

**Genetic Research with Hmong-ancestry Populations:
Lessons from the Literature and a Pilot Study**

By

**Donny Xiong, MPH
University of Wisconsin-Madison**

**Jennifer K. Meece, PhD
Marshfield Clinic Research Foundation**

**Caitlin S. Pepperell, MD
University of Wisconsin-Madison**

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Abstract

Genetic research with Hmong-ancestry populations has examined differentiation among other Southeast Asian groups and select health conditions; however, there have been few discussions of specific methodological approaches in the literature. Studies within ethnically diverse communities must conduct culturally competent research in order to avoid stigmatization and harm to the communities. We present recommendations for conducting culturally competent genetic research with Hmong-ancestry populations through insights from interviews and observations from a pilot study examining a potential genetic basis of susceptibility to a fungal infection within a Hmong community. Implications for future genetic-based health research and public health are discussed.

Keywords: Hmong, genetics-based health research

Introduction

At the 2010 American Society of Human Genetics annual meeting, Dr. Roderick McInnes delivered the presidential address on the “silent language” of culture that geneticists must learn. Dr. McInnes highlighted several cases of genetic research with indigenous populations that have led to controversy, as well as research that has been successful. Through personal observations and correspondence, Dr. McInnes called for culturally competent research and presented three principles central to genetic research with developing communities: (1) while respecting the culture of the community, do not violate basic principles of ethics, including

institutional review board rules and the use of bribery; (2) realize the existence of many local cultures within one seemingly homogenous group, and act respectfully; and (3) make a long-term commitment as one may need and want to return on multiple occasions to build trust with the community (McInnes, 2011). Additionally, culturally competent research must respect the community's desire for self-determination, desire to benefit from the research, and any request to retain intellectual property rights and ownership of biological samples collected.

A lack of culturally competent study designs may limit future genetic research with culturally diverse populations. A challenge already present is low participation in research from individuals in these populations, which is problematic from both a scientific and social justice standpoint (Bowen and Penchaszadeh, 2008). From a scientific viewpoint, there are missed opportunities to explore specific ethnic differences in disease patterns, to identify differential risks among ethnic populations, and to recognize genetic contributions to health disparities. In terms of social justice, unequal research participation may lead to unequal benefits from this research, and possibly an increase in health disparities. Reasons for low participation from culturally diverse populations include limited knowledge of genetics and genetic testing, and poor access to available educational information and other resources (Catz *et al.*, 2005).

Hmong-Americans are an example of a culturally diverse population that has had a history of challenges with the health care system and with health related research. A hill-tribe minority group originally from the border regions of China, Vietnam, Laos, and Thailand (Lee, 2007), the Hmong now reside in countries all over the world. In 2010, the Hmong population in the United States was estimated to be over 260,000, an increase of 175% since 1990 (Pfeifer *et al.*, 2012). California, Minnesota, and Wisconsin are home to the three largest Hmong populations, respectively.

Hmong-ancestry communities face several health challenges including diabetes, cardiovascular disease, cancer, tuberculosis, hepatitis B, and depression, resulting in notable health outcomes and care disparities (Pinzon-Perez, 2006). Several factors contribute to these disparities including low literacy, high rates of poverty, and cultural barriers. More recently, studies have begun to examine a possible genetic basis of health conditions in this community. Genetic associations with certain cancers have been identified (Kiffmeyer *et al.*, 2004), and many health conditions, including diabetes, gout, and sudden unexpected nocturnal death syndrome, have been postulated to have a genetic basis. Population genetic studies have identified a distinct genetic makeup of the Hmong (Li *et al.*, 2007; Listman *et al.*, 2011; Wen *et al.*, 2005), lending support for this population's unique position for understanding the genetic basis of health conditions, and reducing disparities through targeted therapies and interventions.

Between September 2009 and June 2010, an outbreak of Blastomycosis disproportionately affected Wisconsin Hmong communities (Benedict *et al.*, 2012). Blastomycosis develops from inhaling air-borne spores of the fungus *Blastomyces dermatitidis* that is found in moist soil and decomposing organic matter, and primarily manifests as a pulmonary infection, leading to death if untreated. An investigation found elevated incidence rates of Blastomycosis in Hmong populations compared to other ethnic groups during the outbreak and in previous years; however, investigators could not identify differential exposures or co-morbidities to explain the disparity (Roy *et al.*, 2013). Additionally, exposure may cause no symptoms at all; the investigation identified Hmong individuals who were exposed to the fungus, but did not develop Blastomycosis (Roy *et al.*, 2013). Based on these observations, individuals of Hmong ethnicity may be at an increased risk for Blastomycosis, though the reasons are unclear, and susceptibility to developing Blastomycosis once exposed may have a

genetic basis. Researchers from the University of Wisconsin-Madison and the Marshfield Clinic Research Foundation are currently investigating a potential genetic basis for the disparity.

