8)	94.6	(89.8-99.3)	10.3	(4.9-15.7)	0.513	<0.001
Has had malaria before	75.2	(69.2-81.2)	53.9	(43.4-64.5)	3.9	(0.5-7.4)	<0.001	<0.001
Destination W. Africa	^ 61.8	--	^ 50.0	--	17.8	(11.1-24.5)	--	--
5 or more trips back	20.4	(14.8-26.0)	27.2	(17.9-36.4)	24.4	(16.8-32.0)	0.199	0.644
Number of trips back	**%**	--					**Wald $\chi 2$ (*df=2*)**	
Will be first / 1	46.8	--	54.3	--	64.6	--		
2 to 4	32.8	--	18.5	--	11.0	--	0.040	0.209
5 or more	20.4	--	27.2	--	24.4	--		
Malaria Knowledge & Attitudes	**x̃**	**x̄ (95% CI)**					**Mann-Whitney U**	
Concern about malaria	4	3.8 (3.6-4.0)	4	3.5 (3.2-3.8)	3	2.7 (2.5-2.9)	0.174	<0.001
Malaria is deadly	5	4.6 (4.5-4.7)	5	4.5 (4.3-4.6)	5	4.5 (4.4-4.7)	0.035	0.196
Deadly-concern differential	0	0.8 (0.6-1.0)	0	1.0 (0.6-1.4)	2	1.8 (1.6-2.1)	0.065	<0.001
--	**%**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Malaria is preventable	91.8	(88.0-95.6)	98.9	(96.7-100)	96.9	(93.9-99.9)	0.040	0.328
Listed incorrect method of preventing malaria	36.2	(29.0-43.4)	39.1	(29.0-49.3)	27.6	(19.7-35.4)	0.639	0.072
Listed incorrect method of contracting malaria	16.5	(11.3-21.7)	27.1	(18.0-36.1)	16.3	(9.8-22.7)	0.034	0.051
Had malaria on a previous trip	12.5	(7.3-17.7)	7.6	(1.0-14.1)	3.6	(0.0-8.6)	0.288	0.354
Planned[&] & Actualized[%] Malaria Prevention	**%**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Will take antimalarial	94.6	(87.0-100)	97.8	(94.8-100)	99.2	(97.6-100)	0.349	0.416
Did take antimalarial	61.9	(54.5-69.3)	83.0	(71.8-94.1)	98.7	(96.2-100)	0.009	0.011
Will pick where to stay to avoid mosquitos	88.9	(78.1-99.7)	93.8	(88.8-98.7)	83.7	(77.3-90.2)	0.353	0.027
Did pick where to stay to avoid mosquitos	63.1	(55.7-70.5)	80.9	(69.2-92.5)	71.8	(61.6-82.0)	0.025	0.259
Will educate oneself about malaria	91.7	(82.2-100)	91.7	(86.0-97.3)	95.3	(91.7-99.0)	1.000	0.264
Did educate oneself about malaria	63.1	(55.7-70.5)	91.5	(83.2-99.8)	92.3	(86.3-98.4)	0.001	0.870
Will use mosquito repellent	83.3	(70.5-96.1)	91.7	(86.0-97.3)	95.3	(91.7-99.0)	0.174	0.264
Did use mosquito repellent	66.1	(58.8-73.3)	78.7	(66.6-90.9)	80.8	(71.8-89.7)	0.102	0.782
Will stay indoors when mosquitos are out	73.3	(70.5-96.1)	87.5	(80.8-94.2)	68.2	(60.1-76.4)	0.536	0.001
Did stay indoors when mosquitos were out	59.5	(52.0-67.0)	80.9	(69.2-92.5)	66.2	(55.4-77.0)	0.009	0.083
Will wear long clothing	77.8	(63.5-92.0)	88.5	(82.1-95.0)	94.6	(90.6-98.5)	0.123	0.106
Did wear long clothing	63.1	(55.7-70.5)	74.5	(61.5-87.4)	92.3	(86.3-98.4)	0.150	0.009
Will use bed nets	91.7	(82.2-100)	79.2	(70.9-87.4)	69.8	(61.7-77.8)	0.104	0.115
Did use bed nets	63.7	(56.3-71.0)	44.7	(29.9-59.4)	71.8	(61.6-82.0)	0.020	0.003
Will use mosquito coil	63.9	(47.4-80.4)	45.8	(35.7-56.0)	17.1	(10.5-23.6)	0.067	<0.001
Did use mosquito coil	29.8	(22.8-36.7)	24.4	(11.4-37.5)	7.7	(1.6-13.7)	0.484	0.013
Health Care System Experiences	**%**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Has a primary care provider @	82.5	(72.9-92.2)	94.5	(89.7-99.3)	88.3	(82.6-93.9)	0.023	0.123
Saw health care provider before last trip	73.2	(66.4-80.0)	^ 100.0	--	^ 100.0	--	--	--
Of those who saw a HCP, PCP	59.7	(50.7-68.6)	--	--	--	--	--	--
Of those who saw a HCP, travel clinic	66.4	(57.8-75.0)	^ 100.0	--	^ 100.0	--	--	--
Of those who saw a HCP, both PCP & travel	26.9	(18.8-35.0)	--	--	--	--	--	--
If sick with malaria symptoms, would…	**%**	**(95% CI)**					**Wald $\chi 2$ (*df=1*)**	
Try and treat at home before seeing HCP	13.1	(8.4-17.9)	4.2	(0.1-8.3)	7.8	(3.1-12.5)	0.025	0.280
Have concerns seeing HCP	12.9	(8.3-17.6)	7.4	(2.0-12.7)	4.7	(1.0-8.4)	0.161	0.402

* Foreign-born respondents only

[&] Community VFR group includes only respondents who have not yet traveled, reporting planned malaria prevention for first trip (n=36-37)

[%] Community VFR group includes only respondents who had traveled, reporting malaria prevention used on last trip (n=168)

@ Paper and online versions of the community survey omitted this prompt; community is ED exclusively

^ Noninformative; sampling protocol-determined outcome

α=0.05; p values in red are statistically significant

Malaria prevention approaches

Planned malaria prevention approaches among post-travel VFR and Other Traveler respondents at the travel clinic

Travel clinic VFRs were more likely than Other Travelers to plan to use certain malaria prevention approaches including: picking where they stayed to avoid mosquitoes (93.8% [90/96] versus 83.7% [108/129], p=0.011), staying indoors when mosquitoes are out (87.5% [84/96] versus 68.2% [88/129], p=0.001), and using mosquito coils (45.8% [44/96] versus 17.1% [22/129], p<0.001). Differences were not observed in the planned use of other prevention approaches between VFRs and Other Travelers (Table 10).

Actualized malaria prevention approaches among post-travel VFR and Other Traveler respondents at the travel clinic

Differences in reported use of antimalarials, long clothing, using bed nets, and using mosquito coils were observed between VFRs and Other Travelers after return from travel (Figure 12). Antimalarial use was reported among 83.0% (39/47) of VFRs and 98.7% (77/78) of Other Travelers (p=0.011). Wearing long clothes was reported by 74.5% (35/47) of VFRs and 92.3% (72/78) of Other Travelers (p=0.009). Bed net use was reported by 44.7% (21/47) of VFRs and 71.8% (56/78) of Other Travelers (p=0.003). Mosquito coil use was reported by 24.4% (11/45) of VFRs and 7.7% (6/78) of Other Travelers (p=0.013).

Differences in the use of other malaria prevention approaches were not observed between VFRs and Other Travelers after return from travel (Figure 12). Picking where to stay to avoid mosquitoes was reported among 80.9% (38/47) of VFRs and 71.8% (56/78) of Other Travelers. (p=0.259). Educating oneself about malaria was reported by 91.5% (43/47) of VFRs and 92.3% (72/78) of Other Travelers (p=0.870). Repellent use was reported by 78.7% (37/47) of VFRs and 80.8% (63/78) of Other Travelers (p=0.782). Staying indoors to avoid mosquitoes was reported by 80.9% (38/47) of VFRs and 66.2% (51/77) of Other Travelers (p=0.083).

Figure 13 depicts the proportions of VFRs and Other Travelers surveyed before and after their trip regarding their reported planned use of malaria prevention and whether they were successful in actualizing planned prevention. Depicted in light green is the proportion of travelers who did not plan to use a prevention approach but did report using said approach during travel. Depicted in light orange is the proportion of travelers who planned to use a prevention approach but failed

to actualize the prevention approach during travel. In other words, this light orange group are those that faced a barrier to actualizing their planned malaria prevention. Focusing on just those travelers who planned to use prevention approaches, Figure 14 presents the proportion of VFRs and Other Travelers who were successful in their planned malaria prevention. Similar to the overall travel clinic cohort, compared to Other Travelers, VFRs were less successful in actualizing their planned use of antimalarials (98.7% [75/76] versus 82.2% [37/45], p=0.001), wearing long clothing (95.9% [70/73] versus 82.9% [34/41], p=0.019) and using bed nets (81.8% [45/55] versus 56.8% [21/37], p=0.009). Differences were not observed in actualizing other prevention approaches between Other Travelers and VFRs.

Differences in planned and actualized malaria prevention between community and travel clinic VFRs

No differences were observed between community VFRs and travel clinic VFRs in their planned use of any prompted malaria prevention approach, including antimalarial use (Table 10). In the community VFR group, only travelers who had not yet traveled reported on their planned malaria prevention for their first trip; this group included n=36 to 37 respondents for each prevention prompt.

Regarding actualized malaria prevention among travelers recalling their past trip (Table 10), community VFRs were less likely than travel clinic VFRs to report taking an antimalarial (61.9% [104/168] versus 83.0% [39/47] p=0.009) , picking where to stay to avoid mosquitoes (63.1% [106/168] versus 80.9% [38/47] p=0.025), educating oneself about malaria (63.1% [106/168] versus 91.5% [43/47] p=0.001), and staying indoors when mosquitoes were out (59.5% [100/168] versus 80.9% [38/47] p=0.009) than travel clinic VFRs. Community VFRs were more likely to report bed net use than travel clinic VFRs (63.7% [107/168] versus 44.7% [21/47] p=0.020).

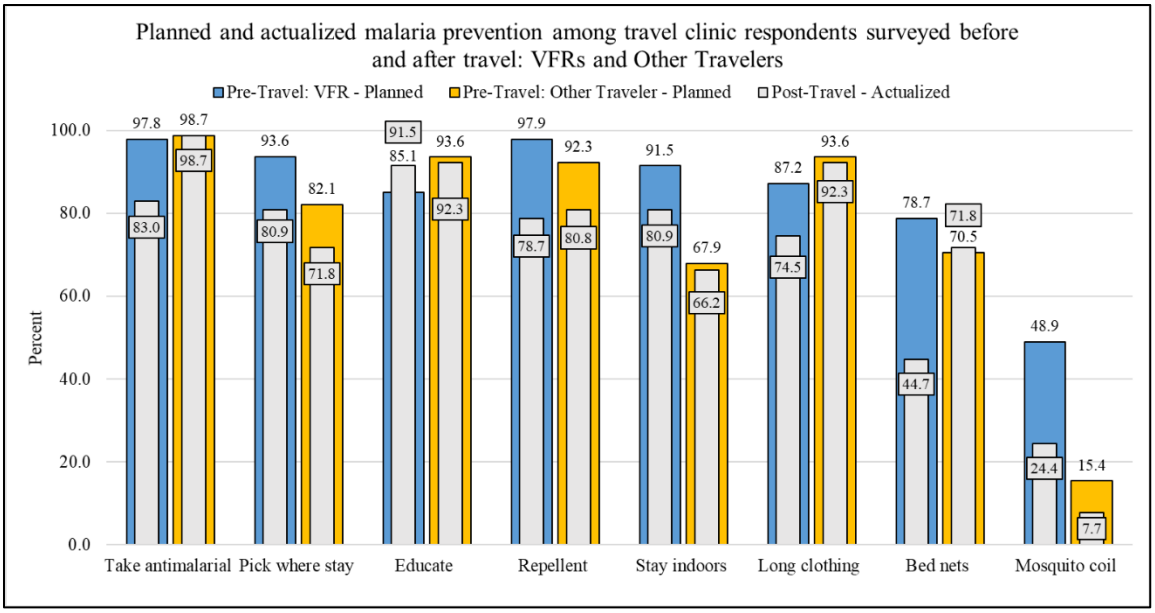


Figure 12: Planned and actualized malaria prevention among travel clinic respondents surveyed before and after travel: VFRs and Other Travelers

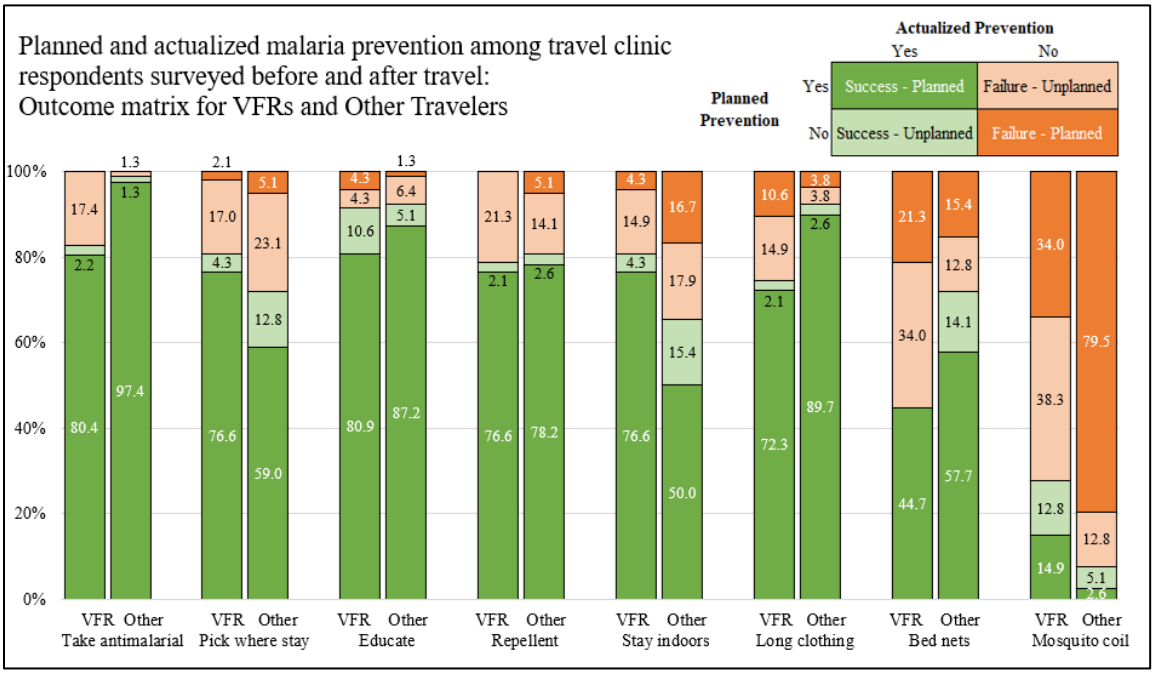


Figure 13: Planned and actualized malaria prevention among travel clinic respondents surveyed before and after travel: Outcome matrix for VFRs and Other Travelers

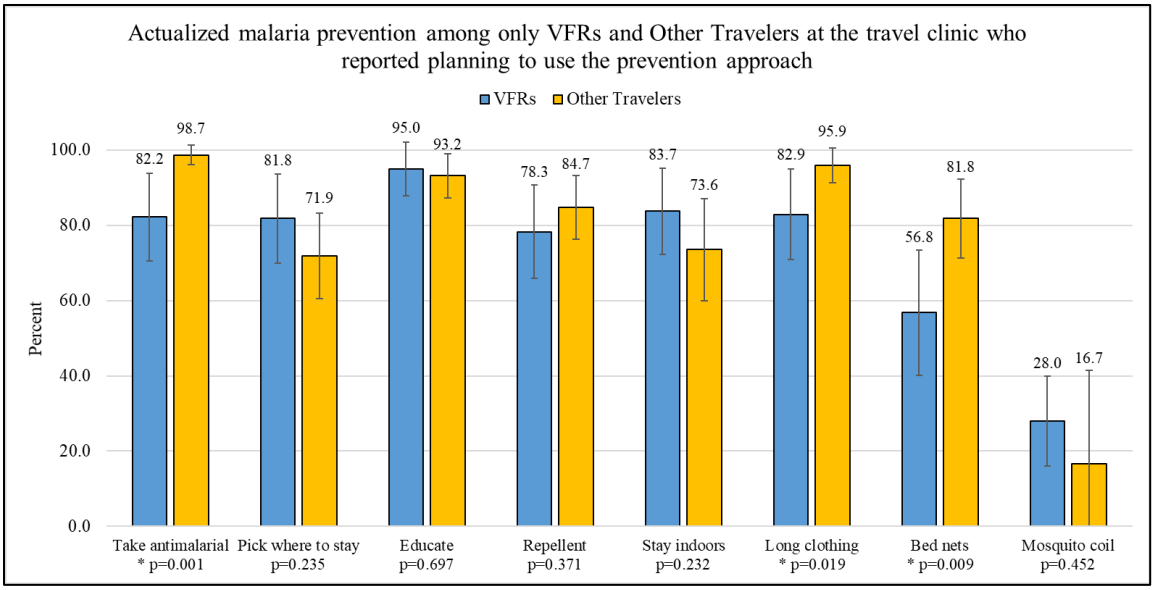


Figure 14: Actualized malaria prevention among only VFRs and Other Travelers at the travel clinic who reported planning to use the prevention approach

Health care system experiences

Health care system experiences were largely equivalent for travel clinic VFRs and Other Travelers at the travel clinic with 94.5% (86/91) of VFRs and 88.3% (113/128) of Other Travelers reporting having a primary care provider (p=0.123). For the hypothetical questions posed of travel clinic respondents around interacting with the health care system when experiencing malaria symptoms, no differences were observed between VFRs and Other Travelers in their likelihood of trying to treat at home before seeing a health care provider (4.2% [4/95] versus 7.8% [10/128], p=0.280) or in having concerns seeing a health care provider with malaria symptoms (7.4% [7/95] versus 4.7% [6/128] p=0.402).

Travel clinic VFRs were more likely to have a primary care provider than community VFRs (94.5% [86/91] versus 82.5% [52/63] p=0.023). Travel clinic VFRs were also less likely to try and treat malaria symptoms at home first than community VFRs if they were to develop symptoms after travel (4.2% [4/95] versus 13.1% [26/198] p=0.025).

Discussion

Key differences between VFRs and Other Travelers at the travel clinic

Greater barriers exist to actualizing certain malaria prevention approaches for VFRs than for Other Travelers. Chiefly, 17.8% of VFRs who planned to take an antimalarial during travel failed to do so whereas just 1.3% of Other Travelers failed to take an antimalarial. As the gold-standard for malaria prevention, antimalarial chemoprophylaxis use is critical to prevent malaria illness in travelers. Although VFRs at the travel clinic appear better engaged with preventive and pre-travel health care than their VFR peers surveyed in the community, specialized pre-travel care does not appear sufficient to ensure chemoprophylaxis use among VFRs.

Financial and structural barriers related to prescription drug dispensing are being concurrently explored by the study team; these findings should elucidate how VFRs may face disparities in antimalarial availability and cost compared to other travelers. One identified barrier to acquiring prescribed chemoprophylaxis identified by the study team is Medicaid policies that limit dispensation of non-maintenance drugs to a 34-day supply.[59] Noting that VFRs in the travel clinic travel on average, for 5.4 weeks, acquiring a complete chemoprophylactic regimen may be a barrier for low income travelers.

VFRs who planned to wear long clothing and sleep under bed nets to avoid mosquito bites were also statistically less successful at achieving these intended prevention approaches than Other Travelers. The impracticality of using bed nets in warm living conditions and their potential misalignment with norms in hosting households have been documented as barriers to using bed nets for VFR travelers.[56,78,83] Failure to wear long clothing is hypothesized to be based in these same issues of local cultural norms that may impact VFRs more than other travelers.

Other Travelers reported statistically lower concern about malaria than VFRs, challenging common assumptions made about VFRs as being less worries about malaria. No observed differences in knowledge about malaria prevention and transmission between VFRs and Other Travelers provides further evidence that that VFR's disparate success in realizing malaria prevention compared to other travelers is not founded in a lack of knowledge or concern alone. Interventions designed to improve malaria prevention among VFRs must extend beyond simply educating travelers about malaria and its risks and address barriers that keep travelers from achieving preventive practices.

Key differences between VFRs surveyed in the community and at the travel clinic

Compared to community VFRs, those surveyed at the travel clinic were more likely to view malaria as preventable. However, community VFRs were less likely to list an incorrect method of contracting malaria. Rather than based in malaria knowledge, this greater level of awareness that malaria can be prevented among travel clinic respondents may relate to their increased preventive health seeking behaviors generally. Travel clinic VFRs were more likely to report having a primary care provider than community VFRs, suggesting travel clinic VFRs may reflect a sub-population more familiar with preventive health, better linked to or better able to navigate the health care system. Improving access to primary care and general preventive health in immigrant populations may have impacts on issues such as malaria and traveler's health.

Differences observed between travel clinic VFRs and community VFRs in actualized malaria prevention suggest that specialized pre-travel care may convey the importance and effectiveness of preventive approaches for travelers. Although reported antimalarial use was higher among community VFRs than reported elsewhere in the literature, it was still significantly lower than antimalarial use among travel clinic VFRs. Travel clinic VFRs were also more likely to report having picked where to stay to avoid mosquitoes, educate themselves about malaria, and staying indoors when mosquitoes were out. Bed net use, however, was more common among community respondents than VFRs. Considering that travel clinic VFRs are better linked to preventive care than community VFRs, this relationship of generally greater malaria prevention among travel clinic VFRs may be confounded by increased preventive behaviors among this population generally. Increased malaria prevention may be simply reflecting travel clinic VFRs increased approach to preventive health and better ability to navigate the health care system.