Although genetic research has been conducted with Hmong-ancestry populations, there are limited discussions on the process of engaging participants in such studies, including concepts of genetics and participants' attitudes toward providing biological samples. Given the need for culturally competent research, we sought to identify barriers and successful methods for conducting genetic research with this population through a review of existing literature, interviews with researchers and Hmong community members, and in parallel with a pilot study examining a potential genetic susceptibility to Blastomycosis among individuals of Hmong-ancestry. In this paper, we present anecdotal evidence on effective methods of engaging Hmong-ancestry populations in research, including Hmong cultural concepts of genetics and perspectives related to providing biological samples for research. We conclude with recommendations for culturally competent, genetic-based research designs with this unique population, as well as public health implications for addressing genetics and health, and Blastomycosis in this community.

Methods

A review of genetic studies with Hmong-ancestry populations was conducted on articles selected through Internet searches of journal databases. Search terms included: Hmong, genetic(s), health, language, research, studies, blood, culture, and challenges (Table 1). Authors were contacted to inquire further about the methods used in their respective studies. Interviews with Hmong community leaders, medical professionals, and community members were also conducted. Individuals were contacted based on prior knowledge of their experience with Hmong-ancestry populations, and additional individuals were referred as contacts. Interviews

included questions about study designs, Hmong perspectives of research and health, and genetic concepts and language (Table 2). Interviews were conducted via electronic mail and in person, and questions pertaining to Hmong language terminology for “genetics” and “DNA” were asked on a social networking website.

Table 1: Literature search terms

Hmong genetic health	Hmong research
Hmong genetic studies	Hmong research challenges
Hmong genetics	Hmong health language
Hmong health	Hmong genetics language
Hmong health challenges	Hmong culture
Hmong health research	Hmong culture blood

Insights from the interviews were used in the design of a pilot study to examine a potential genetic basis of susceptibility to a fungal infection within a Hmong-ancestry population in Wisconsin. Observations on participants’ interactions with researchers and comments about genetics and health research were recorded. Participants were asked about their attitudes toward providing blood as biological samples in genetic studies. Approval for the pilot study was granted by the Institutional Review Board at the Marshfield Clinic Research Foundation.

Table 2: Interview questions about research with Hmong-ancestry populations

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1. How did you promote your study in the Hmong community?
 2. What methods of recruitment did you use?
 3. Where do you think is the best location for study visits?
 4. How did you convey health in a “Western medicine” perspective, indicating the importance of your study?
 5. How did/would you convey the concepts of DNA and genetics in the Hmong language?
 6. How accepting would Hmong-ancestry populations be with providing blood samples as data?
 7. Can an individual give blood for research without stigmatizing Hmong culture and community?
 8. How accepting would Hmong-ancestry populations be with allowing the immortalization of their genetic samples?

9. What challenges did you face when working with this population? What do you perceive are challenges when working with this population?
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Results – Part I: Review of Literature and Interviews

Genetic Studies of Hmong-ancestry Populations: Types of Research

A small number of genetic studies were identified for Hmong-ancestry populations in the United States, Thailand, and China. Original studies that included the discussion of genetic concepts and collection of genetic samples were selected for methodological reviews and researcher correspondence. Studies examining genetic samples collected from routine procedures, such as Guthrie tests or neonatal heel pricks, were excluded.

Existing research has examined population differentiation between Hmong and other Asian populations (Li *et al.*, 2007; Listman *et al.*, 2011; Listman *et al.*, 2007; Wen *et al.*, 2005). Genetic-based health research has examined health conditions such as thalassemia (Vang *et al.*, 2007) and other hematologic genetic disorders (Monzon *et al.*, 1985), variations in drug metabolism (Straka *et al.*, 2006), and a genetic basis of susceptibility to a range of malignancies (Kiffmeyer *et al.*, 2004). Appendix I summarizes the reviewed literature and interview responses.

Study Promotion and Methods of Recruitment

In studies conducted in the United States (Lor *et al.*, 2013; Vang, 2012; Personal Communication, 2012), networking through local community organizations and attendance at community events (e.g. food pantries, parent-teacher events) were reported as effective methods of promoting studies and recruitment. Flyers were utilized in a community health education and intervention project (Vang, 2012); however, this method was reported as ineffective. In subsidized housing communities with numerous Hmong residents, researchers first contacted

program coordinators or other stakeholders to establish a relationship with the community.

These individuals, known and trusted by the Hmong residents, would then advocate and assist with recruitment for the study.

A research study examining the genetic basis of a drug metabolism phenotype within a Hmong-ancestry population in the United States recruited participants through published and posted advertisements (Straka *et al.*, 2006). Interested individuals initiated contact and received follow-up calls from Hmong recruiters. Study documents in English and Hmong were available.

One researcher went door-to-door to discuss the study and to recruit, stating the belief that face-to-face interactions would be beneficial (Personal Communication, 2012). Potential participants were identified by networking among clans, relatives, and previous participants. While some families refused to participate, this method was reported as successful overall for this particular study.

In contrast, researchers conducting a study in Thailand purposely did not conduct door-to-door recruitment for fear of creating pressure among individuals to participate (Listman *et al.*, 2011; Listman *et al.*, 2007). Instead, the researchers contacted the headman or leader in each village and described the study and its purpose. The headman is usually an elder male individual with authoritative influence over functions of the village. The headman would then decide whether or not villagers would participate. A different study in Thailand examining the prevalence of a heritable disorder among Hmong-ancestry populations recruited participants via electronic mail advertisements and personal contacts (Vang *et al.*, 2007).

In studies conducted in China (Li *et al.*, 2007; Wen *et al.*, 2005), the method of first contacting the village leader was also practiced. The researchers explained the purpose of the study, the importance of genetic studies with the Hmong, and information about the Hmong that

the study might yield. Participants were reported as understanding that the study was beneficial to Hmong populations, and the researchers stated no issues with recruitment and participation.

Study Visit Locations

Community centers and participants' homes were reported as locations of visits for studies conducted in the United States (Lor *et al.*, 2013; Vang, 2012). Hospitals or clinics were not used as locations for visits. In population genetic studies in Thailand and China (Li *et al.*, 2007; Listman *et al.*, 2011; Listman *et al.*, 2007; Wen *et al.*, 2005), central locations in villages were selected as sites to conduct study visits. For these studies, the researchers would arrive on a scheduled day after receiving approval from the village leader to conduct the study. Individuals not interested in participating could avoid the area so as to not feel pressure from the researchers to participate. All researchers indicated that visit locations, as well as other aspects of the study designs, were designed to be convenient for the participants.

Concepts of Western Medicine, DNA, and Genetics

Table 3 lists words and phrases reported as ways to convey the concepts of genetics and DNA within Hmong-ancestry populations. One response from a question posed on a social networking website suggested making up a word with the hope that eventually it would “catch on” in the community. Another individual asked a Hmong elder and responded that the elder thought DNA was a government agency [possibly mistaking DNA for DNR (Department of Natural Resources) or for DEA (Drug Enforcement Agency)]. Resources related to genetic conditions and language were identified from Internet searches (Children's Hospitals and Clinics of Minnesota, 2012; University of Wisconsin-Madison, 2006; Wisconsin Department of Public Instruction, 2007).

Table 3: Concepts of genetics and DNA

Hmong Concept	Translation/Scientific Concept ¹
<i>noob</i>	seed; offspring; gene
<i>roj ntsha/ntshav</i>	of or pertaining to the composition of blood
<i>noob caj ces/ceg</i>	genes of the clan/lineage
<i>raws caj ces/ceg</i>	follows clan lineage; heredity
<i>keeb</i>	origin; family origin
<i>mob muaj keeb</i>	condition/illness that follows family origin; heredity
<i>serr sa²</i>	genetic blood

1. Compiled from personal communications and Internet translation resources.

2. Laotian. The spoken Hmong language includes several Laotian words and phrases. Many elderly Hmong still understand and speak Laotian.

In population genetic studies of Hmong-ancestry individuals in Thailand (Listman *et al.*, 2011; Listman *et al.*, 2007), concepts of DNA and genetics were explained as a substance in the body that are passed from parents to children and similarly shared between relatives.