Limitations

The extent to which Other Travelers surveyed in the travel clinic reflect the underlying non-VFR traveling population to malarious areas is unknown and was not explored in the given study design. Due to the fact that Other Travelers were only surveyed through their engagement with pre-travel care suggests that malaria prevention may be overestimated in this population. Airport studies are necessary to achieve a more representative sample of the overall traveler population. When the airport design is used, comparative analyses must be performed to better quantify differences between VFRs and other types of travelers rather than the summary-level analyses that have been reported previously in the literature.

Social desirability bias is hypothesized to impact reported planned and actualized malaria prevention in the study. This would skew results toward the over-reporting of preventive behaviors or affirmative reporting of behaviors that were used inconsistently. Despite this risk of overreported prevention, the differential between planned and actualized preventive behaviors should theoretically remain constant and reliable, assuming planned and actualized prevention are equally socially desirable. Marked decreases in actualized prevention were observed among both VFRs and Other Travelers, suggesting that barriers to malaria prevention do exist and may impact VFRs more strongly. Survey design and sampling method also took social desirability bias into account and techniques were used to develop rapport with respondents and pose the prompts without leading to a preferred answer.

Post-travel follow-up prompts on malaria knowledge and attitudes were not included but could have shown how well travel clinic visits improve malaria knowledge in travelers. Future studies could explore this impact, but because knowledge and concern have been shown to not predict malaria prevention, this research is not imperative.

Small sample sizes, especially among community respondents who have not yet traveled as a VFR could have underpowered statistical significance of some comparisons. Future research seeking to explore differences in planned and actualized prevention should consider the cohort study design and anticipate loss to follow up when performing their sample size calculations.

Next steps

Future research

Future research is necessary to better understand why VFRs disparately fail to achieve malaria prevention, especially chemoprophylaxis use, compared to non-VFR travelers. An exploration of the reasons why unsuccessful travelers, especially those intending to do so, didn't use chemoprophylaxis could shed light on behavioral and structural barriers that are harder to overcome for VFRs. Targeted barrier reduction interventions could then be developed and tested for their impact on reducing the burden of malaria illnesses in VFR travelers.

Additional research distinguishing travel clinic VFRs from the underlying VFR traveler community is also necessary to discern differences in how these groups experience health care. Insurance status, income, immigration status, and other key correlates should be measured to

determine how and to what extent structural barriers impede VFRs who are poorly linked to health care from achieving healthy travel.

Interventions

While malaria prevention barrier reduction interventions targeted to VFRs will be the most impactful on the yearly rate of imported malaria in the US, some VFR-targeted interventions may be impactful more broadly to other traveler populations. Small but meaningful proportions of VFRs and other travelers surveyed in the travel clinic reported they'd be concerned about seeking care with malaria symptoms and may delay care. Messaging to convey that early treatment reduces illness severity could be one intervention delivered to traveler populations broader than VFRs alone.

Interventions with the primary outcome of getting VFRs to seek pre-travel care need to consider that this alone does not guarantee antimalarial use. Informed by future research on why some VFRs fail to take planned chemoprophylaxis, interventions that reduce these barriers are also critical to improving chemoprophylactic coverage among VFRs.

Conclusions

Although commonly described as a monolithic population, VFR traveler subgroups vary in their success at actualizing malaria prevention and interact with the health care system differently. Additionally, VFRs are less successful at actualizing key approaches to malaria prevention than other types of travelers to malaria endemic regions. Heterogeneity of barriers to malaria prevention exist within VFR groups and across traveler populations. Interventions developed to improve malaria prevention among VFRs must consider access to health care and upstream barrier reduction strategies that make intended prevention more achievable, affordable, easier, and resonant among VFRs.

Chapter 7: Conclusions

This study identified impactful behavioral and structural barriers to malaria prevention in VFRs that relate to their increased risk of malaria illness compared to other travelers. Furthermore, key differences were identified within VFR subpopulations and between VFRs and other types of travelers that convey differences in malaria prevention at a level of detail not achieved in previous research. These findings will be used by the MPP study team to inform the development of interventions designed to reduce barriers to malaria prevention and increase chemoprophylaxis use in VFR travelers. Key findings from the three preceding chapters are summarized below and put in context alongside findings from research published in the literature. Suggestions for future research and interventions are posed based upon these findings, and the potential public health impact of these findings and interventions are summarized.

Key findings and takeaways

Behavioral barriers to malaria prevention

Malaria knowledge alone is not linked to increased malaria prevention. VFRs who listed an incorrect method of preventing malaria were no less likely than other VFRs to have taken an antimalarial during travel (p=0.071). This result is supported by similar findings in the literature,[62,81] and aligns with a conclusion made by Behrens et al. (2015) that interventions designed to increase malaria knowledge alone miss the underlying barriers to successful malaria prevention in VFRs.[44]

Increased concern for malaria correlates with increased likelihood of using malaria prevention. VFRs who took an antimalarial on their last trip reported significantly higher concern about malaria than those who did not take an antimalarial (p=0.001). Using mosquito repellent was also associated with increased concern for malaria (p=0.010). This is consistent with the finding that lower concern for malaria, as defined as feeling that malaria is easier to treat than prevent, was associated with a lower likelihood of chemoprophylaxis use in an airport study of West African VFRs.[73] While improving knowledge around malaria may not be an effective intervention alone to impact preventive behaviors in VFRS, conveying information about the severity and deadliness of malaria in target populations to shift risk perception and concern for malaria may impact preventive behaviors. Approaches to increase malaria risk perception are hypothesized to be more impactful alongside barrier reduction strategies that make using chemoprophylaxis and other malaria prevention easier and more accessible.

Even when VFRs plan to use malaria prevention approaches, barriers exist to actualizing preventive measures including taking antimalarials, using bed nets, repellents, or coils, wearing long clothing, educating oneself about malaria, and choosing to stay in order to avoid mosquitoes. Disparities in actualizing planned malaria prevention were observed among VFRs in the study population broadly, within West African and Other SSA subgroups each individually, and within the cohort of travel clinic VFRs who were surveyed before and after travel. Barriers to using intended prevention measures have also been reported in the literature,[56,78,83] but normally center on using bed nets. Although barriers to using bed nets certainly exist, these data highlight the extent to which barriers to intentioned prevention are insurmountable for some VFRs across every method. These findings indicate that interventions intended to encourage malaria prevention measures, especially those with the greatest observed differences in achievability, must address how to reduce barriers to their successful use (e.g. ways to improve ease-of-use, acceptability, cost, and access) rather than simply suggesting travelers use them.

Health system barriers to malaria prevention

Linkage to primary care appears to have a positive relationship with pre-travel care and health care system experiences in VFR populations. VFRs who reported having a primary care provider were more likely to report pre-travel care (p=0.017). VFRs with primary care providers also were less likely to report concerns seeing a healthcare provider when experiencing malaria symptoms (p=0.031). Although VFRs are reported to prefer seeking pre-travel care with their primary care provider,[75] explorations into the impact that access to primary preventive care has on malaria prevention among VFRs has not been previously explored. Being engaged in preventive medicine may be positively impactful on malaria prevention and may relate to perceptions of the health care system. In addition to improving overall health, efforts and policies that improve access to preventive medicine services among immigrants may also improve pre-travel care and malaria prevention.

Specialized pre-travel care alone is not sufficient to guarantee antimalarial use in VFRs. More than one in six (17.8%) of travel clinic VFRs failed to use planned antimalarial chemoprophylaxis while only 1.3% of Other Travelers failed to use an antimalarial (p=0.001). This aligns with a French study of VFRs at a travel clinic which found that 14.1% failed to use any chemoprophylaxis during their trip.[82] Interventions designed to aid VFRs in seeking pre-travel care alone may not be an effective solution for improving chemoprophylaxis adherence broadly.

Other barriers, including dispensing limits, managing side effects, and the cost of complete regimens must also be considered.

Some VFRs are concerned about the quality of care and their treatment in pre-travel and clinical health care settings. Among malaria cases surveyed, 41.6% tried to treat their malaria illness at home before seeking care and 33.3% of cases had concerns seeing a healthcare provider with malaria symptoms. This suggests that some ill VFRs may delay seeking care for a malaria illness, potentially leading to poorer health outcomes and increased health care costs. In the qualitative findings, concern about seeing a healthcare provider centered around feelings that US doctors are unknowledgeable about malaria, or that patients could be quarantined for their illnesses. Concerns about quality of malaria prevention and treatment by US health care providers was expressed by VFRs elsewhere and similar reasons for concern were voiced.[56,63,78,83] Some African VFRs perceive or experience poor treatment in the health care system for malaria and traveler illnesses. Interventions communicating the availability of highly specialized travel and tropical medicine providers may be impactful but should be implemented alongside inward-facing interventions that improve providers' cultural competency and treatment of malaria in VFRs.

Key differences between VFRs and Other Travelers

VFRs in this study reported travel for longer duration (average of 7.0 weeks) than Other Travelers (average of 3.8 weeks). Longer travel duration among VFRs has been reported elsewhere in the literature as well.[60] Long trip duration increases potential malaria exposures and may affect VFR's access to complete chemoprophylactic regimens as Medicaid[59] and other insurer dispensing policies may limit the supply of an antimalarial prescription to a shorter coverage period than the planned duration of the trip. Chemoprophylaxis has been proven to be cost-effective to payers for any duration of travel compared to the risk and downstream costs of treating malaria illness.[43] Clear, impactful, cost-saving opportunities for policy improvement exist in regards to Medicaid dispensing rules and likely elsewhere among private payers that will improve access to malaria prevention among travelers most at risk for illness.

VFRs at the travel clinic reported higher concern for malaria than other travelers. This challenges reports in the literature that VFRs have low concern about malaria,[63,76,78,83] although comparisons on concern for malaria between VFRs and other types of travelers have not been previously performed. Lower concern about malaria among non-VFRs highlights that although some VFRs may not be concerned about malaria, this does not set the VFR population apart from other types

of travelers. Considering this finding alongside evidence that low concern is linked to lower likelihood of antimalarial and repellent use, interventions that are designed to increase risk perception around malaria illness during travel may be impactful more broadly for non-VFR populations as well.

Some planned malaria prevention approaches are better actualized among non-VFRs than among VFRs. In the travel clinic setting compared to non-VFRs, VFRs were less successful in actualizing their planned use of antimalarial chemoprophylaxis (98.7% versus 82.2%, p=0.001), wearing long clothing (95.9% versus 82.9%, p=0.019) and using bed nets (81.8% versus 56.8%, p=0.009). Chemoprophylaxis use has been previously reported as lower among VFRs than non-VFRs and VFRs cited cost of the prescription as a key reason chemoprophylaxis was not used.[60] Larger barriers to antimalarial use as well as other malaria prevention approaches exist for VFRs than other travelers, even when VFRs seek pre-travel care at specialized travel clinics. Future research should be performed to understand the roots of these increased barriers among VFRs, whether due to prescribing policies, availability of antimalarials in pharmacies, costs, or challenges navigating pharmacy and insurance systems.

Key differences within VFR populations

Travel clinic VFRs appear better connected to the health care system (increased report of having preventive care) and better able to actualize malaria prevention approaches than VFRs in the community. Travel clinic VFRs were more likely than community VFRs to report antimalarial use on their last trip, along with multiple other prevention approaches. A study comparing travel clinic VFRs to those surveyed at a travel agency also found that travel clinic VFRs were more likely to use antimalarials than travel agency VFRs, but didn't find differences in the use of other preventive approaches.[82] This suggests that the pre-travel consultation may convey to VFRs the importance of malaria prevention or may assist VFRs in accessing intended malaria prevention. Increasing access to pre-travel care, although not sufficient for ensuring antimalarial use, may increase the proportion of VFR travelers taking antimalarials during travel and using other preventive approaches.

West African VFRs report greater concern about seeing a healthcare provider with malaria symptoms (p=0.005) than VFRs to other parts of Sub-Saharan Africa and are more likely to report trying to treat a malaria illness at home first (p=0.003). Previous research with similar conclusions that concerns about health care exist among West Africa VFRs have focused

exclusively on this population;[56,63,78,83] this new finding suggests concerns about interacting with the health care system appear to be heterogenous across regional traveler populations.

Malaria illness in VFRs

Malaria-like illnesses were reported by more than one in ten (11.1%) VFR travelers. Although this is likely a gross overestimation of the malaria burden among VFRs, it does suggest that many malaria illnesses may go unreported. Reasons malaria illnesses in VFRs may be underestimated are hypothesized to include illnesses occurring still during travel, lower acuity and symptom resolution prior to seeing a health care provider, concerns about seeing a health care provider with malaria symptoms, or self-treatment using chemoprophylaxis or chemotherapeutics purchased abroad. In fact, one respondent explained their experience with malaria while still traveling:

> *I was so sick that I had to be taken to a hospital in Cameroon in 2009 because I contracted malaria during my visit to Cameroon. My hemoglobin went down to 7.*

When considering the cost of treating malaria illness and the risk of local transmission originating from an ill traveler, future research is necessary to better quantify the true proportion of VFR travelers experiencing malaria illnesses during travel.

Novel conceptual framework: The Increased Prevention - Healthy Travel - Decreased Prevention Paradigm

Connections between malaria illness in VFRs and failure to use or adhere to antimalarials have been reported in literature.[2] Indeed, from a pathophysiological perspective, adequate antimalarial use alongside bite prevention is key to preventing malaria illness during travel to highly endemic areas.[1]

Decreased concern about malaria also appears to be linked to decreased use of antimalarials (and thus, malaria illness) in VFR travelers. Some VFRs report being unconcerned about contracting malaria, view it as an inevitable part of travel, or perceive it as an easily treatable illness.[63,76,78,83] A considerable group within the VFR community feels that malaria is easier to treat than it is to prevent.[78,83] While these connections between concern about malaria, antimalarial use, and risk for malaria illness are well-understood in travel medicine, other factors may be affecting VFR risk perception and decision making behavior around malaria prevention.

This study identified significant relationships between antimalarial use and concern for malaria and malaria illness, but also identified links in concern for malaria and antimalarial use with frequency of travel. Figure 9 (Chapter 4) presents the statistical relationships between concern, antimalarial use, and frequency of travel as they relate to one another and to malaria illness. A novel conceptual framework, The Increased Prevention - Healthy Travel - Decreased Prevention Paradigm, is hypothesized to explain these relationships and is presented in Figure 10 (Chapter 4). This conceptual framework shows that concern for malaria leads to increased malaria prevention. Then, frequent recurring healthy trips decreases concern for malaria and consequently, decreases future malaria prevention such as antimalarial use. Finally, failure to use antimalarials increases a traveler's risk of malaria infection and illness when traveling to endemic areas.

This concept of *healthy experiences as a result of prevention leading to decreased prevention* is novel to the travel medicine field, but is a basic concept in risk behavior theory and has been shown to impact the prevention of sexually transmitted infections,[107] and medication adherence broadly.[108] The only potential supporting evidence reported in the travel medicine literature on the relationship between frequency of travel and malaria prevention was made by Behrens et al. (2013) who explored differences in malaria prevention between travelers of Nigerian, Ghanaian and Kenyan nationality.[72] This study found that Nigerian travelers were less likely to report taking an antimalarial during travel and also reported more frequent trips than Ghanaian or Kenyan travelers.[72] However, the direct relationship between frequency of travel and antimalarial use is not reported in this study.

Future research studying impact of frequency of travel on malaria prevention

The relationship between travel frequency, decreased concern for malaria, and decreased prevention should be studied in greater detail to better understand the magnitude of its effect on malaria illness. If data on travel frequency has been collected in previously conducted studies on malaria in VFRs, especially in studies quantifying antimalarial use, secondary data analyses could be performed to examine if this relationship is observed in other study populations.

Furthermore, travel frequency must be better understood broadly in the VFR population to determine what proportion of the underlying travel population are frequent travelers. This is necessary to understand if frequent travelers truly experience a disproportionate risk of malaria

illness, or if they more commonly experience malaria illness because of proportionate increased exposures alone.

Malaria prevention decision theory should be explored in greater detail among VFRs to understand whether VFRs themselves make the conscious connection between increased travel and decreased likelihood of seeking pre-travel care or antimalarial use. This may be best explored through qualitative approaches to understand the nuance of the relationship. Qualitative responses in the present study did not identify this cognitive link but prompts were not structured to directly explore this relationship.

Studies seeking to quantify the relationship between antimalarial use or concern for malaria and trip duration should account for potentially small effect sizes and solicit adequate sample sizes or design studies accordingly. Sample size estimations for links between concern for malaria and travel frequency as well as seeking pre-travel care and travel frequency based on effect sizes identified in the present study are available in Chapters 4 and 5. In all, future research on the impact of frequency of travel on malaria illness could lead to robust conclusions identifying this subgroup as a group particularly at-risk for malaria illness and inform targeted interventions to increase chemoprophylaxis use among frequent VFR travelers.

Future work: Other next steps in researching malaria in VFRs

Health care policy impacts on malaria prevention in VFRs

A gap in understanding of malaria illness in VFRs that was identified in this study is how and to what extent do health policies at a broad range of levels (national, state, insurer, health system) impact VFRs ability to access malaria prevention and pre-travel care. For example, immigration status greatly impacts an individual's access to Medicaid, Medicare, and private insurance services,[105] which in turn affect access and costs of health care and prescriptions. Insurance status was not explored as a part of the present study, nor was this characteristic explored in previous research identified on VFR travelers. Future research should work to define insurance status and its impact on malaria prevention and should be designed to understand specific VFR subpopulations.

Medicaid prescribing policies have already been identified to pose a barrier for complete chemoprophylaxis coverage when VFRs travel for long duration,[59] despite evidence that antimalarials for travelers are cost-effective to payers.[43] If other policy-level barriers to malaria

prevention are identified, cost analyses should be further explored to make compelling arguments for policy and systems change.

Predicting future VFR populations at risk for malaria

There are anecdotal reports that immigrant populations tend to begin to travel more frequently as VFRs after about a decade of residency in the US, once they have saved amassed enough resources to afford to travel to their country of origin. Although this has not been explored quantitatively in the literature, mean length of residence in the US among VFR respondents in this study was 15.3 years overall and 11.4 years among VFR respondents planning their first trip. To predict emerging VFR populations at risk for malaria during travel, immigrant groups should be evaluated in population centers for increasing travel and subsequently, population-specific interventions could be developed to reduce barriers to malaria prevention in these groups as these groups increase their travel to malarious areas.

Future work: Intervention development

Approaches to intervention development and key messages suggested by VFRs

VFR respondents in all survey settings were asked to contribute their ideas of the best way to educate people about malaria. This prompt was intended to ensure solutions and interventions developed around identified behavioral barriers to malaria prevention would be disseminated through resonant approaches. In summary, VFRs feel that health care and community settings would be effective places for disseminating information on malaria prevention and barrier reduction strategies. These findings are described in greater detail below:

Responses to the qualitative prompt, '*In your opinion, what is the best way to educate people about malaria?'* were coded into themes and sorted by frequency (Table 11). Broadly, participants' responses fit into two main categories: approaches to educate people about malaria with 273 total suggestions, and key messages about malaria and travel with 269 total suggestions.

Approaches to educating travelers about malaria

Seventeen unique approach themes were proposed; the most common approach was to educate travelers through their health care provider (suggested by 82 VFRs):

> *If would be helpful if doctors and nurses in the [primary] clinic could mention the travel clinic when meeting with their patients. They could alert their patients*

to make an appointment with the travel clinic if they plan to do any travel in the upcoming months.

Other leading approaches were to educate through community engaged methods (41), using fliers and print materials (25), through media, either traditional approaches or unspecified (25), and through word of mouth (20). A few approaches were proposed to educate people about malaria as a part of the process of securing travel arrangements including through airlines (7), travel agents (4), or governments or embassies (4):

People don't realize you need to see the doctor before you go - if you buy a ticket to that country and have a pop-up reminder from the website.