Participants were informed that this substance is found in blood, saliva, and many other parts of the body, and could be used to learn about a population's history and degrees of ancestral kinship among a people. The author reported that participants were interested in whether the samples could be used to provide health information; however, because the aim of that particular study was to examine ancestry, the researchers said no.

A heritable disorder prevalence study in Thailand used pictures of white and black rabbits to convey the concepts of dominant and recessive traits (Vang *et al.*, 2007). Describing genetics through concepts of interconnection was suggested during corresponding interviews, although this method was not used in the researcher's own study. Another suggested method was to explain genetics in terms of clan lineages and family trees.

Types of Samples Collected

Buccal or cheek cells from the inside of the mouth have been the primary biological samples collected in genetic studies of Hmong-ancestry populations in the United States. A study on the prevalence of an inherited deficiency in protein synthesis among Hmong children collected samples from cheek swabs (Unpublished, Personal Communication, 2012). In corresponding interviews, one researcher in the study reported that there were refusals among some potential informants to provide buccal cells. Given this experience, the researcher expressed concerns over collecting blood as genetic samples, a method viewed as more invasive and harmful. In a study examining genetic indicators of drug metabolizing proteins (Straka *et al.*, 2006), a mouthwash technique was used to collect buccal cells.

Population genetic studies in Thailand collected saliva via Oragene collection kits (DNA Genotek Inc., Ontario, Canada) as biological samples (Listman *et al.*, 2011; Listman *et al.*, 2007). The author reported that the use of blood would have been a challenge for Hmong participants in the study, given cultural beliefs about blood (see Discussion below). Saliva was chosen as it has been shown to yield comparable amounts of DNA as found in blood samples and is less likely to be perceived as harmful (see Discussion below).

Approximately 3ml of blood was collected from participants in a study on the prevalence of a heritable condition in a Hmong-ancestry sample population in Thailand (Vang *et al.*, 2007). This study examined a hematologic disorder, thus blood was required. No issues with collecting samples during the study were reported. The author expressed that the amount of blood requested from participants may affect the acceptability of providing biological samples. For example, providing 3ml of blood may be more acceptable compared to a greater volume, although a specific threshold was not suggested.

Similarly, blood was collected from participants in population genetics studies in China (Li *et al.*, 2007; Wen *et al.*, 2005). Researchers collected samples via FTA cards (Whatman, Springfield Mill, United Kingdom), a method that does not require large amounts of blood, which may be perceived as less invasive. The authors did not report any issues with participants providing blood samples.

From additional interviews, there were mixed responses to what types of biological samples would be acceptable to collect from Hmong-ancestry populations. Buccal cells as samples were reported as possibly being more acceptable than blood; however, participant factors such as duration of assimilation into Western society, adherence to cultural beliefs, or personal experiences would affect the type of sample participants are willing to provide. Additionally, beliefs about potential stigmatization of Hmong culture or the community by participation in research may vary between individual participants, as well as from perceptions among the general community.

The practice of immortalizing genetic samples for future research was reported as being possibly controversial for Hmong-ancestry populations given cultural taboos of leaving a part of the body in the physical world after one passes into the spiritual realm (see Discussion below). Individual factors as discussed previously may also influence perspectives of acceptability toward providing genetic samples for immortalization. However, given the dearth of research on perspectives toward immortalizing genetic samples among this population, one respondent suggested this is a topic of interest to explore.

Research Challenges with Hmong-ancestry Populations

Respondents expressed the difficulty of reaching out to residents in subsidized housing communities in the United States, specifically when faced with certain program coordinators in

these communities who may associate medical research with harm or do not perceive that there are benefits to participation. Researchers expressed frustration regarding these encounters and the inability to provide health information to these populations, and to include these residents in the study. Additionally, perceptions of whether there was any value in research and truth in the results were factors that affected participation. One researcher discussed receiving responses of disbelief from participants after informing them about previous findings. The researcher reported that it was still important to provide the rationale of studies to potential participants even if they did not believe the results.

Limited scientific knowledge and literacy among participants and a lack of Hmong-language medical and scientific terminology posed additional challenges. Medical and scientific terms were often communicated in English and explained with Hmong-language concepts (Lor *et al.*, 2013). Visuals were commonly used to overcome literacy challenges and convey concepts, such as heredity (Figure 1).