Table 11: Qualitative malaria education responses among VFR survey participants, coded into themes. Prompt: *In your opinion, what would be the best way to educate people about malaria?*

Best way to educate people about malaria?	**Count**
Approaches	**273**
Through a healthcare provider	82
Engage the community - CBO, event, school, worship	41
Fliers and print materials	25
Media - unspecified or traditional	25
Online - websites	22
Word of mouth	20
Media - social	18
Airlines	7
Videos or apps	7
Irrelevant / won't work / already knowledgeable	6
Government or embassy - CDC, State Dept, MDH	4
Travel agent	4
Educate HCPs about malaria	3
Storytelling	3
Phone - calls, texts	3
Make malaria prevention required for travel	2
Pharmacy	1
Messages	**269**
See HCP / follow HCP advice	82
How to prevent malaria	75
Take antimalarial	36
General traveler health - hygiene, vaccines	19
Malaria severity	17
Malaria symptoms	13
See HCP if sick with malaria	10
Need to reduce stigma around malaria	7
Provide resources - access, cost, services	6
Where malaria is endemic	4

An infrequent but recurring theme (6) was that people don't need to be educated about malaria, either because travelers are already knowledgeable, or the information isn't important or won't work:

> *Everyone already does an excellent job. Someone may be careless and contract it. Doesn't mean they didn't have knowledge about prevention.*

Educating physicians about malaria and tropical diseases was a repeating theme in this prompt (3), and elsewhere in the survey. It is noteworthy here, however, that the following response was suggested by a VFR ahead of his or her visit to a travel clinic with a team of providers trained in tropical medicine:

> *I think it's hard to educate the general population that has little contact with malaria. However, … physicians would benefit from knowing about tropical diseases because there is so much international travel. At least and there should be enough infrastructure in place so a physician could easily get help. Having a tropical disease specialist in their practice or knowing who to refer a patient to would be very helpful. I don't expect health care providers to have a strong knowledge about tropical diseases and but having access to experts would be very useful.*

Key messages for educating travelers about malaria

Key message suggestions fit into ten themes. Leading key messages proposed by respondents were to see a health care provider or follow their advice (82), how to prevent malaria (75), take an antimalarial during travel (36), and provide general information about traveler health (19). Included in this 'general traveler health' category were responses that suggested getting a malaria vaccine as a key message, an incorrect approach to preventing malaria. Because travelers to malaria endemic regions often need other vaccines for travel, and because some responses were ambiguous, such as '*get shots,*', these inaccurate responses were maintained in this broad general traveler health theme. Seven respondents cautioned that messaging around malaria needs to consider the stigma around malaria (7), often in the context of fear about the disease or experiences with health care providers:

> *Reduce the fear that it is airborne and educate people that it is spread via mosquitoes. Important to reduce stigma and fear. Tell people that malaria is treatable but can be dangerous and that the immune system changes over time.*

Multiple respondents (6) suggested that along with educational information, it is important to provide resources to travelers that improve their access to pre-travel health care, that reduce cost of prevention, or that provide services for successfully following pre-travel advice:

> *People don't have economical support for their family, and it may be a burden. Those realities should be considered. The government should be the first one to provide education and follow through.*

> *Making it mandatory that they see a health professional before they go to these areas. People who don't have the resources or knowledge would not be able to get a prescription.*

<u>Telemedicine as a potential solution to increase antimalarial use among frequent travelers or those taking last-minute trips</u>

Frequent travelers were identified in this study as a potential sub-group of concern within the VFR population due to evidence of decreased concern for malaria, decreased likelihood of seeking pretravel care, and potential overrepresentation among malaria cases. Additionally, VFRs who did not seek pre-travel care frequently expressed that this was due to planning a last-minute trip and not having time to see a healthcare provider, or no appointments were available when sought. Last minute travel as a barrier to pre-travel care and chemoprophylaxis use was also observed in MPP focus groups.[56]

A potential intervention for frequent and last-minute VFR travelers who respectively may not see the value in – or have time for – a pre-travel care appointment is to provide pre-travel care through telemedicine or e-visit approaches. This potential intervention assumes VFRs would be able to access telemedical services quickly and more easily than recurrent travel specialty clinic visits. To ensure travelers are up-to-date on immunizations, and so that adequate information on malaria prevention and general travel health is communicated, these e-visits, for example, could be offered only to travelers who have seen a travel specialist in clinic at least once in a set timeframe (e.g. the last two years). This intervention may be particularly impactful for frequent VFR travelers and those who travel unexpectedly, for example, due to a family member's illness

or death. Careful monitoring of an impact evaluation of this intervention comparing chemoprophylaxis use and adherence and preventive behavior would be necessary to ensure electronic care is as effective as in-person care on realizing recommended malaria prevention and reducing malaria risk. Because chemoprophylaxis use is likely the best malaria prevention approach, telemedicine has the opportunity to fill a gap in VFR antimalarial coverage among frequent and last-minute travelers, groups particularly at risk for traveling without antimalarials.

Impact evaluations of barrier reduction interventions

Evaluations designed to measure the impact and effectiveness of interventions designed to increase malaria prevention among VFRs are rarely reported in the literature. A study by Neave et al. (2013) measured the impact of subsidizing the cost of antimalarial chemoprophylaxis on the incidence of imported malaria in the UK.[46] This study identified that subsidy of chemoprophylaxis does reduce imported malaria, but the effect size was marginal, suggesting that cost may not be the only barrier to chemoprophylaxis use affecting VFRs.[46] A separate policy analysis led by Behrens et al. (2015) found that guidance for providers focuses on increasing knowledge of malaria among VFR patients and is misaligned with findings that have shown that increased knowledge does not relate to malaria prevention and chemoprophylaxis use among VFRs.[44]

Future interventions informed by the findings in this study should be developed in ways in which their impact can be critically evaluated and measured. Additionally, sustainability and cost-effectiveness analyses should accompany these impact evaluations to determine whether interventions, when effective, should be embedded in policy and long-term planning. Partnerships with policy analysts and intervention evaluators will be necessary to create robust impact evaluations and develop sustainable mechanisms of reducing the burden of malaria illness in VFRs over time.

Public health impact

Reducing imported malaria has broad impacts for public health. Unnecessary, preventable morbidity and mortality from malaria in travelers would be reduced.[2,7] Nearly 1,500 travelers are diagnosed with malaria in the US each year, with 6 to 11 preventable deaths reported per year in recent years.[2] Local and national malaria morbidity and mortality surveillance estimates likely underestimate the true burden of malaria among VFRs due to illnesses occurring during travel and some cases going undiagnosed.

Targeted, sustainable interventions and policy changes designed to reduce barriers to malaria prevention and chemoprophylaxis use among VFRs has the potential to lessen the disparate burden of imported malaria among VFR travelers in the United States. Reduced imported malaria among VFRs, the most heavily burdened group will in turn, reduce health care costs related to malaria illness for payers, and will reduce the risk of imported malaria leading to local transmission and outbreaks through competent mosquito vectors. Additionally, interventions designed to improve access to pre-travel care among could lead to public health benefits broader than malaria illness alone. Increased pre-travel care could lessen VFR risk of acquiring other travel-associated diseases, also leading to reduced downstream health care costs and risk of local outbreaks of other communicable diseases.

Reducing health care costs associated with imported malaria

Malaria has been shown to be the most likely cause for post-travel hospitalization among ill travelers.[42] It is estimated that a single case of malaria hospitalization costs payers on average $25,789 (2017 dollars).[4] Chemoprophylaxis use is highly effective in preventing malaria and has been shown to be cost-effective for payers at any duration of client travel to malaria endemic areas.[43] Malaria prevention is greatly cost-effective to the health care system, yet VFRs consistently cite the cost of chemoprophylaxis and pre-travel care as key reasons they travel unprotected.[11,44,45] Interventions that subsidize the cost of malaria chemoprophylaxis have been shown to marginally reduce the number of imported malaria cases.[46] Further research is necessary to explore ways in which malaria prevention cost reduction strategies can be applied in resonant populations to encourage use of chemoprophylaxis and subsequently reduce imported malaria and the costs of treating the illness.

Reducing the risk of local malaria transmission

Autochthonous transmission of malaria in the United States has occurred as recently as 2003, causing eight locally acquired cases of vivax malaria and a massive public health response to stop the outbreak.[47–49] *Anopheles freeborni* and *A. quadrimaculatus* are competent mosquito vectors for malaria transmission and are present over much of the United States, including *A. quadrimaculatus* throughout the southern two thirds of Minnesota.[50]

Climate change is expected to lengthen the season of ideal temperature conditions for mosquito activity in much of the United States and may expand vector range,[50] increasing the risk for future autochthonous outbreaks when travelers import malaria into the United States. Furthermore, the

consistently observed summer seasonality of imported malaria cases in the US[2] aligns with the seasonal activity of local competent vectors, further increasing the risk for local transmission.[50] Although local outbreaks of malaria are not expected to reintroduce malaria as an endemic disease in the US, the public health response to such outbreaks is expensive, time-intensive, and requires strategic community engagement to reduce the risk of public concern and unintended negative impacts on affected communities.[47] Reducing malaria illness in retuned VFR travelers will reduce the risk that local mosquitoes will encounter infected hosts and transmit the illness to others and subsequently prevent large, resource intensive public health efforts to slow and stop local outbreaks.

Improving linkage to pre-travel care will impact other travel-associated illnesses

A downstream effect of successfully increasing pre-travel care among VFRs for malaria prevention could be the reduction of other imported, travel-associated, tropical, or vaccine-preventable illnesses important to public health.[24,27] A recent outbreak of measles in Minnesota, a vaccine-preventable disease, was traced to international travel.[51] Some immigrant VFRs may be under-immunized due to incomplete childhood vaccine administration and the loss of immunization records.[29] In a large study of febrile illness in returned travelers, VFRs had greater odds of being diagnosed with a vaccine-preventable illness than non-VFR travelers.[25]

Successful barrier reduction interventions that effectively increase access to specialized pre-travel care for malaria to a greater proportion of VFR travelers could also lead to increased immunization in this population. This would lead to reduced risk of imported vaccine-preventable infectious diseases imported by US resident travelers,[29] subsequently reducing the need for broad, expensive public health emergency action.[51] Health care costs associated with the treatment of individuals ill with malaria would be reduced for payers and health systems.[4,43] Finally, sustained intervention and partnership with communities at-risk for malaria could build stronger public health-community relationships. These relationships could establish better pathways for communication through which other public health interventions could be initiated in the future.

Final thoughts

Imported malaria is a pressing public health issue, not only for the approximately 1,500 ill travelers diagnosed in the US each year,[2] but also for public health and emergency preparedness officials, health systems, payers, and especially burdened communities such as VFR travelers. The disproportionate burden of malaria illness experienced by VFRs, alongside evidence from this study that VFRs, even those best connected to pre-travel care, experience larger barriers to malaria prevention than other travelers suggests that this population requires special attention and shoulder-to-shoulder collaboration in efforts to reduce prevention disparities. Building upon published literature on the topic, findings from this study elucidate certain behavioral and structural barriers to malaria prevention experienced by VFRs, indicate the heterogeneity of VFR experiences, and identify key differences between VFRs and other travelers. As VFR travel to malaria endemic areas continues to grow in coming years,[15,16] it is imperative that evidence-based barrier reduction strategies are developed, implemented, and evaluated to increase access to chemoprophylaxis, other malaria prevention, and pre-travel care in this population.

Bibliography

1. Arguin P, Tan K. Malaria - Chapter 3: Infectious diseases related to travel. In: *CDC Yellow Book 2018: Health Information for International Travel*. Centers for Disease Control and Prevention; 2018. https://wwwnc.cdc.gov/travel/yellowbook/2018/infectious-diseases-related-to-travel/malaria.

2. Mace KE, Arguin PM, Tan KR. Malaria surveillance - United States, 2015. *MMWR Surveill Summ*. 2018;67(7):1-28. doi:https://dx.doi.org/10.15585/mmwr.ss6707a1

3. World Health Organization. *World Malaria Report 2016*. Geneva, Switzerland. Licence: CC BY-NC-SA 3.0 IGO.; 2016. http://apps.who.int/iris/bitstream/handle/10665/252038/9789241511711-eng.pdf;jsessionid=2627A7829636C2728B845F114F5D6F84?sequence=1.

4. Khuu D, Eberhard ML, Bristow BN, et al. Malaria-related hospitalizations in the United States, 2000-2014. *Am J Trop Med Hyg*. 2017;97(1):213-221. doi:10.4269/ajtmh.17-0101

5. US National Travel and Tourism Office. *International Air Travel Statistics*. Washington, DC; 2018. https://travel.trade.gov/research/monthly/departures/index.asp.

6. Minnesota Department of Health. Annual summary of communicable diseases reported to the Minnesota Department of Health, 2015. *Dis Control Newsl*. 2016;43(1). https://www.health.state.mn.us/diseases/reportable/dcn/sum15/2015dcn.pdf.

7. Mace KE, Arguin PM. Malaria surveillance - United States, 2014. *MMWR Surveill Summ*. 2017;66(12):1-24. doi:https://dx.doi.org/10.15585/mmwr.ss6612a1

8. Cullen KA, Mace KE, Arguin PM, (CDC). Malaria surveillance - United States, 2013. *Morb Mortal Wkly Report Surveill Summ*. 2016;65(2):1-22. doi:https://dx.doi.org/10.15585/mmwr.ss6502a1

9. Cullen KA, Arguin PM, (CDC). Malaria surveillance--United States, 2012. *Morb Mortal Wkly Report Surveill Summ*. 2014;63(12):1-22. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med10&NEWS=N&AN=25474160.

10. Cullen KA, Arguin PM, (CDC). Malaria surveillance - United States, 2011. *Morb Mortal Wkly Report Surveill Summ*. 2013;62(5):1-17. https://www.cdc.gov/mmwr/pdf/ss/ss6205.pdf.

11. Bacaner N, Stauffer B, Boulware DR, Walker PF, Keystone JS. Travel medicine considerations for North American immigrants visiting friends and relatives. *JAMA*. 2004;291(23):2856-2864. doi:10.1001/jama.291.23.2856

12. Keystone JS. Immigrants returning home to visit friends and relatives (VFRs) - Chapter 8: Advising travlers with specific needs. In: *CDC Yellow Book 2018: Health Information for International Travel*. Centers for Disease Control and Prevention; 2018. wwwnc.cdc.gov/travel/yellowbook/2018/advising-travelers-with-specific-needs/immigrants-returning-home-to-visit-friends-relatives-vfrs.

13. Arguin PM. Editorial: A definition that includes first and second generation immigrants returning to their countries of origin to visit friends and relatives still makes sense to me. *J*

Travel Med. 2010;17(3):147-149. doi:10.1111/j.1708-8305.2010.00412.x

14. Matteelli A, Barnett ED, MacPherson DW, et al. The vsiting friends or relatives traveler in the 21st Century: Time for a new definition. *J Travel Med*. 2010;17(3):163-170. doi:10.1111/j.1708-8305.2010.00411.x

15. United Nations World Tourism Organization. *UNWTO Tourism Highlights: 2016 Edition*.; 2016. doi:10.18111/9789284418145

16. United Nations World Tourism Organization. *UNWTO Tourism Highlights: 2000 - Second Edition*.; 2000. doi:10.18111/9789284403745

17. Backer E, King B. VFR traveller demographics: The social tourism dimension. *J Vacat Mark*. 2017;23(3):191-204. doi:10.1177/1356766716665439

18. US National Travel and Tourism Office. *Profile of U.S. Resident Travelers Visiting Overseas Destinations: 2015*.; 2016. https://travel.trade.gov/outreachpages/download_data_table/2015_Outbound_Profile.pdf.

19. Angell SY, Behrens RH. Risk assessment and disease prevention in travelers visiting friends and relatives. *Infect Dis Clin North Am*. 2005;19(1):49-65. doi:10.1016/j.idc.2004.11.001

20. Pavli A, Maltezou HC. Malaria and travellers visiting friends and relatives. *Travel Med Infect Dis*. 2010;8(3):161-168. doi:https://dx.doi.org/10.1016/j.tmaid.2010.01.003

21. Freedman DO, Kozarsky PE, Weld LH, Cetron MS. GeoSentinel: The global emerging infections sentinel network of the International Society of Travel Medicine. *J Travel Med*. 1999;6(2):94-98. doi:10.1111/j.1708-8305.1999.tb00839.x

22. Leder K, Tong S, Weld L, et al. Illness in travelers visiting friends and relatives: A review of the GeoSentinel Surveillance Network. *Clin Infect Dis*. 2006;43(9):1185-1193. doi:10.1086/507893

23. Hagmann S, Neugebauer R, Schwartz E, et al. Illness in children after international travel: Analysis from the GeoSentinel surveillance network. *Pediatrics*. 2010;125(5):e1072-80. doi:10.1542/peds.2009-1951

24. Hagmann SHFF, Han P V., Stauffer WM, et al. Travel-associated disease among US residents visiting US GeoSentinel clinics after return from international travel. *Fam Pract*. 2014;31(6):678-687. doi:10.1093/fampra/cmu063

25. Wilson ME, Weld LH, Boggild A, et al. Fever in returned travelers: Results from the GeoSentinel surveillance network. *Clin Infect Dis*. 2007;44(12):1560-1568. doi:10.1086/518173

26. Angelo KM, Libman M, Caumes E, et al. Malaria after international travel: A GeoSentinel analysis, 2003–2016. *Malar J*. 2017;16(1):293. doi:10.1186/s12936-017-1936-3

27. Adams M, Leder K, Torresi J, et al. GeoSentinel surveillance of illness in returned travelers, 2007–2011. *Ann Intern Med*. 2016;158(6):456-470. doi:10.7326/0003-4819-158-6-201303190-00005

28. dos Santos CC, Anvar A, Keystone JS, Kain KC. Survey of use of malaria prevention

measures by Canadians visiting India. *Can Med Assoc J*. 1999;160(2):195-200. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=9951440.

29. Angell SY, Cetron MS. Health disparities among travelers visiting friends and abroad. *Ann Intern Med*. 2005;142(1):67-72. doi:10.7326/0003-4819-142-1-200501040-00013

30. Heywood AE, Forssman BL, Seale H, MacIntyre CR, Zwar N. General practitioners' perception of risk for travelers visiting friends and relatives. *J Travel Med*. 2015;22(6):368-374. doi:10.1111/jtm.12229

31. Hagmann S, Schlagenhauf P, L R, PM. A. Prevention of imported pediatric malaria—Travel medicine misses the bull's eye. *J Travel Med*. 2011;18(3):151-152. doi:10.1111/j.1708-8305.2011.00504.x

32. Stäger K, Legros F, Krause G, et al. Imported malaria in children in industrialized countries, 1992-2002. *Emerg Infect Dis*. 2009;15(2):185-191. doi:10.3201/EID1502.080712

33. Venturini E, Chiappini E, Mannelli F, Bonsignori F, Galli L, de Martino M. Malaria prophylaxis in African and Asiatic children traveling to their parents' home country: A Florentine study. *J Travel Med*. 2011;18(3):161-164. doi:10.1111/j.1708-8305.2011.00513.x

34. Maltezou HC, Pavli A, Theodoridou K, et al. Preparedness of adolescents departing from Athens International Airport to Africa or Asia: A five-year airport-based prospective study. *Travel Med Infect Dis*. 2018;21:69-73. doi:https://dx.doi.org/10.1016/j.tmaid.2017.07.011

35. Maltezou HC, Pavli A, Theodoridou K, et al. Vaccinations and malaria chemoprophylaxis of adolescents traveling from Greece to international destinations: A nine-year prospective study. *Pediatr Infect Dis J*. 2018;37(5):e132-e135. doi:https://dx.doi.org/10.1097/INF.0000000000001782

36. Hickey PW, Cape KE, Masuoka P, et al. A local, regional, and national assessment of pediatric malaria in the United States. *J Travel Med*. 2011;18(3):153-160. doi:10.1111/j.1708-8305.2011.00514.x

37. Hagmann S, Reddy N, Neugebauer R, Purswani M, Leder K. Identifying future VFR travelers among immigrant families in the Bronx, New York. *J Travel Med*. 2010;17(3):193-196. doi:10.1111/j.1708-8305.2010.00399.x

38. Goldman-Yassen AE, Mony VK, Arguin PM, Daily JP. Higher rates of misdiagnosis in pediatric patients versus adults hospitalized with imported malaria. *Pediatr Emerg Care*. 2016;32(4):227-231. doi:10.1097/PEC.0000000000000251

39. Arnáez J, Roa MA, Albert L, et al. Imported malaria in children: A comparative study between recent immigrants and immigrant travelers (VFRs). *J Travel Med*. 2010;17(4):221-227. doi:10.1111/j.1708-8305.2010.00416.x

40. Murray CJL, Lopez AD. Measuring the global burden of disease. *N Engl J Med*. 2013;369:448-457. doi:10.1056/NEJMra1201534

41. Collinet-Adler S, Stauffer WM, Boulware DR, Larsen KL, Rogers TB, Williams DN. Financial implications of refugee malaria: The impact of pre-departure presumptive treatment with anti-malarial drugs. *Am J Trop Med Hyg*. 2007;77(3):458-463. http://www.ajtmh.org/docserver/fulltext/14761645/77/3/0770458.pdf?expires=1504720531&id=id&accname=guest&checksum=A70887A908C74325B72FB009D8784BEE.

42. Stienlauf S, Segal G, Sidi Y, Schwartz E. Epidemiology of travel-related hospitalization. *J Travel Med*. 2005;12:136-141.

43. Adachi K, Coleman MS, Khan N, et al. Economics of malaria prevention in US travelers to West Africa. *Clin Infect Dis*. 2014;58(1):11-21. doi:10.1093/cid/cit570

44. Behrens RH, Neave PE, Jones COH. Imported malaria among people who travel to visit friends and relatives: is current UK policy effective or does it need a strategic change? *Malar J*. 2015;14:149. doi:https://dx.doi.org/10.1186/s12936-015-0666-7

45. Neave PE, Jones COH, Behrens RH. A review of risk factors for imported malaria in the European African diaspora. *J Travel Med*. 2010;17(5):346-350. doi:https://dx.doi.org/10.1111/j.1708-8305.2010.00440.x

46. Neave PE, Taylor S, Behrens RH, et al. Does public subsidy of the cost of malaria chemoprophylaxis reduce imported malaria? A comparative policy analysis. *Malar J*. 2013;12(1):238. doi:https://dx.doi.org/10.1186/1475-2875-12-238

47. Filler, SJ; MacArthur, JR; Parise, M; Wirtz REMDASR. Locally acquired mosquito-transmitted malaria: A guide for investigations in the United States. *Morb Mortal Wkly Rep*. 2006;5(RR-13):1-9. https://pdfs.semanticscholar.org/4a3b/a89936fff315f8bfa009ec5a6acc87bbf9e4.pdf?_ga=2.244185292.877155369.1529439096-720552279.1529439096.

48. CDC. Multifocal autochthonous transmission of malaria—Florida, 2003. *Morb Mortal Wkly Rep*. 2004;53:412-413. doi:10.1001/jama.292.3.324

49. CDC. Local transmission of Plasmodium vivax malaria - Palm Beach County, Florida, 2003. *Morb Mortal Wkly Rep*. 2003;52:908-911. doi:10.1001/jama.290.22.2931

50. Berrang-Ford L, MacLean JD, Gyorkos TW, Ford JD, Ogden NH. Climate change and malaria in Canada: A systems approach. *Interdiscip Perspect Infect Dis*. 2009;2009(May 2014):1-13. doi:10.1155/2009/385487

51. Hall V, Banerjee E, Kenyon C, et al. Measles Outbreak - Minnesota April-May 2017. *MMWR Morb Mortal Wkly Rep*. 2017;66(27):713-717. doi:10.15585/mmwr.mm6627a1

52. Walz EJ, Wanduragala D, Adedimeji AA, et al. Community-based participatory research in travel medicine to identify barriers to preventing malaria in VFR travellers. *J Travel Med*. 2019;26(1). doi:10.1093/jtm/tay148

53. Newman SD, Andrews JO, Magwood GS, Jenkins C, Cox MJ, Williamson DC. Community advisory boards in community-based participatory research: A synthesis of best processes. *Prev Chronic Dis*. 2011;8(3):A70. http://www.ncbi.nlm.nih.gov/pubmed/21477510.

54. Silvestre AJ, Quinn SJ, Rinaldo CR. A 22-year-old community advisory board: Health

research as an opportunity for social change. *J Community Pract*. 2010;18(1):58-75. doi:10.1080/10705421003766685

55. Redman-Maclaren M, MacLaren DJ, Harrington H, et al. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *Int J Equity Health*. 2012;11(1):79. doi:10.1186/1475-9276-11-79

56. Walz EJ, Volkman HR, Adedimeji AA, et al. Barriers to malaria prevention in US-based travelers visiting friends and relatives abroad: A qualitative study of West African immigrant travelers. *J Travel Med*. January 2019. doi:10.1093/jtm/tay163

57. Lee EH, Miller RH, Masuoka P, et al. Predicting risk of imported disease with demographics: Geospatial analysis of imported malaria in Minnesota, 2010-2014. *Am J Trop Med Hyg*. 2018;99(4):978-986. doi:10.4269/ajtmh.18-0357

58. Kirby RS, Delmelle Phd E, Eberth JM. Advances in spatial epidemiology and geographic information systems. *Ann Epidemiol*. 2016;27:1-9. doi:10.1016/j.annepidem.2016.12.001

59. Scott LA, Dunlop SJ, Walz EJ, et al. Prescription drug-dispensing limits in the USA-implications for malaria chemoprophylaxis among VFR travellers. *J Travel Med*. 2018;25(1):1-3. doi:https://dx.doi.org/10.1093/jtm/tay039

60. Rowe K, Chaves N, Leder K. Challenges to providing pre-travel care for travellers visiting friends and relatives: An audit of a specialist travel medicine clinic. *J Travel Med*. 2017;24(5). doi:10.1093/jtm/tax038

61. Schlagenhauf P, Weld L, Goorhuis A, et al. Travel-associated infection presenting in Europe (2008-12): An analysis of EuroTravNet longitudinal, surveillance data, and evaluation of the effect of the pre-travel consultation. *Lancet Infect Dis*. 2015;15(1):55-64. doi:10.1016/S1473-3099(14)71000-X

62. van Genderen PJJ, Van Thiel PPAM, Mulder PGH, et al. Trends in the knowledge, attitudes and practices of travel risk groups towards prevention of malaria: Results from the Dutch Schiphol Airport Survey 2002 to 2009. *Malar J*. 2012;11:179. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med7&NEWS=N&AN=22642661.

63. Leonard L, VanLandingham M. Adherence to travel health guidelines: The experience of Nigerian immigrants in Houston, Texas. *J Immigr Health*. 2001;3(1):31-45.

64. Kambili C, Murray HW, Golightly LM. Malaria: 30 years of experience at a New York City teaching hospital. *Am J Trop Med Hyg*. 2004;70(4):408-411. http://www.ncbi.nlm.nih.gov/pubmed/15100455.

65. Bear KA, Higginson AI, Hickey PW. Disparities exist in the availability of outpatient malaria treatment in Maryland, USA. *J Travel Med*. 2010;17(4):228-232. doi:10.1111/j.1708-8305.2010.00404.x

66. Casuccio A, Immordino P. Visiting friends and relatives (VFRs) role on imported malaria: A literature review. *Epidemiol Prev*. 2014;38(6 Suppl 2):23-28. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med8&NEWS=N&AN=25759339.

67. van Genderen PJJ, Mulder PGH, Overbosch D. The knowledge, attitudes and practices of wintersun vacationers to the Gambia toward prevention of malaria: is it really that bad? *Malar J*. 2014;13:74. doi:https://dx.doi.org/10.1186/1475-2875-13-74

68. Dahlgren A-L, DeRoo L, Steffen R. Prevention of travel-related infectious diseases: knowledge, practices and attitudes of Swedish travellers. *Scand J Infect Dis*. 2006;38(11-12):1074-1080. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN=17148080.

69. Wilder-Smith A, Khairullah NS, Song J-H, Chen C-Y, Torresi J. Travel health knowledge, attitudes and practices among Australasian travelers. *J Travel Med*. 2004;11(1):9-15. https://pdfs.semanticscholar.org/4140/6bd7efd7dc5f9f270c944f36dfd55fc5b94a.pdf?_ga=2.152550777.1316123744.1550699936-1717284980.1550699936.

70. Toovey Jamieson A, Holloway M, Toovey S, Jamieson A, Holloway M. Travelers' knowledge, attitudes and practices on the prevention of infectious fiseases: Results from a study at Johannesburg International Airport. *J Travel Med*. 2004;11(1):1-74. doi:10.2310/7060.2004.13587

71. Hamer DH, Connor BA. Travel health knowledge, attitudes and practices among United States travelers. *J Travel Med*. 2004;11(1):23 LP - 26. doi:10.2310/7060.2004.13577

72. Behrens RH, Alexander N. Malaria knowledge and utilization of chemoprophylaxis in the UK population and in UK passengers departing to malaria-endemic areas. *Malar J*. 2013;12(1):461. doi:10.1186/1475-2875-12-461

73. Wieten RW, Harting J, Biemond PM, Grobusch MP, van Vugt MM. Towards improved uptake of malaria chemoprophylaxis among West African travellers: Identification of behavioural determinants. *Malar J*. 2013;12(1):360. doi:https://dx.doi.org/10.1186/1475-2875-12-360

74. Van Herck K, Van Damme P, Castelli F, et al. Knowledge, attitudes and practices in travel-related infectious diseases: The European airport survey. *J Travel Med*. 2004;11(1):3-8. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN=14769280.

75. Heywood AE, Zwar N. Improving access and provision of pre-travel healthcare for travellers visiting friends and relatives: A review of the evidence. *J Travel Med*. 2018;25(1). doi:10.1093/jtm/tay010

76. Scolari C, Tedoldi S, Casalini C, et al. Knowledge, attitudes, and practices on malaria preventive measures of migrants attending a public health clinic in northern Italy. *J Travel Med*. 2002;9(3):160-162. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=12088584.

77. Farquharson L, Noble LM, Barker C, Behrens RH. Health beliefs and communication in the travel clinic consultation as predictors of adherence to malaria chemoprophylaxis. *Br J Health Psychol*. 2004;9(Pt 2):201-217. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN

=15125805.

78. Neave PE, Behrens RH, Jones COH. “You’re losing your Ghanaianess”: understanding malaria decision-making among Africans visiting friends and relatives in the UK. *Malar J*. 2014;13(1):287. doi:https://dx.doi.org/10.1186/1475-2875-13-287

79. Flaherty G. Malaria awareness in the African migrant population living in Ireland. *Travel Med Infect Dis*. 2016;14(2):165-166. doi:https://dx.doi.org/10.1016/j.tmaid.2015.12.005

80. Baer A, Libassi L, Lloyd JK, et al. Risk factors for infections in international travelers: An analysis of travel-related notifiable communicable diseases. *Travel Med Infect Dis*. 2014;12(5):525-533. doi:https://dx.doi.org/10.1016/j.tmaid.2014.05.005

81. Schilthuis HJ, Goossens I, Ligthelm RJ, De Vlas SJ, Varkevisser C, Richardus JH. Factors determining use of pre-travel preventive health services by West African immigrants in The Netherlands. *Trop Med Int Health*. 2007;12(8):990-998. doi:10.1111/j.1365-3156.2007.01856.x

82. Pistone T, Guibert P, Gay F, et al. Malaria risk perception, knowledge and prophylaxis practices among travellers of African ethnicity living in Paris and visiting their country of origin in sub-Saharan Africa. *Trans R Soc Trop Med Hyg*. 2007;101(10):990-995. doi:10.1016/j.trstmh.2007.05.009

83. Morgan M, Figueroa-Muñoz JI. Barriers to uptake and adherence with malaria prophylaxis by the African community in London, England: focus group study. *Ethn Health*. 2005;10(4):355-372. doi:10.1080/13557850500242035

84. Grieve A. Malaria: awareness and compliance with preventive measures. *Nurs Stand*. 2005;19(46):48-53. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN=16097198.

85. Van Herck K, Zuckerman J, Castelli F, et al. Travelers’ knowledge, attitudes, and practices on prevention of infectious diseases: Results from a pilot study. *J Travel Med*. 2003;10(2):75-78. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=12650648.

86. Lopez-Velez R, Bayas J-MJ. Spanish travelers to high-risk areas in the tropics: airport survey of travel health knowledge, attitudes, and practices in vaccination and malaria prevention. *J Travel Med*. 2007;14(5):297-305. doi:10.1111/j.1708-8305.2007.00142.x

87. Pistone T, Ezzedine K, Gaudin A-FA-F, Hercberg S, Nachbaur GG, Malvy D. Malaria prevention behaviour and risk awareness in French adult travellers. *Travel Med Infect Dis*. 2010;8(1):13-21. doi:https://dx.doi.org/10.1016/j.tmaid.2009.10.005

88. Genton B, Behrens RH. Specialized travel consultation part I: Travelers’ prior knowledge. *J Travel Med*. 1994;1(1):8-12. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=medp&NEWS=N&AN=9815301.

89. Teodósio R, Gonçalves L, Atouguia J, et al. Quality assessment in a travel clinic: A study of travelers’ knowledge about malaria. *J Travel Med*. 2006;13(5):288-293.

doi:10.1111/j.1708-8305.2006.00060.x

90. Askling HH, Tegnell A, Henric Braconier J, et al. Travellers returning to Sweden with falciparum malaria: Pre-travel advice, behaviour, chemoprophylaxis and diagnostic delay. *Scand J Infect Dis*. 2005;37(10):760-765. doi:10.1080/00365540510044120

91. Laver SM, Wetzels J, Behrens RH. Knowledge of malaria, risk perception, and compliance with prophylaxis and personal and environmental preventive measures in travelers exiting Zimbabwe from Harare and Victoria Falls International airport. *J Travel Med*. 2001;8(6):298-303. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=11726294.

92. Paudel P, Raina C, Zwar N, et al. Risk activities and pre-travel health seeking practices of notified cases of imported infectious diseases in Australia. *J Travel Med*. 2017;24(5). doi:https://dx.doi.org/10.1093/jtm/tax044

93. Savage RD, Rosella LC, Crowcroft NS, et al. How can we keep immigrant travelers healthy? Health challenges experienced by Canadian South Asian travelers visiting friends and relatives. *Qual Health Res*. 2018;28(4):610-623. doi:10.1177/1049732317746381

94. Kuna A, Gajewski M, Stanczak J. Evaluation of knowledge and use of the malaria prevention measures among the patients of the Department of Tropical and Parasitic Diseases University Center of Maritime and Tropical Medicine, Gdynia, based on a questionnaire performed in the years 2012-20. *Przegl Epidemiol*. 2017;71(1):33-44. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med13&NEWS=N&AN=28654740.

95. Gisler S, Steffen R, Mutsch M. Knowledge, attitudes and practices among travellers to tropical and subtropical countries. *Praxis (Bern 1994)*. 2005;94(23):967-974. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN=16001539.

96. Minnesota Department of Health. Annual summary of communicable diseases reported to the Minnesota Department of Health, 2017. *Dis Control Newsl*. 2018;45(1). http://www.health.state.mn.us/diseasereport.

97. Minnesota Department of Health. Annual summary of communicable diseases reported to the Minnesota Department of Health, 2016. *Dis Control Newsl*. 2017;44(1). http://www.health.state.mn.us/diseasereport.

98. Lozano R, Naghavi M, Lim SS, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2095-2128. www.thelancet.com.

99. Green RG, Murphy KD, Snyder SM. Should demographics be placed at the end or at the beginning of mailed questionnaires? An empirical answer to a persistent methodological question. *Soc Work Res*. 2000;24(4):237-241. doi:10.1093/swr/24.4.237

100. Kelley K, Clark B, Brown V, Sitzia J. Good practice in the conduct and reporting of survey research. *Int J Qual Heal Care*. 2003;15(3):261-266. doi:10.1093/intqhc/mzg031

101. Brooks GP, Johanson GA. Sample size considerations for multiple comparison procedures

in ANOVA. *J Mod Appl Stat Methods*. 2011;10. doi:10.22237/jmasm/1304222940

102. European Centre for Disease Prevention and Control. *Annual Epidemiological Report 2016 – Malaria*. Stockholm; 2016. https://ecdc.europa.eu/sites/portal/files/documents/Malaria AER_1.pdf.

103. Neave PE, Jones CO, Behrens RH. Challenges facing providers of imported malaria-related healthcare services for Africans visiting friends and relatives (VFRs). *Malar J*. 2014;13(1):17. doi:10.1186/1475-2875-13-17

104. Hsieh FY. Sample size tables for logistic regression. *Stat Med*. 1989;8:795-802. doi:10.1002/sim.4780080704

105. Fried B, Pintor JK, Graven P, Blewett LA. Implementing federal health reform in the states: Who is included and excluded and what are their characteristics? *Health Serv Res*. 2014;49(S2):2062-2085. doi:10.1111/1475-6773.12232

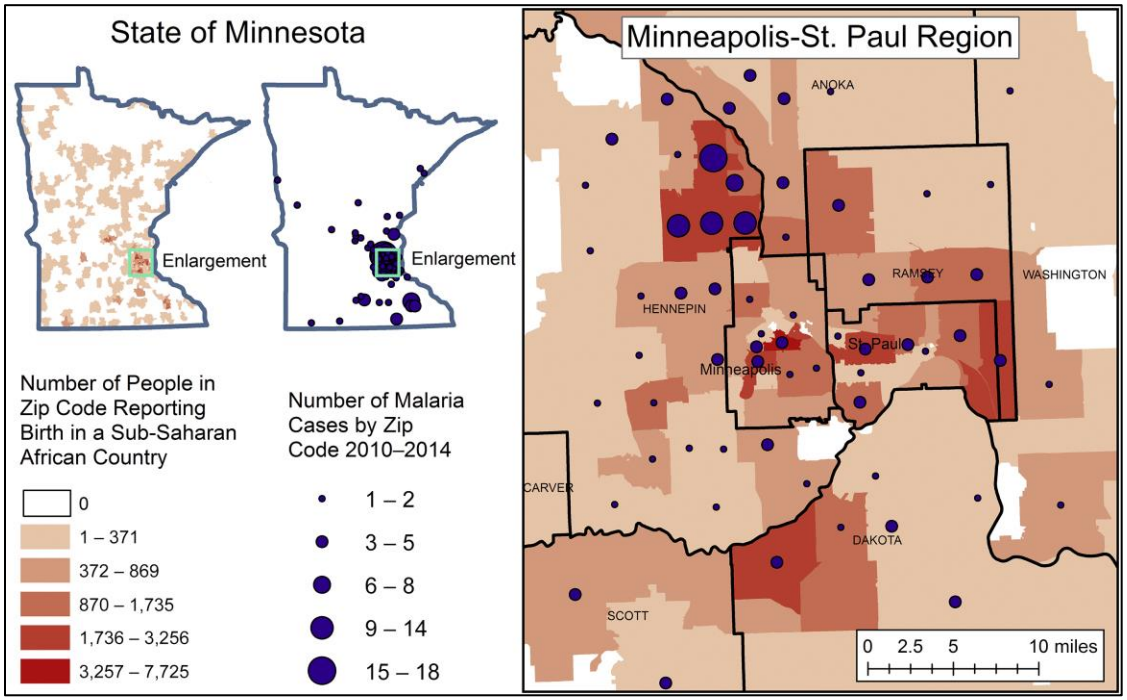
106. Baggett HC, Graham S, Kozarsky PE, et al. Pretravel health preparation among US residents traveling to India to VFRs: importance of ethnicity in defining VFRs. *J Travel Med*. 2009;16(2):112-118. doi:https://dx.doi.org/10.1111/j.1708-8305.2008.00284.x

107. Lal L, Audsley J, Murphy DA, et al. Medication adherence, condom use and sexually transmitted infections in Australian preexposure prophylaxis users. *AIDS*. 2017;31(12):1709-1714. doi:10.1097/QAD.0000000000001519

108. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care*. 1986;24(1):67-74. https://ovidsp-tx-ovid-com.ezp1.lib.umn.edu/sp-3.33.0b/ovidweb.cgi?WebLinkFrameset=1&S=IDKDFPKFMBDDHDODNCDKMCMCIGHPAA00&returnUrl=ovidweb.cgi%3FMain%2BSearch%2BPage%3D1%26S%3DIDKDFPKFMBDDHDODNCDKMCMCIGHPAA00&directlink=https%3A%2F%2Fovidsp.tx.ovid.com%2Fo.

Appendices

Appendix 1: Map of Minnesota imported malaria cases and birth in Sub-Saharan Africa[57]



Source: Lee EH, Miller RH, Masuoka P, et al. Predicting risk of imported disease with demographics: Geospatial analysis of imported malaria in Minnesota, 2010-2014. *Am J Trop Med Hyg*. 2018;99(4):978-986.

Imported malaria cases (blue dots) overlaid on the number of people reporting birth in a sub-Saharan African country by ZIP Code Tabulation Area (ZCTA) (red area symbols). Malaria cases cluster with ZCTAs reporting larger populations of individuals reporting birth in sub-Saharan African countries. Malaria case Zip Codes were obtained from Minnesota Department of Health. Location of birth was obtained from the American Community Survey.[57]

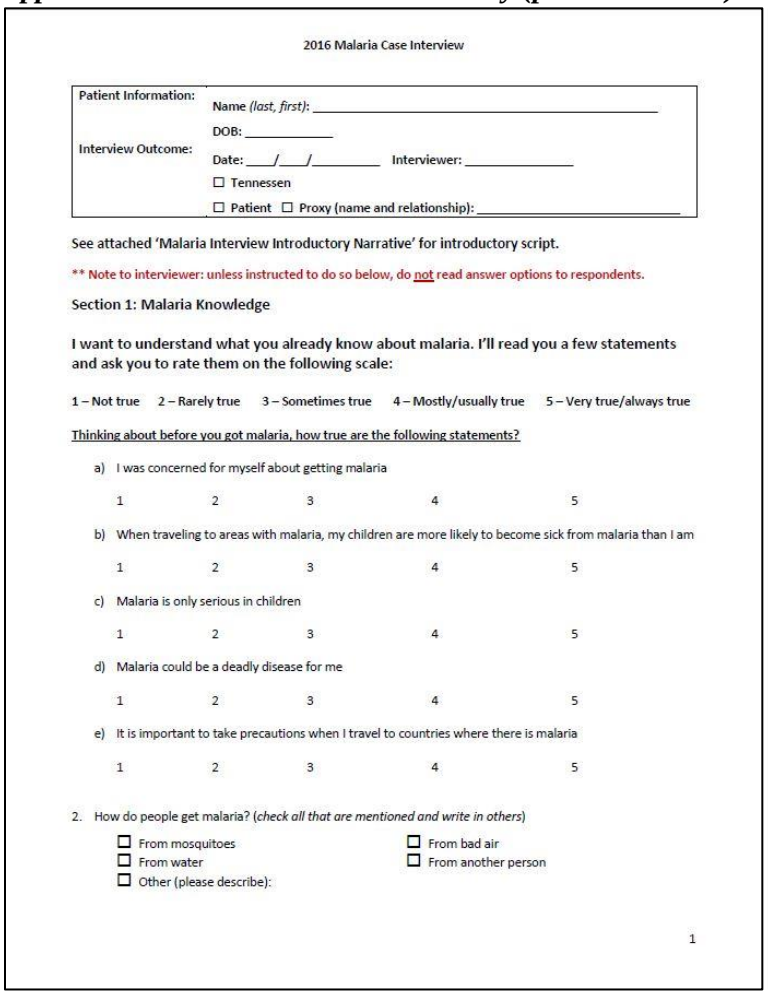
Appendix 2: Ovid MEDLINE search parameters for literature review

#	Searches	Results*	Condensed categories	Notes
1	exp MALARIA/	62,768		MeSH
2	malaria.mp.	87,416		keyword
3	1 or 2	87,473	Malaria	
4	exp TRAVEL/	25,574		MeSH
5	exp Travel Medicine/	598		MeSH
6	4 or 5	25,812	Travel	
7	"visiting friends and relatives".mp.	207		keyword
8	“visit friends and relatives”.mp.	84		keyword
9	"VFR travel*".mp.	58		keyword
10	7 or 8 or 9	273	VFR	
11	exp Health Knowledge, Attitudes, Practice/	101,001	KAP	MeSH
12	3 and 6	3,380	Malaria + Travel	
13	3 and 10	155	Malaria + VFR	
14	3 and 6 and 10	125	Malaria + Travel + VFR	Not a useful reduction from #13
15	13 not 14	30	Malaria + VFR – Travel	Checked discrepant papers in #13 v #14; all relevant
16	3 and 6 and 11	107	Malaria + Travel + KAP	
17	3 and 9 and 10	15	Malaria + VFR + KAP	Identical to #19
18	**13 or 16**	**247**	**(Malaria + VFR) OR (Malaria + Travel + KAP)**	**All abstracts reviewed (minimum)**
19	3 and 6 and 10 and 11	15	Malaria + Travel + VFR + KAP	

* As run on Feb 16, 2019

Appendix 3: Surveys

Appendix 3.1: 2016 Case Interview Survey (pilot instrument)



2016 Malaria Case Interview

Patient Information:	Name *(last, first)*: _____
	DOB: _____
Interview Outcome:	Date: ____/____/_____ Interviewer: _____
	☐ Tennessen
	☐ Patient ☐ Proxy (name and relationship): _____

See attached 'Malaria Interview Introductory Narrative' for introductory script.