The Western idea of individuality, particularly that of self-determination and privacy, is a challenge in clan-based populations. Concepts of informed and voluntary consent that are required by institutional review boards may conflict with populations in which a headman can make decisions for the village. This was especially troublesome for population genetic studies in Thailand. After the headman agreed that the village could participate, researchers informed potential participants on an individual basis that they had the option to refuse participation. This approach was successful in recruiting participants for the studies and, more importantly, adhered to ethical principles of research.

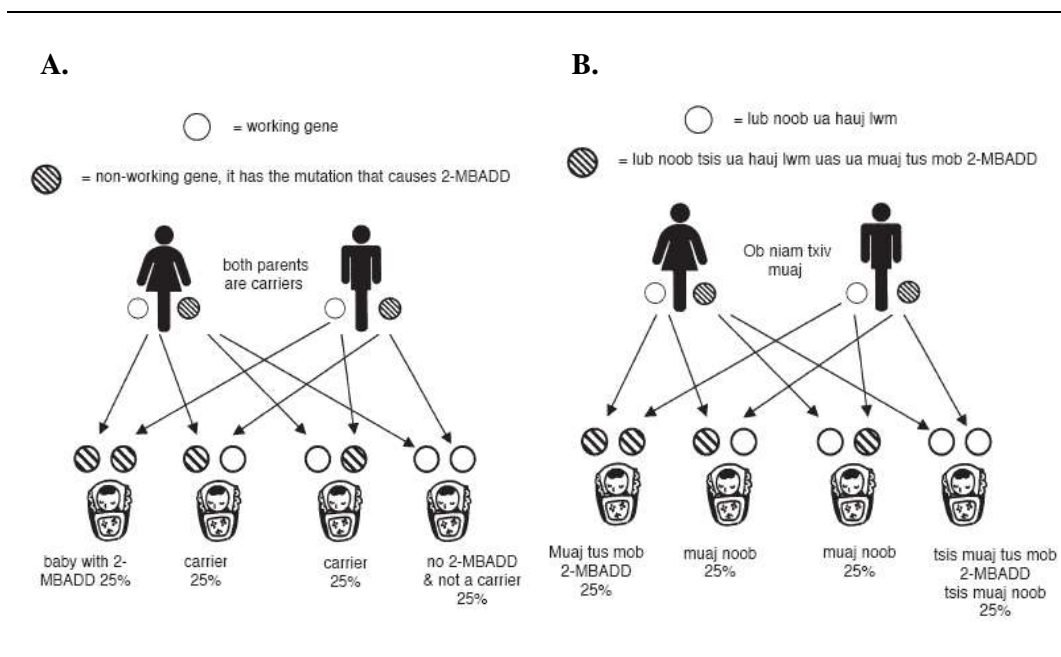


Figure 1. Visual concept of 2-MBADD inheritance. English (A) and Hmong (B). (University of Wisconsin-Madison, Waisman Center, Dept. of Biochemical Genetics, 2006)

Results – Part II: Pilot Study

Study Design

The original design of the pilot study was modified to incorporate insights gained from the interviews. An analogy of the Hmong cultural concept of the “spirit” was originally included in study documents to convey how genetics is linked with ancestors and may cause health conditions. However, this analogy was omitted as some Hmong individuals may no longer practice this cultural belief and some may perceive that we are studying the spirit. Originally, we were interested in collecting blood samples; however, based on responses to acceptability of providing blood, we decided to use buccal cells instead. Further discussions with genetic researchers ultimately led to the decision to use saliva as biological samples. Local clinics were the original sites for study visits. Previous research indicated success with community centers, thus we contacted the Wausau Area Hmong Mutual Association, a Hmong community

organization in Marathon County, Wisconsin, to reserve space as a central location for the study visits. Ultimately, we asked participants individually where the most convenient location would be and we conducted study visits there.

Recruitment and Participation

The pilot study sought to recruit at least five cases (clinically diagnosed with Blastomycosis) and one control (immunologically reactive but had no clinical symptoms). Inclusion criteria included being age 18 or older and English-speaking. Potential participants (n = 24) were identified through medical records and from a pool of participants from an investigation following the outbreak in 2010. Letters, including a copy of the informed consent document, were mailed to potential participants and individuals received follow-up phone calls. Contact information for several individuals was outdated, resulting in returned letters (4) and the inability to reach individuals by phone (2). At the time study visits began, two individuals declined participation, two requested more time to review the documents, six agreed to participate, and the remaining eight had yet to be re-contacted. Participants were compensated for their time.

Study Visit Locations

Participants were individually asked at the time of recruitment follow-up calls where they would like us to conduct study visits. Two participants requested clinic visits (one had a medical appointment the same day), four preferred home visits, and one visit was conducted at the participant's private business. All locations were convenient for the participants.

Concepts of Genetics and DNA

DNA was conveyed as a material that is found in many parts of the body, including the inside of the mouth and blood. Participants were informed that genes are made up of DNA and

that DNA is the genetic material we are interested in examining. DNA carries information about the way bodies work and respond to illnesses, and differences in a person's DNA may cause some people to become ill while others do not. Furthermore, participants were informed that their DNA is unique to them, but they do share some similar genetic information with their family members and other relatives, and that DNA is passed down from ancestors.

Type of Biological Sample Collected

Approximately 2 ml of saliva were collected from participants using a special kit, Oragene (DNA Genotek Inc., Ontario, Canada). Participants were instructed to abstain from eating, drinking, smoking, or chewing gum 30 minutes prior to providing the sample. One participant had a difficult time reaching the fill line; however, we informed all participants to take as much time as needed.

Observations During Study Visits

One participant believed the study visit had been cancelled due to having not received a reminder telephone call to confirm the visit, resulting in a delayed visit time. This prompted us to call the remaining participants to verify that we were conducting visits as previously scheduled. We did not encounter any scheduling conflicts thereafter.

Participants were highly engaged and eagerly shared their experience with Blastomycosis during the study visits. Many recalled specific activities in which they may have been exposed. Several participants expressed an interest in why they became ill while others they know, individuals who spent more time outdoors or engaged in similar outdoor activities, did not get sick. We explained that this disparity was something we hoped to uncover with the study. A common experience among participants was being misdiagnosed, resulting in a prolonged state

of illness and hospitalization. Some participants communicated in the Hmong language with D.X., a Hmong member of the research team.

One participant was concerned about researchers using the genetic sample for cloning purposes; we ensured the participant that this was not going to occur. All participants were open to providing blood as biological samples. Additionally, the participants were willing to be contacted for future studies.

Reaching out to the community through a Hmong radio network was a method that was suggested by participants. A Hmong physician from the community hosts a monthly program on health; however, Blastomycosis was reported as having not been discussed yet. Participants expressed interest in a session on Blastomycosis.

Discussion

Few genetic studies with Hmong-ancestry populations have been conducted, and in-depth discussions on the methodology of engaging the sample populations in the study and genetic concepts used are limited in the literature. Correspondence with researchers and authors provided information on effective study designs, including acceptable types of biological samples for collection. Additionally, personal communications with Hmong community members and medical professionals yielded insights on culturally relevant concepts of genetics.

A presentation at the 1983 Hmong Research Conference focused on experiences of Hmong-ancestry populations with medical research and offered recommendations on conducting research with this community (Hurlich *et al.*, 1986). Our results echoed themes from these recommendations. We expand on lessons from this early work and offer recommendations for future genetic-based research with this population, along with implications for public health.

Outreach, Recruitment, and Participation

Interaction with the community prior to the onset of the study allows potential participants to become familiar with the researchers and enables the researchers to gauge whether their approach to the community is effective (Hurlich *et al.*, 1986). Initial contact with community leaders is an effective way of reaching out to the community. These leaders may be coordinators at subsidized housing communities, personnel from Hmong-community organizations, elders in the community, or medical professionals. These individuals, recognized and trusted by the community, can offer support for the research. One challenge, though, is that if community leaders associate medical research with harm or do not perceive that there are benefits from participation, they may inhibit or influence individuals from participating. However, it may be more likely that the community leader is “pro-indigenous” or community rights (McInnes, 2011), thus culturally competent approaches, such as including results that benefit the community, may overcome this barrier.

While the village headman may decide participation in clan-based Hmong villages in Asia, this approach may not translate completely to Hmong-ancestry populations in the United States. There may be similarities in the structure of subsidized housing communities, and social influence may affect participation rates, but the decision to participate will likely vary at the individual level. However, should access to participants depend on the decision of a community leader or head of household, researchers must remember to respect the individual choices of potential participants and follow the recommendation of McInnes (2011) to not violate principles of ethics and rules of institutional review boards, as demonstrated with success in population genetic studies in Thailand (Listman *et al.*, 2011; Listman *et al.*, 2007).