** Note to interviewer: unless instructed to do so below, do not read answer options to respondents.

Section 1: Malaria Knowledge

I want to understand what you already know about malaria. I'll read you a few statements and ask you to rate them on the following scale:

1 – Not true 2 – Rarely true 3 – Sometimes true 4 – Mostly/usually true 5 – Very true/always true

Thinking about before you got malaria, how true are the following statements?

a) I was concerned for myself about getting malaria

1 2 3 4 5

b) When traveling to areas with malaria, my children are more likely to become sick from malaria than I am

1 2 3 4 5

c) Malaria is only serious in children

1 2 3 4 5

d) Malaria could be a deadly disease for me

1 2 3 4 5

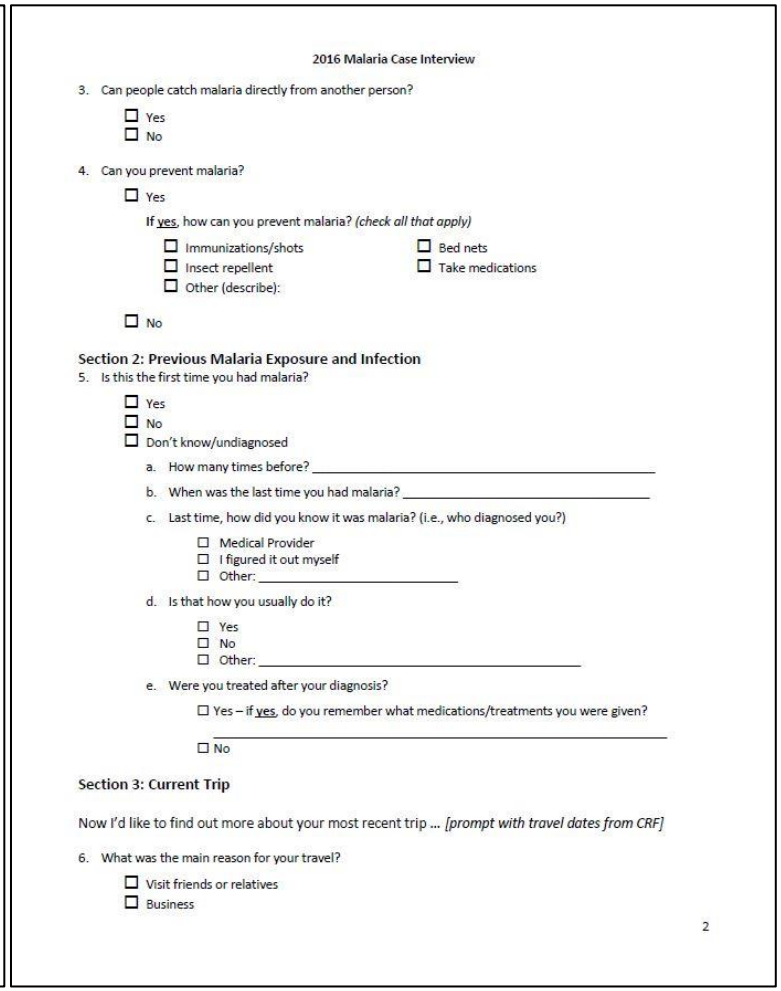
e) It is important to take precautions when I travel to countries where there is malaria

1 2 3 4 5

2. How do people get malaria? (*check all that are mentioned and write in others*)

☐ From mosquitoes
☐ From water
☐ Other (please describe):
☐ From bad air
☐ From another person

1



2016 Malaria Case Interview

3. Can people catch malaria directly from another person?

☐ Yes
☐ No

4. Can you prevent malaria?

☐ Yes

If yes, how can you prevent malaria? *(check all that apply)*

☐ Immunizations/shots
☐ Insect repellent
☐ Other (describe):
☐ Bed nets
☐ Take medications

☐ No

Section 2: Previous Malaria Exposure and Infection

5. Is this the first time you had malaria?

☐ Yes
☐ No
☐ Don't know/undiagnosed

a. How many times before? _____

b. When was the last time you had malaria? _____

c. Last time, how did you know it was malaria? (i.e., who diagnosed you?)

☐ Medical Provider
☐ I figured it out myself
☐ Other: _____

d. Is that how you usually do it?

☐ Yes
☐ No
☐ Other: _____

e. Were you treated after your diagnosis?

☐ Yes – if yes, do you remember what medications/treatments you were given?

_____

☐ No

Section 3: Current Trip

Now I'd like to find out more about your most recent trip … *[prompt with travel dates from CRF]*

6. What was the main reason for your travel?

☐ Visit friends or relatives
☐ Business

2

- ☐ Vacation – not visiting friends or relatives
- ☐ Studying abroad / research
- ☐ Mission trip
- ☐ Other: _____

7. Where did you travel to? *(List specific country[ies], city[ies])*

8. How long were you there? (days, weeks, months)

9. Did you or anyone traveling with you talk to someone about malaria before you left?

- ☐ Yes – **if yes, go to 9a.**
- ☐ No – **skip to question 10**

9a. **If yes**, who did you/they talk to?

- ☐ Family member
- ☐ Community elder
- ☐ Healthcare provider
- ☐ Religious leader
- ☐ Travel agent
- ☐ Other: _____

If it was a **healthcare provider**, was it your regular healthcare provider, travel clinic, or somewhere else?

- ☐ Your regular healthcare provider (primary care)
- ☐ At a travel clinic
- ☐ Other: _____

9b. If you traveled as a family, did all the family members see a health care provider before travel or only specific family members? Which ones?

- ☐ N/A (traveled alone)
- ☐ All travelers
- ☐ Only children
- ☐ A pregnant traveler
- ☐ Other: _____

10. During your most recent trip to _____ when you got malaria, did you use insect repellent?

- ☐ Yes
- ☐ No
- ☐ Sometimes

10a. If **yes/sometimes**, when did you use it?

- ☐ Applied in morning when getting ready
- ☐ Only when I saw mosquitoes
- ☐ When I knew I would be outside
- ☐ Throughout the day
- ☐ Before I went to bed
- ☐ Only if I saw mosquito bites on my skin

- ☐ When I was outside after sundown
- ☐ If other people complained of mosquitoes
- ☐ Other: _____

10b. If **yes/sometimes**, do you remember what kind of repellent?

10c. **Were there any other times you used repellent?** *(ask again to prompt and use check boxes above)*

11. Did you use anything else to keep mosquitoes away?

- ☐ Yes (if yes, please describe):
- ☐ No

12. During your most recent trip to _____ when you got malaria, did you sleep underneath a bed net?

- ☐ Yes – **go to question 12a.**
- ☐ No – **go to question 12b.**

12a. Did you use the bed net all of the time or only in some situations?

- ☐ All the time
- ☐ Other (please describe): _____

12b. If you did not use a bed net, why not? *(check all that apply)*:

- ☐ I did not think I needed a bed net/to sleep under a bed net
- ☐ I did not know where to buy a net
- ☐ I do not like sleeping under a net
- ☐ I gave my net to someone else to use/not enough nets for everyone
- ☐ I slept in a place in which a bed net was unnecessary

13. When you last traveled, were any special health precautions recommended to you?
(Read list to case and select all that apply)

- ☐ Vaccines
- ☐ Medications for malaria
- ☐ Medications for diarrhea
- ☐ Other (please describe):
- ☐ Hand sanitizer
- ☐ Insect repellents
- ☐ Bed nets

13a. Who recommended these to you?

Section 4: Current illness

Now I'd like to ask you some more questions about how malaria affected you. For your most recent/current illness:

14. When did you start feeling sick? *(test/doctor's visit was on [lab date])* Estimated date: _____

15. When you started to feel sick were you abroad, traveling between countries/cities, or back in the US?

- ☐ In another country
- ☐ Traveling between countries/cities
- ☐ Back in the U.S.

16. Before you traveled this time, were you prescribed a malaria prevention medication?

- ☐ Yes
- ☐ No – **skip to question 18**

16a. **If yes**, who prescribed the medication?

- ☐ Regular doctor
- ☐ Travel clinic
- ☐ Pharmacist (didn't see a provider)
- ☐ Other: _____

16b. **If yes**, did you pick up the prescription?

- ☐ Yes
- ☐ No – **go to question 18**

16c. **If yes**, did you take the malaria prevention medication?

- ☐ Yes
- ☐ No

17a. Do you remember what medication(s) you received?

- ☐ Chloroquine (Aralen®)
- ☐ Atovaquone-proguanil (Malarone®)
- ☐ Don't remember
- ☐ Mefloquine (Lariam ®)
- ☐ Doxycycline
- ☐ Other: _____

If don't remember the name of the medicine, do you remember…

a. Was it once a day or once a week?
- ☐ Once a day
- ☐ Once a week

b. The shape of the pill?
- ☐ Liquid
- ☐ Oval
- ☐ Circle

c. Color of pill?

d. If you break it open, was there powder inside?
- ☐ Powder inside (capsule)
- ☐ Pill was same texture inside and out (tablet)

17b. How often were you supposed to take it?

- ☐ Once a day
- ☐ Once a week
- ☐ Don't know

17c. After you got back, how long did you take it?

- ☐ Stopped right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 3 weeks after I got back
- ☐ 4 weeks after I got back

17d. Do you remember how long were you supposed to take it after you got back?

- ☐ Stop right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 4 weeks after I got back
- ☐ Can't remember

17e. Did you take it as prescribed or did you miss or skip any doses?

- ☐ As prescribed
- ☐ Missed/skipped doses
  - ☐ Missed one
  - ☐ Missed a few days
  - ☐ Missed a lot of days
- ☐ I stopped taking it

17f. If you skipped or missed doses or stopped taking it, what were the reasons?

- ☐ Forgot to take medicine
- ☐ The pharmacy didn't give me enough
- ☐ Lost it
- ☐ Had side effects (describe): _____
- ☐ Other: _____

18a. If medications were not prescribed OR if medications were prescribed but you didn't take them, why not?

[*Not prescribed only*:]

- ☐ No one told me I needed preventive medications
- ☐ Didn't know there were preventive medications

[*Prescribed, didn't take it only*:]

- ☐ Could not get medication at pharmacy/pharmacy did not stock medication

[*Either*:]

- ☐ It was too expensive
- ☐ Not a serious disease

- ☐ I would rather take my chances
- ☐ Don't think I needed it
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I planned to just buy medicine if I got sick while traveling/easier to just treat if you get sick
- ☐ My trip was too long for me to take a prevention medication
- ☐ They didn't give me enough for my whole trip
- ☐ My insurance didn't cover it
- ☐ I forgot
- ☐ I didn't think there was malaria where I was going
- ☐ I planned to get it when I got to my destination
- ☐ It wasn't the rainy season
- ☐ Medications do not work well
- ☐ I don't like to take medications
- ☐ Other: _____

18b. Are there any other reasons that you didn't take medication? (ask question again and use options above)

Section 5: Traveling with children

19. On your last trip did any children travel with you?

- ☐ Yes – if yes, how many? _____
- ☐ No – **skip to question 23**

20. Before you traveled, was the child prescribed a malaria prevention medication?

- ☐ Yes
- ☐ No – **skip to question 22**

20a. <u>If yes</u>, did someone pick up the prescription?

- ☐ Yes
- ☐ No – **skip to question 22**

20b. <u>If yes</u>, did the child take the malaria prevention medication?

- ☐ Yes
- ☐ No – **skip to question 22**

21. a. Do you know what medication/s the child received?

- ☐ Chloroquine (Aralen®)
- ☐ Atovaquone-proguanil (Malarone®)
- ☐ Don't remember
- ☐ Mefloquine (Lariam ®)
- ☐ Doxycycline
- ☐ Other: _____

<u>If don't remember the name of the medicine, do you remember…</u>

a. Was it once a day or once a week?

- ☐ Once a day
- ☐ Once a week

b. Shape of the pill?

- ☐ Liquid
- ☐ Oval
- ☐ Circle

c. Color of pill?

d. If you break it open, was there powder inside?

- ☐ Powder inside (capsule)
- ☐ Pill was same texture inside and out (tablet)

21b. How often was the child supposed to take it?

- ☐ Once a day
- ☐ Once a week
- ☐ Don't know

21c. After you got back, how long did the child take it?

- ☐ Stopped right when child got back
- ☐ For <3 days after child got back
- ☐ 1 week after child got back
- ☐ 2 weeks after child got back
- ☐ 4 weeks after child got back

21d. How long was the child supposed to take it after he/she got back?

- ☐ Stop right when child got back
- ☐ For <3 days after child got back
- ☐ 1 week after child got back
- ☐ 2 weeks after child got back
- ☐ 4 weeks after child got back
- ☐ Can't remember

21e. Did the child take it as prescribed on the label or did he/she miss or skip any doses?

- ☐ As prescribed
- ☐ Missed/skipped doses
  - ☐ Missed one
  - ☐ Missed a few days
  - ☐ Missed a lot of days
- ☐ I stopped taking it

21f. If he/she skipped or missed doses or stopped taking it, what were the reasons?

- ☐ Forgot to take medicine
- ☐ The pharmacy didn't give me enough
- ☐ Lost it
- ☐ Had side effects (describe): _____
- ☐ Other: _____

22a. If medications were not prescribed OR if medications were prescribed but he/she didn't take the medication, why not?

[*Not prescribed only*:]
- ☐ No one told me preventive medications were needed
- ☐ Didn't know there were preventive medications

[*Prescribed, didn't take it only*:]
- ☐ Could not get medication at pharmacy / pharmacy did not stock medication

[*Either*:]
- ☐ It was too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think child needed it
- ☐ The medication has too many side effects/worried about side effects in children
- ☐ I planned to just buy medicine if child got sick while traveling/easier to just treat if you get sick
- ☐ My trip was too long for child to take a prevention medication
- ☐ They didn't give child enough for whole trip
- ☐ My insurance didn't cover it
- ☐ I forgot to make sure child took
- ☐ I didn't think there was malaria where we were going
- ☐ I planned to get it when we got to our destination
- ☐ It wasn't the rainy season
- ☐ Medications do not work well
- ☐ I don't like to take medications/give medications to children
- ☐ Other: _____

22b. Are there any other reasons the child didn't take medication? (ask question again and use options above)

Section 6: Post-travel questions

My next set of questions is about when you got back from your recent trip to _____:

23. When you started to feel sick/first noticed your symptoms, what did you think was making you sick?
- ☐ Malaria
- ☐ Something else (describe): _____

24. When you noticed your symptoms, where was the first place you looked for information/advice about your illness?
- ☐ Family or friend abroad
- ☐ Healthcare provider abroad
- ☐ Family or friend in US
- ☐ Primary care in US
- ☐ Urgent care/ER in US
- ☐ Travel clinic in US
- ☐ Internet
- ☐ Other: _____

25. Did you try to treat yourself (or your child) before seeking medical care?
- ☐ Yes
- ☐ No

25a. If yes, why? (*Check all that apply*):
- ☐ Doctors in the US don't know about malaria
- ☐ Going to the doctor is too expensive
- ☐ I knew it was malaria and how to treat it
- ☐ I already had the medicine
- ☐ Buying medicine is too expensive
- ☐ Didn't know it was malaria
- ☐ Malaria is easy to treat
- ☐ Malaria is not a serious problem
- ☐ Other: _____

25b. If yes, what did you do to treat yourself? (*Check all that apply*):
- ☐ Took medication for fever and/or pain? (e.g. paracetamol, Tylenol, ibuprofen)
  If yes, what medicine: _____
- ☐ Herbal remedy
- ☐ Other: _____

25c. If yes, did you take a medicine specifically for malaria?
- ☐ Yes
  If yes, what medicine? _____
  Where was the medicine from/where did you get it? _____
- ☐ No

26. After returning from any trip to a country with malaria, have you ever self-treated a child in your family for malaria before going to a doctor?
- ☐ Yes – **skip to question 25a.**
- ☐ No – **skip to question 25b.**

26a. If yes, why? (*Check all that apply*):
- ☐ Malaria is easy to treat
- ☐ Malaria is not a serious problem
- ☐ Didn't know it was malaria
- ☐ I already had the medicine
- ☐ Buying medicine is too expensive
- ☐ Going to the doctor is too expensive
- ☐ I knew it was malaria and how to treat it
- ☐ Doctors in the US don't know about malaria
- ☐ Other:

26b. If no, why not? *(please explain)*: _____

27. How many health professionals did you see or visits to clinics, urgent care, emergency departments did you have before you were told that malaria was your diagnosis?

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four or more
- ☐ Never told I had malaria

Section 7: Future plans

28. Would you seek medical advice before traveling outside the U.S. if you might be going to a malaria area?

☐ Yes -- If yes; where would you get this advice (Check all that apply)?

- ☐ Internet
- ☐ Travel agent
- ☐ Pharmacy
- ☐ Urgent care
- ☐ Primary care
- ☐ Travel clinic
- ☐ Other: _____

☐ No -- If no, why not? (Check all that apply)

- ☐ I don't have insurance
- ☐ Rather take my chances
- ☐ Too busy
- ☐ Not worried about malaria/don't think I can get malaria ("I am immune")
- ☐ Other:

29. The next time you (or your child) travel to a country with malaria, would you take malaria prevention medication if it was suggested to you?

- ☐ Yes
- ☐ No

If no, why not?

- ☐ Too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think I'll need it
- ☐ I will probably forget
- ☐ I don't like to take medications
- ☐ My insurance doesn't cover it
- ☐ Medications do not work well
- ☐ It won't be the rainy season
- ☐ Can't get enough medication for my whole trip
- ☐ I don't think there is malaria where I'll travel
- ☐ I will get it when I got to my destination
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I plan to just buy medicine if I get sick while traveling/easier to treat if you get sick
- ☐ My trip will be too long for me to take a prevention medication
- ☐ I can't find a pharmacy that stocks the medication
- ☐ Other:

30. The next time you travel to a country with malaria, would you use a bed net if it were recommended to you?

- ☐ Yes
- ☐ No – if no, why not?

31. The next time you travel to a country with malaria, would you use mosquito repellent if it were recommended to you?

- ☐ Yes
- ☐ No – if no, why not?

32. The next time you travel to a country with malaria, would you use insecticide-treated clothing if it were recommended to you?

- ☐ Yes
- ☐ No – if no, why not?

33. Is there anything you know about malaria now that you wish you had known before you got sick?

34. In your opinion, what would be the best way to educate people about malaria?

Additional Demographic Information

35. Gender:

- ☐ Male
- ☐ Female

36. Were you born in the United States?

- ☐ Yes
- ☐ No

35a. If no, where were you born? (Record country of birth): _____

37. Have you ever lived in a country other than the United States or the country you were born?

- ☐ Yes – where? _____
- ☐ No

38. Have you ever lived in an area that has malaria? (Not recent trip, but lived there)

- ☐ Yes
- ☐ No – **skip to question 39**

38a. When was the last time? _____

38b. Where did you live? _____

38c. How long did you live there? _____ (weeks, months, years)

38d. How long have you lived in the US? _____ (weeks, months, years)

39. Where were your parents born?

Mom: _____

Dad: _____

40. How would you describe your race/ethnicity?:

_____

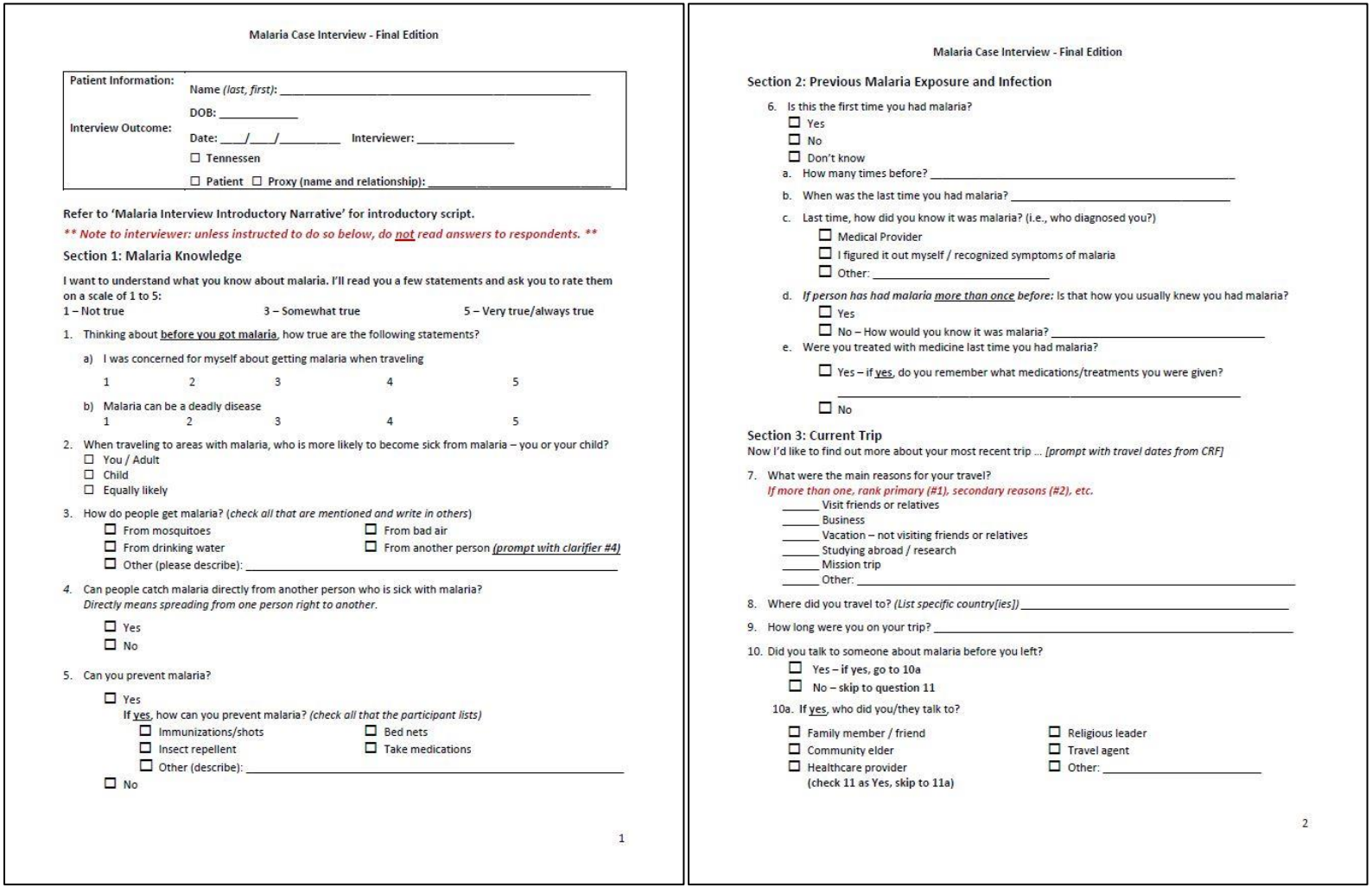
41. Before this most recent trip, how long ago did you last travel to a country with malaria?

42. What is the highest level of educational you completed?

- ☐ Grade school
- ☐ High School
- ☐ Associate Degree
- ☐ Bachelor's Degree
- ☐ Graduate School

43. Additional notes:

Appendix 3.2: Case Interview Survey



Malaria Case Interview - Final Edition

Patient Information:	Name *(last, first)*: _____
	DOB: _____
Interview Outcome:	Date: ____/____/_____ Interviewer: _____
	☐ Tennessen
	☐ Patient ☐ Proxy (name and relationship): _____

Refer to 'Malaria Interview Introductory Narrative' for introductory script.

*** Note to interviewer: unless instructed to do so below, do not read answers to respondents. ****

Section 1: Malaria Knowledge

I want to understand what you know about malaria. I'll read you a few statements and ask you to rate them on a scale of 1 to 5:
1 – Not true 3 – Somewhat true 5 – Very true/always true

1. Thinking about before you got malaria, how true are the following statements?
   a) I was concerned for myself about getting malaria when traveling
      1 2 3 4 5
   b) Malaria can be a deadly disease
      1 2 3 4 5
2. When traveling to areas with malaria, who is more likely to become sick from malaria – you or your child?
   - ☐ You / Adult
   - ☐ Child
   - ☐ Equally likely
3. How do people get malaria? (*check all that are mentioned and write in others*)
   - ☐ From mosquitoes
   - ☐ From bad air
   - ☐ From drinking water
   - ☐ From another person *(prompt with clarifier #4)*
   - ☐ Other (please describe): _____
4. Can people catch malaria directly from another person who is sick with malaria?
   Directly means spreading from one person right to another.
   - ☐ Yes
   - ☐ No
5. Can you prevent malaria?
   - ☐ Yes
     If yes, how can you prevent malaria? *(check all that the participant lists)*
     - ☐ Immunizations/shots
     - ☐ Bed nets
     - ☐ Insect repellent
     - ☐ Take medications
     - ☐ Other (describe): _____
   - ☐ No

1

Malaria Case Interview - Final Edition

Section 2: Previous Malaria Exposure and Infection

6. Is this the first time you had malaria?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know
   a. How many times before? _____
   b. When was the last time you had malaria? _____
   c. Last time, how did you know it was malaria? (i.e., who diagnosed you?)
      - ☐ Medical Provider
      - ☐ I figured it out myself / recognized symptoms of malaria
      - ☐ Other: _____
   d. *If person has had malaria more than once before:* Is that how you usually knew you had malaria?
      - ☐ Yes
      - ☐ No – How would you know it was malaria? _____
   e. Were you treated with medicine last time you had malaria?
      - ☐ Yes – if yes, do you remember what medications/treatments you were given?
        _____
      - ☐ No

Section 3: Current Trip

Now I'd like to find out more about your most recent trip … *[prompt with travel dates from CRF]*

7. What were the main reasons for your travel?
   If more than one, rank primary (#1), secondary reasons (#2), etc.
   _____ Visit friends or relatives
   _____ Business
   _____ Vacation – not visiting friends or relatives
   _____ Studying abroad / research
   _____ Mission trip
   _____ Other: _____
8. Where did you travel to? *(List specific country[ies])* _____
9. How long were you on your trip? _____
10. Did you talk to someone about malaria before you left?
    - ☐ Yes – if yes, go to 10a
    - ☐ No – skip to question 11

    10a. If yes, who did you/they talk to?
    - ☐ Family member / friend
    - ☐ Religious leader
    - ☐ Community elder
    - ☐ Travel agent
    - ☐ Healthcare provider
    - ☐ Other: _____

    (check 11 as Yes, skip to 11a)

2

11. *If participant does not list healthcare provider above:* Did you see a healthcare provider before you left?
- ☐ Yes – Go to 11a
- ☐ No – Why not? _____

11a. If yes: Was it your regular healthcare provider, travel clinic, or somewhere else?
- ☐ Regular healthcare provider (primary care)
- ☐ Travel clinic
- ☐ Both regular healthcare provider and travel clinic
- ☐ Urgent care
- ☐ Pharmacy / minute clinic
- ☐ Other: _____

12. Did you travel with family? *If yes, continue question, if no go to question 13*
- ☐ Yes
- ☐ No, did not travel with family

12a. If yes Did everyone in the family who traveled see a healthcare provider?
- ☐ Yes
- ☐ No
- ☐ Some were seen → Who? _____

12b. Were you more concerned about making sure certain family members were seen by a healthcare provider than others?
- ☐ No
- ☐ Yes → Who? _____

12c. Why?
- ☐ Only certain family members have insurance
- ☐ Cost
- ☐ Risk of Illness
- ☐ Age (very young or old)
- ☐ Pregnancy
- ☐ Other: _____

13. During your most recent trip did you use any of the following strategies to keep mosquitos away or stay healthy? *I'm going to list a few examples and you can respond: yes, no, or sometimes*

Did you sleep under bed nets? ☐ Yes ☐ No ☐ Sometimes

If sometimes, when? _____

If no, why not?
- ☐ I did not think I needed a bed net/to sleep under a bed net
- ☐ I did not know where to buy a net
- ☐ I do not like sleeping under a net
- ☐ I gave my net to someone else to use/not enough nets for everyone
- ☐ I slept in a place in which a bed net was unnecessary
- ☐ Other: _____

Did you use repellent / creams /sprays / lotions? ☐ Yes ☐ No ☐ Sometimes

If yes / sometimes, when did you wear repellent?
- ☐ Applied in morning when getting ready
- ☐ Only when I saw mosquitoes
- ☐ When I knew I would be outside
- ☐ Throughout the day
- ☐ Before I went to bed
- ☐ Only if I saw mosquito bites on my skin
- ☐ When I was outside after sundown
- ☐ If other people complained of mosquitoes
- ☐ Other: _____

If yes / sometimes, do you know what the active ingredient was?
- ☐ Deet
- ☐ Picaridin
- ☐ Other: _____

☐ Yes	☐ No	☐ Sometimes	Mosquito coils
☐ Yes	☐ No	☐ Sometimes	Environmental cleanup e.g removing sources of standing water
☐ Yes	☐ No	☐ Sometimes	Staying indoors when mosquitos are out
☐ Yes	☐ No	☐ Sometimes	Wear long clothing
☐ Yes	☐ No	☐ Sometimes	Practice good food safety / hygiene
☐ Yes	☐ No	☐ Sometimes	Ensure clean water source (safe, bottled)
☐ Yes	☐ No	☐ Sometimes	Educate yourself on risks of malaria before traveling
☐ Yes	☐ No	☐ Sometimes	Pick where you stayed in order to avoid mosquitos (AC/screens)
☐ Yes	☐ No	☐ Sometimes	Get vaccinations

Anything else? _____

Section 4: Current illness

Now I'd like to ask you some more questions about how malaria affected you. For your most recent/current illness:

14. When did you start feeling sick? *(test/doctor's visit was on [lab date])* Estimated date: _____

15. When you started to feel sick were you abroad, traveling between countries/cities, or back in the US?
- ☐ In another country
- ☐ Traveling between countries/cities
- ☐ Back in the U.S.

16. Did you take a malaria prevention medicine during your last trip?
- ☐ Yes
- ☐ No
- ☐ Sometimes

17. Did a healthcare provider write you a prescription for a malaria prevention medicine?
- ☐ Yes
- ☐ No – **If 16 & 17 are No, skip to 23**

17a. **If yes,** did you pick up the medicine in the US or once you arrived to your destination?
- ☐ Picked up the medicine in the US

If in the US: Who prescribed the medication?
- ☐ Regular doctor
- ☐ Pharmacist (didn't see a provider)
- ☐ Travel clinic
- ☐ Other: _____

- ☐ Picked up the prescription in destination country

17b. **If 16 is yes/sometimes and 17 is no, clarify:** Did you buy the malaria prevention medicine without a prescription once you arrived to your destination?
- ☐ Yes
- ☐ No – Explain: _____

18. Do you remember what medication(s) you received?
- ☐ Chloroquine (Aralen®)
- ☐ Atovaquone-proguanil (Malarone®)
- ☐ Don't remember
- ☐ Mefloquine (Lariam ®)
- ☐ Doxycycline
- ☐ Other: _____

18a-d. **If don't remember the name of the medicine, do you remember…**

a. Was it once a day or once a week? ☐ Circle
- ☐ Once a day
- ☐ Once a week

b. The shape of the pill?
- ☐ Liquid
- ☐ Oval

c. Color of pill?

d. If you break it open, was there powder inside?
- ☐ Powder inside (capsule)
- ☐ Pill was same texture inside and out (tablet)

19. How often were you supposed to take it?
- ☐ Once a day
- ☐ Once a week
- ☐ Don't know

20. Did you take it as prescribed or did you miss or skip any doses?
- ☐ No, I took it as prescribed
- ☐ Missed/skipped doses
  - ☐ Missed one
  - ☐ Missed a few days
  - ☐ Missed a lot of days
- ☐ I stopped taking it

20a. **If you skipped or missed doses or stopped taking it**: What were the reasons?
- ☐ Forgot to take medicine
- ☐ The pharmacy didn't give me enough
- ☐ Lost it
- ☐ Had side effects (describe): _____
- ☐ Other: _____

21. Do you remember how long were you supposed to take it after you got back?
- ☐ Stop right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 4 weeks after I got back
- ☐ Can't remember

22. After you got back, how long did you take it?
- ☐ Stopped right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 3 weeks after I got back
- ☐ 4 weeks after I got back

23. **If you didn't take medications,** why not?

[*Not prescribed only*:]
- ☐ No one told me I needed preventive medications
- ☐ Didn't know there were preventive medications

[*Prescribed, didn't take it only*:]
- ☐ Could not get medication at pharmacy/pharmacy did not stock medication

[*Either*:]
- ☐ It was too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think I needed it
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I planned to just buy medicine if I got sick while traveling/easier to just treat if you get sick
- ☐ My trip was too long for me to take a prevention medication
- ☐ They didn't give me enough for my whole trip
- ☐ My insurance didn't cover it
- ☐ I forgot
- ☐ I didn't think there was malaria where I was going
- ☐ I planned to get it when I got to my destination
- ☐ It wasn't the rainy season
- ☐ Medications do not work well
- ☐ I don't like to take medications
- ☐ Other: _____

23b. Are there any other reasons that you didn't take medication? (ask question again and use options above)

Section 5: Traveling with Children

24. On your last trip did any children travel with you?
- ☐ Yes – if yes, how many? _____ How old were they? _____
- ☐ No – skip to question 33

25. Did your child/ren take a malaria prevention medicine during your last trip?
- ☐ Yes →Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall
- ☐ No
- ☐ Sometimes→Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall

26. Did a healthcare provider write your child/ren a prescription for a malaria prevention medicine?
- ☐ Yes
- ☐ No – **If 25 & 26 are No, skip to 32**

26a. **If yes,** did you pick up the medicine for your child/ren in the US or once you arrived to your destination?
- ☐ Got the medicine in the US

If in the US: Who prescribed the medication?
- ☐ Regular doctor
- ☐ Pharmacist (didn't see a provider)
- ☐ Travel clinic
- ☐ Other: _____

- ☐ Got the prescription in destination country

26b. **If 25 is yes/sometimes and 26 is no, clarify:** So you bought the malaria prevention medicine for your child/ren without a prescription once you arrived to your destination?
- ☐ Yes.
- ☐ No – Explain: _____

27. Do you remember what medication(s) you received for your child/ren?
- ☐ Chloroquine (Aralen®)
- ☐ Mefloquine (Lariam ®)
- ☐ Atovaquone-proguanil (Malarone®)
- ☐ Doxycycline
- ☐ Don't remember
- ☐ Other: _____

27a-d. **If don't remember the name of the medicine, do you remember…**

a. Was it once a day or once a week?
- ☐ Once a day
- ☐ Once a week

b. The shape of the pill?
- ☐ Liquid
- ☐ Oval
- ☐ Circle

c. Color of pill?

d. If you break it open, was there powder inside?
- ☐ Powder inside (capsule)
- ☐ Pill was same texture inside and out (tablet)

28. How often was your child/ren supposed to take it?
- ☐ Once a day
- ☐ Once a week
- ☐ Don't know

29. Did your child/ren take it as prescribed or did you miss or skip any doses?
- ☐ No, he/she took it as prescribed
- ☐ Missed/skipped doses
  - ☐ Missed one
  - ☐ Missed a few days
  - ☐ Missed a lot of days
- ☐ He/she stopped taking it

29a. **If your child/ren skipped or missed doses or stopped taking it**: What were the reasons?
- ☐ Forgot to take medicine
- ☐ The pharmacy didn't give me enough
- ☐ Lost it
- ☐ Child couldn't tolerate bad taste of medicine
- ☐ Had side effects (describe): _____
- ☐ Other: _____

30. Do you remember how long were your child/ren supposed to take it after you got back?
- ☐ Stop right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 4 weeks after I got back
- ☐ Can't remember

31. After you got back, how long did your child/ren take it?
- ☐ Stopped right when I got back
- ☐ For <3 days after I got back
- ☐ 1 week after I got back
- ☐ 2 weeks after I got back
- ☐ 3 weeks after I got back
- ☐ 4 weeks after I got back

32. **If your child/ren didn't take medications,** why not?

[*Not prescribed only*:]
- ☐ No one told me I needed preventive medications
- ☐ Didn't know there were preventive medications

[*Prescribed, didn't take it only*:]
- ☐ Could not get medication at pharmacy/pharmacy did not stock medication

[*Either*:]
- ☐ It was too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think I needed it
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I planned to just buy medicine if I got sick while traveling/easier to just treat if you get sick

- ☐ My trip was too long for me to take a prevention medication
- ☐ They didn't give me enough for my whole trip
- ☐ My insurance didn't cover it
- ☐ I forgot
- ☐ I didn't think there was malaria where I was going
- ☐ I planned to get it when I got to my destination
- ☐ It wasn't the rainy season
- ☐ Medications do not work well
- ☐ I don't like to take medications
- ☐ Other: _____

32b. Are there any other reasons that your child/ren didn't take medication? (ask question again and use options above)

Section 6: Post-travel questions

My next set of questions is about when you got back from your recent trip to _____:

33. When you started to feel sick/first noticed your symptoms, what did you think was making you sick?
    - ☐ Malaria
    - ☐ Something else (describe): _____

34. When you noticed your symptoms, where was the first place you looked for information/advice about your illness?
    - ☐ Family or friend abroad
    - ☐ Healthcare provider abroad
    - ☐ Family or friend in US
    - ☐ Primary care in US
    - ☐ Urgent care/ER in US
    - ☐ Travel clinic in US
    - ☐ Internet
    - ☐ Other: _____

35. Did you try to treat yourself before seeking medical care?
    - ☐ Yes
    - ☐ No

    35a. If yes, why? (*Check all that apply*):
    - ☐ Doctors in the US don't know about malaria
    - ☐ Going to the doctor is too expensive
    - ☐ I knew it was malaria and how to treat it
    - ☐ I already had the medicine
    - ☐ Other: _____
    - ☐ Buying medicine is too expensive
    - ☐ Didn't know it was malaria
    - ☐ Malaria is easy to treat
    - ☐ Malaria is not a serious problem

    35b. If yes, what did you do to treat yourself? (*Check all that apply*):
    - ☐ Took a malaria medication. What medicine? _____
    - ☐ Took medication for fever and/or pain? (e.g. Tylenol, ibuprofen, paracetamol)
      If yes, what medicine: _____
    - ☐ Herbal remedy: _____
    - ☐ Other: _____

SKIP question 36 if the participant did not travel with a child

36. How many times did you do to the doctor before you were told you had malaria?
    - ☐ One
    - ☐ Two
    - ☐ Three
    - ☐ Four or more
    - ☐ Never told I had malaria

37. Did you have any concerns about going to the doctor with malaria symptoms?
    - ☐ Yes. Please explain: _____
    - ☐ No

38. After returning from any trip to a country with malaria, have you ever self-treated a child in your family for malaria before going to a doctor?
    - ☐ Yes – Go to 38a.
    - ☐ No – I did not try to self-treat the child before going to the doctor – Go to 38b.
    - ☐ No – Child has never seemed sick with malaria after a trip – Go to 39

    38a. If yes, why? (*Check all that apply*):
    - ☐ Malaria is easy to treat
    - ☐ Malaria is not a serious problem
    - ☐ Didn't know it was malaria
    - ☐ I already had the medicine
    - ☐ Buying medicine is too expensive
    - ☐ Going to the doctor is too expensive
    - ☐ I knew it was malaria and how to treat it
    - ☐ Doctors in the US don't know about malaria
    - ☐ Other:

    36b. If no, why not? *(please explain)*: _____

Section 7: Future plans

39. Next time you travel to a country with malaria, where would you seek advice on your health?
    Check all participant mentions
    - ☐ Internet
    - ☐ Travel agent
    - ☐ Pharmacy
    - ☐ Urgent care
    - ☐ Primary care
    - ☐ Travel clinic
    - ☐ Friends / family
    - ☐ Community leaders
    - ☐ CDC / MDH
    - ☐ Other: _____
    - ☐ Not going to seek advice
      Why not? _____

40. The next time you travel to a country with malaria, will you take a malaria prevention medication?
    - ☐ Yes
    - ☐ No

    If no, why not?
    - ☐ Too expensive
    - ☐ Not a serious disease
    - ☐ I would rather take my chances
    - ☐ Don't think I'll need it
    - ☐ I will probably forget
    - ☐ I don't like to take medications
    - ☐ My insurance doesn't cover it
    - ☐ Medications do not work well
    - ☐ It won't be the rainy season
    - ☐ Can't get enough medication for my whole trip
    - ☐ I don't think there is malaria where I'll travel
    - ☐ I will get it when I got to my destination
    - ☐ The medication has too many side effects/am worried about side effects
    - ☐ I plan to just buy medicine if I get sick while traveling/easier to treat if you get sick
    - ☐ My trip will be too long for me to take a prevention medication
    - ☐ I can't find a pharmacy that stocks the medication
    - ☐ Other: _____

41. The next time you travel to a country with malaria, will you use a bed net?
    - ☐ Yes
    - ☐ No – if no, why not? _____

42. The next time you travel to a country with malaria, will you use mosquito repellent?
    - ☐ Yes
    - ☐ No – if no, why not? _____

43. Is there anything you know about malaria now that you wish you had known before you got sick?

44. In your opinion, what would be the best way to educate people about malaria?

Additional Demographic Information

45. Gender:
    - ☐ Male
    - ☐ Female
    - ☐ Other: _____

46. Were you born in the United States?
    - ☐ Yes
    - ☐ No

    46a. If no: Where were you born? (Country): _____

    46b. If no: When did you last live there? _____

    46c. If no: How long did you live there? _____

    46d. If no: How long have you lived in the US? _____

47. Have you ever lived in a country other than the United States or the country you were born?
    - ☐ Yes – where? _____
    - ☐ No

    47a. If yes: When did you last live there? _____

    47b. If yes: How long did you live there? _____

48. *(Since living in the United States)* how many times have you traveled to places with malaria / Africa?
    - ☐ 1 – this was my first time back
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5 or more times

49. Where were your parents born? (Country): Mom: _____ Dad: _____

50. How would you describe your race/ethnicity? _____

51. What is the highest level of educational you completed?
    - ☐ Grade school
    - ☐ Some high school
    - ☐ High school
    - ☐ Associate degree / some college / post-secondary training
    - ☐ Bachelor's degree
    - ☐ Graduate school / PhD / Advanced

52. Primary care doctors are doctors you go to for checkups and health problems that aren't emergencies. Do you go to a primary care doctor?
    - ☐ Yes
    - ☐ No

    52a. If yes, when is the last time you went to your primary care doctor?
    - ☐ Within the last month
    - ☐ Within the last 6 months
    - ☐ Within the last year
    - ☐ 1-2 years
    - ☐ More than 2 years ago

53. Additional notes: _____

*Appendix 3.3: Emergency Department Community Survey *Amharic, French, and Somali translations not shown*

Emergency Department Community Survey

Survey Date: _____ **Interviewer Initials:** _____ **Unique Participant ID:** _____
Participated? (Y/N) _____ **Completed? (Y/N)**_____

Target Population:
First and second generation immigrants from Sub-Saharan Africa who have traveled to a malaria area in any part of Africa in the past 10 years, or who plan to travel in the coming 1 year

Inclusion Criteria

- ☐ **Chart:** Presenting to ED waiting room in stable status (non-critical)
- ☐ **Chart/Ask:** 18 years of age or older
- ☐ **Chart/Ask:** Place of birth in a Sub-Saharan African country: _____
  —OR— Reported ethnicity from Sub-Saharan Africa: _____
- ☐ **Ask:** Traveled to a malaria-endemic area of Africa in the past 10 years or plan to travel in the next year
- ☐ **Ask:** Resides in the United States
- ☐ **Ask:** Has heard of malaria before

1. In the past 10 years, have you traveled from the US to any country in Africa?
   - ☐ Yes → When was the last time? _____ Where did you go? _____ →INCLUDE
   - ☐ No → Do you plan to travel to a county in Africa in the next one year?
     - ☐ Yes → Where? _____ → INCLUDE
     - ☐ No → DOES NOT FIT INCLUSION CRITERIA

2. Do you live in Minnesota or in the United States?
   - ☐ Yes → INCLUDE
   - ☐ No → DOES NOT FIT INCLUSION CRITERIA

3. Have you heard of malaria?
   - ☐ Yes →INCLUDE
   - ☐ No → DOES NOT FIT INCLUSION CRITERIA

---IF PATIENT FULFILLS ALL INCLUSION CRITERIA ABOVE, COMPLETE ENROLLMENT PROCESS BEFORE BEGINNING SURVEY ---

Emergency Department Community Survey

*** Note to interviewer: unless instructed to do so below, do not read answers to respondents. ***

Section 1: Malaria Knowledge

I want to understand what you know about malaria. I'll read you a few statements and ask you to rate them on a scale of 1 to 5:
1 – Not true **3 – Somewhat true** **5 – Very true/always true**

1. How true are the following statements?

   1a. I am concerned for myself about getting malaria when traveling
   1 2 3 4 5

   1b. Malaria can be a deadly disease
   1 2 3 4 5

2. When traveling to areas with malaria, who is more likely to become sick from malaria – you or your child?
   - ☐ You / Adult
   - ☐ Child
   - ☐ Equally likely

3. How do people get malaria? (*check all that are mentioned and write in others*)
   - ☐ From mosquitoes
   - ☐ From bad air
   - ☐ From drinking water
   - ☐ From another person ***(prompt with clarifier #4)***
   - ☐ Other (please describe): _____

4. Can people catch malaria directly from another person who is sick with malaria?
   Directly means spreading from one person right to another.
   - ☐ Yes
   - ☐ No

5. Can you prevent malaria?
   - ☐ Yes
     5a. If yes, how can you prevent malaria? *(check all that the participant lists)*
     - ☐ Immunizations/shots
     - ☐ Bed nets
     - ☐ Insect repellent
     - ☐ Taking medications
     - ☐ Other (describe): _____
   - ☐ No

Section 2: Previous Malaria Exposure and Infection

6. Have you ever had malaria?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

Section 3: Most Recent Trip / Upcoming Trip

Only use upcoming trip prompts if participant has not traveled to a malaria area in the past 10 years*

Now I'd like to find out more about your **most recent trip** to _____ / the trip you plan to take to _____

7. What were the main reasons for your travel? / What are the main reasons you are going to travel?
   If more than one rank primary (#1), secondary reasons (#2), etc.
   - _____ Visit friends or relatives
   - _____ Business
   - _____ Vacation – not visiting friends or relatives
   - _____ Studying abroad / research
   - _____ Mission trip
   - _____ Other: _____

8. What country(ies) did you travel to? / What country(ies) will you travel to? _____

9. How long were you on your trip? / How long will you be on your trip? (indicate weeks/days) _____

10. Did you talk to someone about malaria before you left? / Will you talk with someone about malaria before you go?
    - ☐ Yes – **Go to question 10a**
    - ☐ No – **Skip to question 11**

    10a. If yes, who did you talk to? / Who will you talk to?
    - ☐ Family member / friend
    - ☐ Community elder
    - ☐ Healthcare provider
      (check 11 as Yes, skip to 11a)
    - ☐ Religious leader
    - ☐ Travel agent
    - ☐ Other: _____

11. ***If participant does not list healthcare provider above:*** Did you see a healthcare provider before you left? / Do you plan to see a healthcare provider before you go?
    - ☐ Yes – **Go to question 11a**
    - ☐ No – **Why not?** _____

    11a. If yes: Was / Is it your regular healthcare provider, travel clinic, or somewhere else?
    - ☐ Regular healthcare provider (primary care)
    - ☐ Travel clinic
    - ☐ Both regular healthcare provider and travel clinic
    - ☐ Urgent care
    - ☐ Pharmacy / minute clinic
    - ☐ Other: _____

12. If you traveled as a family, was everyone traveling seen by a healthcare provider?
    - ☐ Yes
    - ☐ No
    - ☐ Some were seen → How are the people that were seen related to you (e.g., son, mother, etc.)?
      _____

12a. Were you more concerned about making sure certain family members were seen by a healthcare provider than others?
- ☐ No
- ☐ Yes – Why? (check all that apply)
  - ☐ Only certain family members covered by insurance
  - ☐ Cost
  - ☐ Risk of illness
  - ☐ Age (very young or very old)
  - ☐ Pregnancy
  - ☐ Other: _____

13. During your most recent trip did you use any of the following strategies to keep mosquitos away or stay healthy? / Do you plan to use any of the following strategies to keep mosquitos away or stay healthy?
    I'm going to list a few examples and you can respond: yes, no, or sometimes

☐ Yes	☐ No	☐ Sometimes	Bed nets
☐ Yes	☐ No	☐ Sometimes	Repellent / creams / sprays / lotions
☐ Yes	☐ No	☐ Sometimes	Mosquito coils
☐ Yes	☐ No	☐ Sometimes	Environmental cleanup i.e., removing sources of standing water
☐ Yes	☐ No	☐ Sometimes	Staying indoors when mosquitoes are out
☐ Yes	☐ No	☐ Sometimes	Wear long clothing
☐ Yes	☐ No	☐ Sometimes	Practice good food safety / hygiene
☐ Yes	☐ No	☐ Sometimes	Ensure clean water source (safe, bottled)
☐ Yes	☐ No	☐ Sometimes	Educate yourself on risks of malaria before traveling
☐ Yes	☐ No	☐ Sometimes	Pick where you stayed in order to avoid mosquitos (AC/screens)
☐ Yes	☐ No	☐ Sometimes	Get vaccinations

Anything else? _____

If participant is a prospective traveler, SKIP to question 22 *

Section 4: Antimalarial Use During Travel

14. Did you take a malaria prevention medicine during your last trip?
    - ☐ Yes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall
    - ☐ No
    - ☐ Sometimes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall

15. Did a healthcare provider write you a prescription for a malaria prevention medicine?
    - ☐ Yes
    - ☐ No

    15a. If yes, did you pick up the medicine in the US or once you arrived to your destination?
    - ☐ Picked up the medicine in the US
    - ☐ Picked up the medicine in destination country

If 14 is yes/sometimes and 15 is no, clarify: Did you buy the malaria prevention medicine without a prescription once you arrived to your destination?
- ☐ Yes
- ☐ No – Explain: _____

Section 5: Traveling with Children

16. On your last trip did any children travel with you?
- ☐ Yes – if yes, how many? _____ How old were they? _____
- ☐ No

16a. If yes, did the child/ren take a malaria prevention medicine during your last trip?
- ☐ Yes → Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall
- ☐ No
- ☐ Sometimes→Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall

16b. Did a healthcare provider write your child/children a prescription for malaria prevention medicine?
- ☐ Yes
- ☐ No

16c. If yes, did you pick up the medicine for your child/ren in the US or once you arrived to your destination?
- ☐ Picked up the medicine in the US
- ☐ Picked up the medicine in destination country

If 16a is yes/sometimes and 16b is no: Did you buy the malaria prevention medicine for your child/ren without a prescription once you arrived to your destination?
- ☐ Yes
- ☐ No Explain: _____

Section 6: Illnesses During Travel and Healthcare Seeking Behaviors

17. Since living in the United States, do you think you have gotten malaria while traveling outside of the US?
- ☐ Yes
- ☐ No – **Skip to question 22**

18. When you noticed your symptoms, where was the first place you looked for information/advice about your illness?
- ☐ Family or friend abroad
- ☐ Healthcare provider abroad
- ☐ Family or friend in US
- ☐ Primary care in US
- ☐ Urgent care/ER in US
- ☐ Travel clinic in US
- ☐ Internet
- ☐ Other: _____

19. Did you try to treat yourself before seeking medical care?
- ☐ Yes
- ☐ No

19a. If yes, why? (*Check all that apply*):
- ☐ Doctors in the US don't know about malaria
- ☐ Going to the doctor is too expensive
- ☐ I knew it was malaria and how to treat it
- ☐ I already had the medicine
- ☐ Other: _____
- ☐ Buying medicine is too expensive
- ☐ Didn't know it was malaria
- ☐ Malaria is easy to treat
- ☐ Malaria is not a serious problem

19b. If yes, what did you do to treat yourself? (*Check all that apply*):
- ☐ Took malaria medication. Which medicine? _____
- ☐ Took medication for fever and/or pain? (e.g., Tylenol, ibuprofen, paracetamol)
  If yes, which medicine: _____
- ☐ Herbal remedy: _____
- ☐ Other: _____

20. Did you end up seeing a healthcare provider when you thought you had malaria?
- ☐ **Yes (answer questions 20a through 20d)**

20a. What made you decide to go? _____

20b. Were you tested for malaria?
☐Yes ☐No ☐ Don't know / don't remember

20c. Did a healthcare provider tell you that you had malaria?
☐Yes ☐No ☐ Don't know / don't remember

20d. How many times did you see a healthcare provider before you were told you had malaria?
☐ One ☐Two ☐ Three ☐ Four or more ☐ Don't remember

- ☐ No 20f. If no: Why not?
  - ☐ I got better on my own
  - ☐ Malaria is easy to treat
  - ☐ Malaria is not a serious problem
  - ☐ I already had the medicine
  - ☐ Buying medicine is too expensive
  - ☐ Going to the doctor is too expensive
  - ☐ I knew it was malaria and how to treat it
  - ☐ Doctors in the US don't know about malaria
  - ☐ Other: _____

21. After returning from any trip to a country with malaria, have you ever self-treated a child in your family for malaria before seeing a healthcare provider?
- ☐ Yes – **Go to question 21a**
- ☐ No – I did not try to self-treat the child before going to the doctor - **Skip to question 21b**
- ☐ No – Child never seemed sick with malaria – **Skip to question 22.**

21a. If yes, why? (*Check all that apply*):
- ☐ Malaria is easy to treat
- ☐ Malaria is not a serious problem
- ☐ Didn't know it was malaria
- ☐ I already had the medicine
- ☐ Buying medicine is too expensive
- ☐ Going to the doctor is too expensive
- ☐ I knew it was malaria and how to treat it
- ☐ Doctors in the US don't know about malaria
- ☐ Other: _____

21b. If no, why not? *(please explain)*: _____

22. Imagine you just got back to the United States from a trip to [country of travel] and started to feel symptoms of malaria such as fever and chills. Would you go to the doctor right away or try to treat it yourself at home first?

- ☐ I would go to the doctor right away. Why?
  - ☐ Malaria is dangerous/serious
  - ☐ Doctors can prescribe antimalarial medicines
  - ☐ Other: _____
- ☐ I would try to treat it at home first. Why?
  - ☐ Malaria is easy to treat; I know how to treat it
  - ☐ Malaria is not a serious problem
  - ☐ Going to the doctor is too expensive
  - ☐ Doctors in the US don't know about malaria
  - ☐ Doctors in the US would treat me bad / fear of being quarantined
  - ☐ Other: _____

23. Do you have any concerns about seeing a healthcare provider if you had malaria symptoms?

- ☐ Yes. Please explain: _____
- ☐ No

Section 7: Future Plans

24. If you traveled again to [country], where would you seek advice on your health?
Check all participant mentions

- ☐ Internet
- ☐ Travel agent
- ☐ Pharmacy
- ☐ Urgent care
- ☐ Primary care
- ☐ Travel clinic
- ☐ Friends / family
- ☐ Community leaders
- ☐ CDC / MDH
- ☐ Other: _____
- ☐ Not going to seek advice
  Why not? _____

25. The next time you travel to [country], will you take a malaria prevention medication?

- ☐ Yes
- ☐ No

If no, why not?

- ☐ Too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think I'll need it
- ☐ I will probably forget
- ☐ I don't like to take medications
- ☐ My insurance doesn't cover it
- ☐ Medications do not work well
- ☐ It won't be the rainy season
- ☐ Can't get enough medication for my whole trip
- ☐ I don't think there is malaria where I'll travel
- ☐ I will get it when I got to my destination
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I plan to just buy medicine if I get sick while traveling/easier to treat if you get sick
- ☐ My trip will be too long for me to take a prevention medication
- ☐ I can't find a pharmacy that stocks the medication
- ☐ Other: _____

26. In your opinion, what would be the best way to educate people about malaria?

_____

Additional Demographic Information

27. Gender

- ☐ Male
- ☐ Female
- ☐ Other: _____

28. Age: _____
If older than 89 years, list ">89"

29. Were you born in the United States?

- ☐ Yes
- ☐ No

29a. If no: How long have you lived in the US? _____

29b. If no: Where were you born? (Country): _____

29c. If no: When did you last live there? _____

29d. If no: How long did you live there? _____

30. Have you ever lived in a country other than the United States or the country you were born?

- ☐ Yes – where? _____
- ☐ No

30a. If yes: When did you last live there? _____

30b. If yes: How long did you live there? _____

31. Since living in the United States, how many times have you traveled to places with malaria/ Africa?

- ☐ Never – this will be my first time
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more times

32. Where were your parents born? (Country): Mom: _____ Dad: _____

33. How would you describe your race/ethnicity? _____

34. What is the highest level of education you completed?

- ☐ Grade school
- ☐ Some high school
- ☐ High school
- ☐ Associate degree / some college / post-secondary training
- ☐ Bachelor's degree
- ☐ Graduate school

35. Primary care doctors are doctors you go to for checkups and health problems that aren't emergencies. Do you go to a primary care doctor?

- ☐ Yes
- ☐ No

35a. If yes, when is the last time you went to your primary care doctor?

- ☐ Within the last month
- ☐ Within the last 6 months
- ☐ Within the last year
- ☐ 1-2 years
- ☐ More than 2 years ago

36. Additional notes: _____

Appendix 3.4: Paper and Online Community Survey *Amharic, French, and Somali translations not shown

Malaria Community Survey

INCLUSION CRITERIA

Please return this page to the staff member to review to see if you are eligible to participate.

1. Are you 18 years of age or older?
   - ☐ Yes
   - ☐ No

2. Were you born in a Sub-Saharan African country?
   - ☐ Yes. What country? _____
   - ☐ No

   Were your parents born in a Sub-Saharan African country?
   - ☐ Yes.
     - Where was your mom born? _____
     - Where was your dad born? _____
   - ☐ No

3. In the past 10 years, have you traveled from the US to any country in Africa?
   - ☐ Yes
     - When was the last time? _____
     - Where did you go? _____
   - ☐ No

     Do you plan to travel to a county in Africa in the next one year?
     - ☐ Yes
       - Where? _____
     - ☐ No

4. Do you live in the United States?
   - ☐ Yes
   - ☐ No

5. Have you heard of malaria?
   - ☐ Yes
   - ☐ No

Malaria Community Survey

IF you have traveled in the past please answer all questions about your most recent trip

Please rate the following statements on a scale of 1 to 5:
1 – Not true 3 – Somewhat true 5 – Very true/always true

1. How true are the following statements?

   1a. I am concerned for myself about getting malaria when traveling

   1 2 3 4 5

   1b. Malaria can be a deadly disease

   1 2 3 4 5

2. **How do people get malaria?** *You may list multiple ways.*

   _____

3. **Can you prevent malaria?**
   - ☐ Yes → How can you prevent malaria? _____
   - ☐ No

4. **Have you ever had malaria?**
   - ☐ Yes
   - ☐ No
   - ☐ I don't know

Now I'd like to find out more about your **most recent past trip** / the trip you plan to take

5. What were the main reasons for your travel? / What are the main reasons you are going to travel?
   If more than one rank primary (#1), secondary reasons (#2), etc.
   _____ Visit friends or relatives
   _____ Business
   _____ Vacation – not visiting friends or relatives
   _____ Studying abroad / research
   _____ Mission trip
   _____ Other: _____

6. What country(ies) did you travel to? / What country(ies) will you travel to?

_____

7. How long were you on your trip? / How long will you be on your trip? (indicate weeks)

_____

8. Did you talk to someone about avoiding malaria before you left? / Will you talk with someone about avoiding malaria before you go?
   ☐ Yes
   Who did you talk to? / Who will you talk to? _____
   ☐ No

9. Did you see a healthcare provider before you left? / Do you plan to see a healthcare provider before you go?
   ☐ Yes → Was / Is it your regular healthcare provider, travel clinic, or somewhere else?
   ☐ Regular healthcare provider (primary care)
   ☐ Travel clinic
   ☐ Both regular healthcare provider and travel clinic
   ☐ Urgent care
   ☐ Pharmacy / minute clinic
   ☐ Other: _____
   ☐ No – Why not? _____

10. During your most recent trip did you use any of the following strategies to keep mosquitos away or stay healthy? / Do you plan to use any of the following strategies to keep mosquitos away or stay healthy?

- ☐ Yes ☐ No Bed nets
- ☐ Yes ☐ No Repellent / creams / sprays / lotions
- ☐ Yes ☐ No Mosquito coils
- ☐ Yes ☐ No Staying indoors when mosquitoes are out
- ☐ Yes ☐ No Wear long clothing
- ☐ Yes ☐ No Educate yourself on risks of malaria before traveling
- ☐ Yes ☐ No Pick where you stayed in order to avoid mosquitos (Air conditioning/screens)

11. Did you take a malaria prevention medicine during your last trip?

- ☐ Yes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall
- ☐ No

12. Since living in the United States, do you think you have gotten malaria while traveling outside of the US?

☐ Yes

Answer 12a-12d on the last time you thought you had malaria while traveling outside the US:
Did you end up seeing a healthcare provider when you thought you had malaria?

☐ Yes

12a. What made you decide to seek care? _____

12b. Were you tested for malaria?
☐ Yes ☐ No ☐ Don't know / don't remember

12c. Did a healthcare provider tell you that you had malaria?
☐ Yes ☐ No ☐ Don't know / don't remember

12d. How many times did you see a healthcare provider before you were told you had malaria?
☐ One ☐ Two ☐ Three ☐ Four or more ☐ Don't remember

No → Why not? _____

12f. Did you try to treat yourself?
☐ Yes
☐ No

12g. Anything else to share about the last time you got malaria while traveling outside the US?
_____

☐ No

13. Imagine you just got back to the United States from a trip to [country of travel] and started to feel symptoms of malaria such as fever and chills. Would you go to the doctor right away or try to treat it yourself at home first?

- ☐ I would go to the doctor right away. Why? _____
- ☐ I would try to treat it at home first. Why? _____

14. Do you have any concerns about seeing a healthcare provider if you had malaria symptoms?
- ☐ Yes. Please explain: _____
- ☐ No

15. If you traveled again to [country], where would you seek advice on your health before you leave?

_____

16. The next time you travel to [country], will you take a malaria prevention medication if recommended?
- ☐ Yes
- ☐ No
  Why not?_____

17. In your opinion, what would be the best way to educate people about malaria?

_____

18. Gender
- ☐ Male
- ☐ Female
- ☐ Other: _____

19. Age: _____

20. Were you born in the United States?
- ☐ Yes
- ☐ No
  - 20a. If no: How long have you lived in the US? _____
  - 20b. If no: Where were you born? (Country): _____
  - 20c. If no: When did you last live there? _____
  - 20d. If no: How long did you live there? _____

21. Since living in the United States, how many times have you traveled to places with malaria/ Africa?
- ☐ Never – this will be my first time
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more times

22. Where were your parents born? (Country): Mom: _____ Dad: _____

23. What is the highest level of education you completed?
- ☐ Grade school
- ☐ Some high school
- ☐ High school
- ☐ Associate degree / some college / post-secondary training
- ☐ Bachelor's degree
- ☐ Graduate school

THANK YOU FOR COMPLETING THE SURVEY!!

Appendix 3.5: Travel Clinic Survey *Amharic, French, and Somali translations not shown

Target Population:
All prospective travelers to Africa visiting a HealthPartners travel clinic that speak one of the four survey languages.

Survey Languages:
- ☐ English
- ☐ French
- ☐ Somali
- ☐ Amharic

Inclusion Criteria
- ☐ **Chart:** Presenting to a HealthPartners travel clinic in stable condition (non-critical)
- ☐ **Chart:** 18 years of age or older
- ☐ **Chart:** Traveling to Africa in the next 1 year (from clinic visit)
- ☐ **Ask:** Resides in the United States
- ☐ **Ask:** Has heard of malaria before

1. Have you heard of malaria? **(Record "No" responses)**
   - ☐ Yes →INCLUDE
   - ☐ No → DOES NOT FIT INCLUSION CRITERIA

2. Do you live in Minnesota or in the United States? **(Record "No" responses)**
   - ☐ Yes → INCLUDE
   - ☐ No → DOES NOT FIT INCLUSION CRITERIA

---IF PATIENT FULFILLS ALL INCLUSION CRITERIA ABOVE, COMPLETE ENROLLMENT PROCESS BEFORE BEGINNING SURVEY ---

Travel Clinic Survey

*** Note to interviewer: unless instructed to do so below, do not read answers to respondents. ***

Section 1: Malaria Knowledge

I want to understand what you know about malaria. I'll read you a few statements and ask you to rate them on a scale of 1 to 5:
1 – Not true **3 – Somewhat true** **5 – Very true/always true**

1. How true are the following statements?

   1a. I am concerned for myself about getting malaria when traveling

   1 2 3 4 5

   1b. Malaria can be a deadly disease

   1 2 3 4 5

2. When traveling to areas with malaria, who is more likely to become sick from malaria – you or your child?
   - ☐ You / Adult
   - ☐ Child
   - ☐ Equally likely

3. How do people get malaria? *(check all that are mentioned and write in others)*
   - ☐ From mosquitoes
   - ☐ From bad air
   - ☐ From drinking water
   - ☐ From another person *(prompt with clarifier #4)*
   - ☐ Other (please describe):_____

4. Can people catch malaria directly from another person who is sick with malaria?
   Direct means spreading from one person right to another.
   - ☐ Yes
   - ☐ No

5. Can you prevent malaria?
   - ☐ Yes

     5a. If yes, how can you prevent malaria? *(check all that the participant lists)*
     - ☐ Immunizations/shots
     - ☐ Bed nets
     - ☐ Insect repellent
     - ☐ Take medications
     - ☐ Other (describe): _____
   - ☐ No

Section 2: Previous Malaria Exposure and Infection

6. Have you ever had malaria?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

1

Section 3: Upcoming Trip

Now I'd like to find out more about your upcoming trip

7. Where will you travel to? *(List specific country[ies])* _____

8. How long will you be on your trip? If unknown, approximate: _____

9. What are the main reasons you are going to travel?
   If more than one rank primary (#1), secondary reasons (#2), etc.
   _____ Visit friends or relatives
   _____ Business
   _____ Vacation – not visiting friends or relatives
   _____ Studying abroad / research
   _____ Mission trip
   _____ Other: _____

10. Do you plan to use any of the following strategies to keep mosquitos away or stay healthy?
    I'm going to list a few examples and you can respond: yes, no, or sometimes

    ☐ Yes ☐ No Bed nets
    ☐ Yes ☐ No Repellent / creams / sprays / lotions
    ☐ Yes ☐ No Mosquito coils
    ☐ Yes ☐ No Environmental cleanup i.e., removing sources of standing water
    ☐ Yes ☐ No Staying indoors when mosquitoes are out
    ☐ Yes ☐ No Wear long clothing
    ☐ Yes ☐ No Practice good food safety / hygiene
    ☐ Yes ☐ No Ensure clean water source (safe, bottled)
    ☐ Yes ☐ No Educate yourself on risks of malaria before traveling
    ☐ Yes ☐ No Pick where you stay in order to avoid mosquitos (AC/screens)
    ☐ Yes ☐ No Get vaccinations
    Anything else? _____

11. Did someone tell you to come to this travel clinic?

    ☐ Yes, Who?
    - ☐ Primary care provider / family physician / "regular" doctor
    - ☐ Friend or family member
    - ☐ Insurance provider
    - ☐ Other: _____

    ☐ No, I chose to come to the travel clinic on my own

12. Why did you choose to visit the travel clinic before your trip?
    ☐ Need immunization required for travel
    ☐ Generally, want to prevent illnesses while traveling
    ☐ Specifically, want to prevent malaria while traveling
    ☐ Referral from question 11
    ☐ Other: _____

13. Are you more concerned about making sure certain family members are seen by a healthcare provider than others?
    ☐ No
    ☐ Yes → Why? (check all that apply)
    - ☐ Only certain family members covered by insurance
    - ☐ Cost
    - ☐ Risk of illness
    - ☐ Age (very young or very old
    - ☐ Pregnancy
    - ☐ Other: _____

*****If participant is traveling for the first time, SKIP to question 23*****

Section 4: Previous Travel and Antimalarial Use

14. Have you traveled from the United States to Africa before?
    ☐ Yes
    ☐ No, this will be my first time traveling from the US to Africa

15. Did you take a malaria prevention medicine during your last trip?
    ☐ Yes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall
    ☐ No
    ☐ Sometimes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall

16. Did a healthcare provider write you a prescription for a malaria prevention medicine?
    ☐ Yes
    ☐ No
    16a. <u>If yes,</u> did you pick up the medicine in the US or once you arrived to your destination?
    - ☐ Picked up the medicine in the US
    - ☐ Picked up the medicine in destination country

If 15 is yes/sometimes and 16 is no, clarify: Did you buy the malaria prevention medicine without a prescription once you arrived to your destination?
☐ Yes
☐ No – Explain: _____

Section 5: Traveling with Children

17. On your last trip did any children travel with you?
    ☐ Yes – if yes, how many? _____ How old were they? _____
    ☐ **No Skip to question 18**

    17a. <u>If yes</u>, did the child/ren take a malaria prevention medicine during your last trip?
    ☐ Yes → Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall
    ☐ No
    ☐ Sometimes→Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall

    17b. Did a healthcare provider write your child/children a prescription for malaria prevention medicine?
    ☐ Yes

☐ No

17c. If yes, did you pick up the medicine for your child/ren in the US or once you arrived to your destination?

☐ Picked up the medicine in the US
☐ Picked up the medicine in destination country

If 17a is yes/sometimes and 17b is no: Did you buy the malaria prevention medicine for your child/ren without a prescription once you arrived to your destination?

☐ Yes
☐ No Explain: _____

Section 6: Illnesses During Travel and Healthcare Seeking Behaviors

18. Since living in the United States, do you think you have gotten malaria while traveling outside of the US?

☐ Yes
☐ No – **Skip to question 23**

19. When you noticed your symptoms, where was the first place you looked for information/advice about your illness?

☐ Family or friend abroad
☐ Healthcare provider abroad
☐ Family or friend in US
☐ Primary care in US
☐ Urgent care/ER in US
☐ Travel clinic in US
☐ Internet
☐ Other: _____

20. Did you try to treat yourself before seeking medical care?

☐ Yes
☐ No

20a. If yes, why? (*Check all that apply*):

☐ Doctors in the US don't know about malaria
☐ Going to the doctor is too expensive
☐ I knew it was malaria and how to treat it
☐ I already had the medicine
☐ Other: _____
☐ Buying medicine is too expensive
☐ Didn't know it was malaria
☐ Malaria is easy to treat
☐ Malaria is not a serious problem

20b. If yes, what did you do to treat yourself? (*Check all that apply*):

☐ Took malaria medication. What medicine? _____
☐ Took medication for fever and/or pain? (e.g. Tylenol, ibuprofen, paracetamol)
If yes, what medicine: _____
☐ Herbal remedy: _____
☐ Other: _____

21. Did you end up seeing a healthcare provider when you thought you had malaria?

☐ Yes **(answer questions 21a through 21d)**
21a. What made you decide to go? _____

21b. Were you tested for malaria?
☐Yes ☐No ☐ Don't know / don't remember

21c. Did a healthcare provider tell you that you had malaria?
☐Yes ☐No ☐ Don't know / don't remember

21d. How many times did you see a healthcare provider before you were told you had malaria?
☐ One ☐Two ☐ Three ☐ Four or more ☐ Don't remember

☐ No, 21f. If no: Why not?

☐ I got better on my own
☐ Malaria is easy to treat
☐ Malaria is not a serious problem
☐ I already had the medicine
☐ Buying medicine is too expensive
☐ Going to the doctor is too expensive
☐ I knew it was malaria and how to treat it
☐ Doctors in the US don't know about malaria
☐ Other: _____

22. After returning from any trip to a country with malaria, have you ever self-treated a child in your family for malaria before or instead of going to a doctor?

☐ Yes – Go to 22a.
☐ No – I did not try to self-treat the child before going to the doctor - Go to 22b.
☐ No – Child has never seemed sick with malaria – Go to 23.

22a. If yes, why? (*Check all that apply*):

☐ Malaria is easy to treat
☐ Malaria is not a serious problem
☐ Didn't know it was malaria
☐ I already had the medicine
☐ Buying medicine is too expensive
☐ Going to the doctor is too expensive
☐ I knew it was malaria and how to treat it
☐ Doctors in the US don't know about malaria
☐ Other: _____

22b. If no, why not? *(please explain)*: _____

23. Imagine you just got back to the United States from a trip to [country of travel] and started to feel symptoms of malaria such as fever and chills. Would you go to the doctor right away or try to treat it yourself at home first?

☐ I would go to the doctor right away. Why?
☐ Malaria is dangerous/serious
☐ Doctors can prescribe antimalarial medicines
☐ Other: _____

☐ I would try to treat it at home first. Why?
☐ Malaria is easy to treat; I know how to treat it
☐ Malaria is not a serious problem
☐ Going to the doctor is too expensive
☐ Doctors in the US don't know about malaria
☐ Doctors in the US would treat me bad / fear of being quarantined
☐ Other: _____

24. Do you have any concerns about seeing a healthcare provider if you had malaria symptoms?

☐ Yes. Please explain: _____
☐ No

Section 7: Future Plans

25. Besides this travel clinic visit, where do you plan to seek advice on your health for this trip?
Check all participant mentions

- ☐ Internet
- ☐ Travel agent
- ☐ Pharmacy
- ☐ Urgent care
- ☐ Primary care
- ☐ Travel clinic
- ☐ Friends / family
- ☐ Community leaders
- ☐ CDC / MDH
- ☐ Other: _____
- ☐ Not going to seek advice
  Why not? _____

26. Do you plan to take a medication to prevent malaria if the doctor prescribes it for your upcoming trip?

- ☐ Yes
- ☐ No

<u>If no</u>, why not?

- ☐ Too expensive
- ☐ Not a serious disease
- ☐ I would rather take my chances
- ☐ Don't think I'll need it
- ☐ I will probably forget
- ☐ I don't like to take medications
- ☐ My insurance doesn't cover it
- ☐ Medications do not work well
- ☐ It won't be the rainy season
- ☐ Can't get enough medication for my whole trip
- ☐ I don't think there is malaria where I'll travel
- ☐ I will get it when I got to my destination
- ☐ The medication has too many side effects/am worried about side effects
- ☐ I plan to just buy medicine if I get sick while traveling/easier to treat if you get sick
- ☐ My trip will be too long for me to take a prevention medication
- ☐ I can't find a pharmacy that stocks the medication
- ☐ Other: _____

27. In your opinion, what would be the best way to educate people about malaria?
_____

Additional Demographic Information

28. Gender

- ☐ Male
- ☐ Female
- ☐ Other: _____

29. Age: _____
If older than 89 years, list ">89"

30. Were you born in the United States?

- ☐ Yes
- ☐ No

30a. <u>If no</u>: How long have you lived in the US? _____

30b. <u>If no</u>: Where were you born? (Country): _____

30c. <u>If no</u>: When did you last live there? _____

30d. <u>If no</u>: How long did you live there? _____

31. Have you ever lived in a country other than the United States or the country you were born?

- ☐ Yes – where? _____
- ☐ No

31a. <u>If yes:</u> When did you last live there? _____

31b. <u>If yes:</u> How long did you live there? _____

32. Since living in the United States, how many times have you traveled to places with malaria/ Africa?

- ☐ Never – this will be my first time back
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more times

33. Where were your parents born? (Country): Mom: _____ Dad: _____

34. How would you describe your race/ethnicity? _____

35. What is the highest level of education you completed?

- ☐ Grade school
- ☐ Some high school
- ☐ High school
- ☐ Associate degree / some college / post-secondary training
- ☐ Bachelor's degree
- ☐ Graduate school

36. Primary care doctors are doctors you go to for checkups and health problems that aren't emergencies. Do you go to a primary care doctor?

- ☐ Yes
- ☐ No

36a. If yes, when is the last time you went to your primary care doctor?

- ☐ Within the last month
- ☐ Within the last 6 months
- ☐ Within the last year
- ☐ 1-2 years
- ☐ More than 2 years ago

37. Additional notes: _____

POST TRAVEL FOLLOW UP SURVEY (PHONE CALL)

1. During your most recent trip did you use any of the following strategies to keep mosquitos away or stay healthy?
   I'm going to list a few examples and you can respond: yes, no, or sometimes

   ☐ Yes ☐ No ☐ Sometimes Bed nets
   ☐ Yes ☐ No ☐ Sometimes Repellent / creams / sprays / lotions
   ☐ Yes ☐ No ☐ Sometimes Mosquito coils
   ☐ Yes ☐ No ☐ Sometimes Environmental cleanup i.e., removing sources of standing water
   ☐ Yes ☐ No ☐ Sometimes Staying indoors when mosquitoes are out
   ☐ Yes ☐ No ☐ Sometimes Wear long clothing
   ☐ Yes ☐ No ☐ Sometimes Practice good food safety / hygiene
   ☐ Yes ☐ No ☐ Sometimes Ensure clean water source (safe, bottled)
   ☐ Yes ☐ No ☐ Sometimes Educate yourself on risks of malaria before traveling
   ☐ Yes ☐ No ☐ Sometimes Pick where you stayed in order to avoid mosquitos (AC/screens)
   ☐ Yes ☐ No ☐ Sometimes Get vaccinations

   Anything else? _____

2. Did you take a malaria prevention medicine during your last trip?
   ☐ Yes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall
   ☐ No
   ☐ Sometimes → Did you finish taking the medicine after you got back? ☐ Yes ☐ No ☐ Don't recall

3. Did a healthcare provider write you a prescription for a malaria prevention medicine?
   ☐ Yes
   ☐ No

   3a. <u>If yes,</u> did you pick up the medicine in the US or once you arrived to your destination?
   ☐ Picked up the medicine in the US
   ☐ Picked up the medicine in destination country

If 2 is yes/sometimes and 3 is no, clarify: Did you buy the malaria prevention medicine without a prescription once you arrived to your destination?
☐ Yes
☐ No – Explain: _____

4. On your last trip did any children travel with you?
   ☐ Yes – if yes, how many? _____ How old were they? _____
   ☐ No **Skip to question 5**

   4a. <u>If yes</u>, did the child/ren take a malaria prevention medicine during your last trip?
   ☐ Yes → Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall
   ☐ No
   ☐ Sometimes→Did the child finish taking the medicine after he/she got back? ☐ Yes ☐ No ☐ Don't recall

   4b. Did a healthcare provider write your child/children a prescription for malaria prevention medicine?
   ☐ Yes
   ☐ No

4c. <u>If yes</u>, did you pick up the medicine for your child/ren in the US or once you arrived to your destination?
☐ Picked up the medicine in the US
☐ Picked up the medicine in destination country

<u>If 4a is yes/sometimes and 4b is no</u>: Did you buy the malaria prevention medicine for your child/ren without a prescription once you arrived to your destination?
☐ Yes
☐ No Explain: _____

5. **Did you experience any of the following health issues during your last trip?**
   ☐ Yes ☐ No ☐ Don't remember Fever Temperature? _____
   ☐ Yes ☐ No ☐ Don't remember Headache
   ☐ Yes ☐ No ☐ Don't remember Body aches
   ☐ Yes ☐ No ☐ Don't remember Diarrhea
   ☐ Yes ☐ No ☐ Don't remember Nausea
   ☐ Yes ☐ No ☐ Don't remember Vomiting
   ☐ Yes ☐ No ☐ Don't remember Mosquito bites
   ☐ Yes ☐ No ☐ Don't remember Heat distress
   ☐ Yes ☐ No ☐ Don't remember Fainting
   ☐ Yes ☐ No ☐ Don't remember Car crash
   ☐ Yes ☐ No ☐ Don't remember Injury Describe: _____
   ☐ Yes ☐ No ☐ Don't remember Animal bite Describe: _____

6. While you were in _____ did you go to the hospital or a clinic for any personal health issues?
   ☐ No
   ☐ Yes Please describe: _____
   _____

7. After you returned to the United States, did you go to the hospital or a clinic for health issues that could have been caused by your travel?
   ☐ No
   ☐ Yes Please describe: _____
   _____

8. Did anyone travelling with you go to the hospital or a clinic for any health issues while you were travelling?
   ☐ No
   ☐ Yes Please describe: _____
   _____

9. After you returned to the United States, did anyone travelling with you go to the hospital or a clinic for health issues that could have been caused by the travel?
   ☐ No
   ☐ Yes Please describe: _____
   _____

Appendix 4: Informational materials developed by the Malaria Prevention Project

Appendix 4.1: Malaria Facts for Travelers

- English
- Amharic
- French
- Somali

Malaria Facts for Travelers

What is malaria?

Malaria is a sickness you can get from a mosquito bite. There is no vaccine to protect you from malaria. Malaria can be very serious. The best ways to prevent malaria are by avoiding mosquito bites and taking a prescription medicine while you travel and after you return. People can die in 12 hours from the time they first feel sick, even if they have had malaria before.

Where is malaria a problem?

Malaria is in many countries. The countries in red and yellow are where you may be at risk for malaria.

Who can get malaria while traveling?

All travelers—children AND adults—who go to a country where there is malaria should take prescription medicine and try to avoid mosquito bites during your trip.

You are NOT SAFE from malaria even if you have had it many times in the past. People may have some protection against malaria if they have had it many times in the past but the protection goes away, usually within months of leaving an area where there is malaria. Taking malaria medication and avoiding mosquito bites are the best way to keep you and your family safe.

Malaria can make children very sick, especially children who have always lived in the US. Children or adults who have never had malaria can die quickly when they first feel sick.

What if I am pregnant?

Getting malaria while you are pregnant can harm you and your baby. It is best not to travel to places with malaria during your pregnancy.

If you have to travel, there are malaria medicines that are safe to take during pregnancy. Your doctor will help you choose the medicine that is best for you.

What are the symptoms of malaria? What should I do if I have them?

Symptoms of malaria include fever, shaking, chills, headache, muscle aches, and tiredness. You might feel like you have the flu. You may also have nausea, vomiting, or diarrhea. Malaria can be deadly if it is not treated right away. Any traveler who becomes ill with a fever or flu-like illness should go to the doctor. You can get sick with malaria while traveling or after returning to the US. Tell your doctor that you were in a country with malaria and want to be tested for malaria.

For more information on malaria, visit www.cdc.gov and search for 'malaria.'

To see if malaria is a risk in the places you are traveling to, visit www.headinghomehealthy.com

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www.health.state.mn.us

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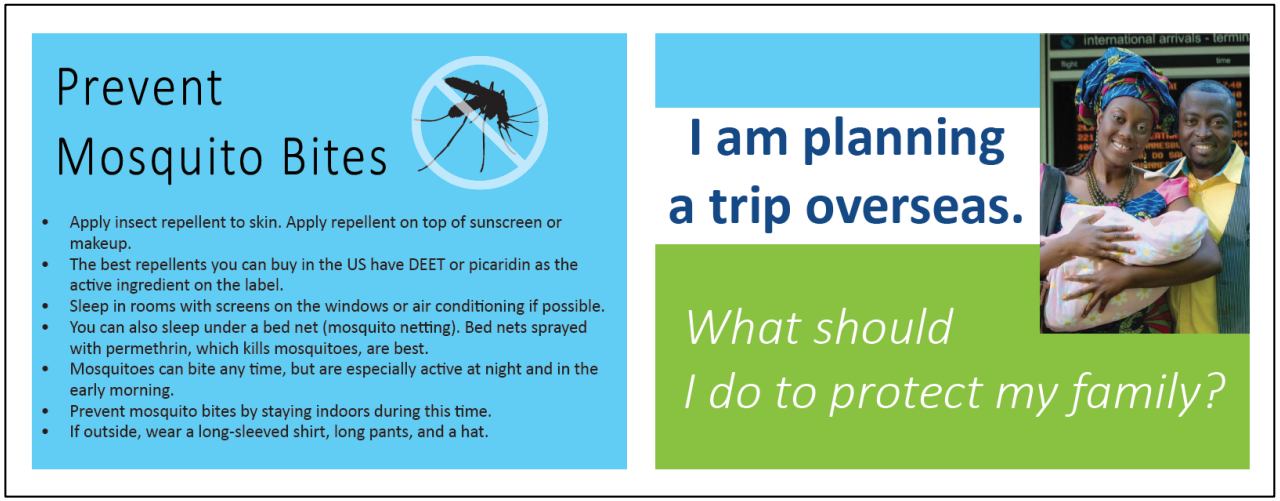
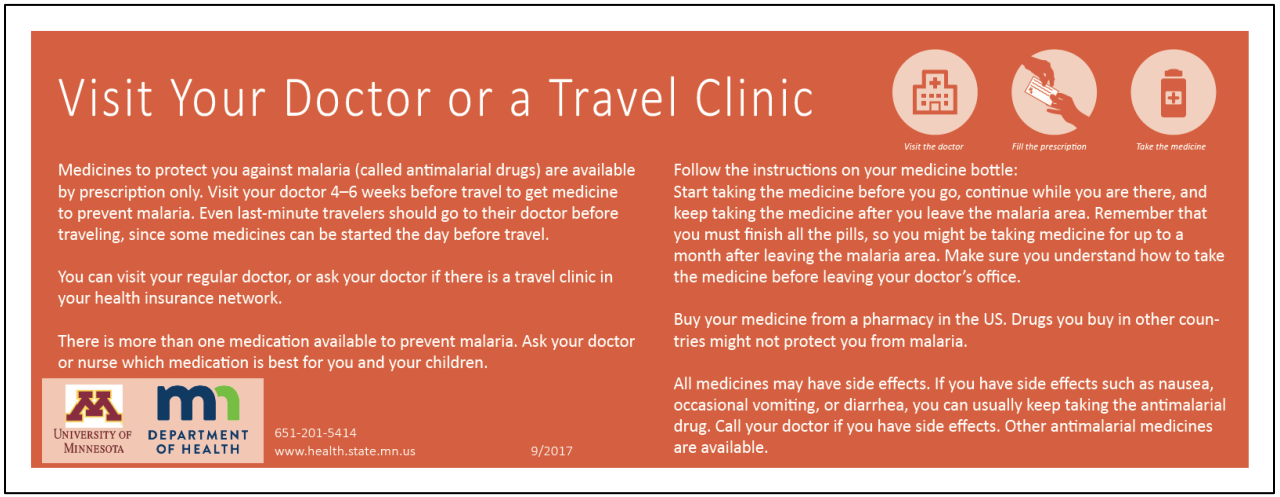
Appendix 4.2: I am planning a trip overseas. What should I do to protect my family?

- English
- Amharic
- French
- Somali





Appendix 4.3: It costs how much? What to do if your travel medication is too expensive

- English