Utilizing media resources in the community is another method of outreach. Hmong radio programs are popular and can serve as a way to reach the community with various messages. Programs focusing on the health of Hmong-ancestry populations may be beneficial as an avenue to disseminate health information, promote current research, and recruit potential participants.

Study Visits: Location and Content

Participants may need to be contacted prior to visits to confirm that no changes have been made to the schedule. This may be especially necessary if researchers are affiliated with a health care system and participants are familiar with telephone call reminders for clinic appointments. Locations for study visits should be convenient for participants, which may include participants' homes and private businesses. During the visit, participants should have the opportunity to openly discuss their experiences and ask questions. Providing the opportunity for discussion may allow the development of trust between participants and researchers. Hurlich and colleagues (1986) report that the relationship between Hmong participants and the research group is the most crucial aspect of ensuring a successful study with this population.

Concepts of Genetics and DNA

Different Hmong concepts can be used to convey Western ideas of genetics and DNA. Based on interview responses, the most common understanding of genetics is perceived through the concept of heredity. The understanding of genetics in terms of heredity, and not of the structural and functional nature of genes, is similar to public understandings of genetics (Condit, 2010). Depending on the context, certain phrases may be more appropriate than others and it may be necessary to use more than one concept or proxy words to convey these ideas. For example, the phrase *raws caj ces* combines the word *raws* (follows) with the phrase *caj ces* (clan/lineage) to convey the concept of heredity. In order to best convey these concepts, it will

be necessary to use non-scientific Hmong language to explain genetics and DNA and what they can inform us through research.

Biological Samples

The type of biological sample required from participants will depend on the aims of the study. For example, researchers interested in heritable hematologic disorders within Hmong-ancestry populations will need to collect blood samples. However, the amount requested may affect participants' acceptance of providing blood. Furthermore, some Hmong believe there is a finite amount of blood in the body and drawing blood will weaken and disrupt the balance of the body (Cha, 2003). The traditional cultural perspective is that during reincarnation the individual may be incomplete (manifested as health conditions or illnesses) because a part of his or her body (including blood) was left behind in the previous life cycle (Parker and Kiatoukaysy, 1999). While the acceptability of providing blood is changing among younger cohorts and more assimilated communities, as observed in the pilot study and reported by Culhane-Pera and colleagues (2003), there may be individuals who remain hesitant towards providing blood samples. These observations demonstrate the second principle to conducting successful genetic research presented by McInnes (2011), the existence of local cultures within one seemingly homogenous group, and must be addressed through a culturally competent study design.

Providing buccal cells may be more acceptable; however, as noted from interview responses, there may be resistance from participants with providing buccal cells as well. Saliva has been shown to yield high quality amounts of DNA and may be used as an alternative to blood (Bahlo *et al.*, 2010; Rogers *et al.*, 2007). This procedure is noninvasive, can be self-administered, and remains stable when stored at room temperature for six months or more (Ng *et*

al., 2006). A noninvasive procedure involving the collection of a less culturally harmful biological sample may be more acceptable in Hmong-ancestry populations.

Implications for Public Health

Culturally competent methods of conducting genetic-based health research with Hmong-ancestry populations will allow researchers to work with these communities and to understand genetic factors associated with health conditions in this population. This understanding will provide opportunities to develop targeted therapies and interventions to reduce health disparities affecting this group. In terms of Blastomycosis, public health campaigns can promote awareness of this infection in Hmong communities and urge individuals to seek health care when experiencing symptoms. Given the increased risk of Blastomycosis in the Hmong community, physicians should consider this diagnosis early when patients exhibit symptoms that are compatible in the diagnosis. These approaches will reduce the burden of health disparities and benefit Hmong communities in Minnesota and Wisconsin, states with high Hmong-ancestry populations and a high incidence of Blastomycosis.

Limitations

We recognize that many of the insights we gained were from researcher experiences. Potential follow-up studies could conduct focus groups to examine attitudes and beliefs about genetic research from a broader community perspective. However, given the limited literature on this subject, we believe there is merit in our results for lessons for researchers in addressing methodological issues related to health and genetics research with this population. Additionally, there is reason to be optimistic about conducting health related research with Hmong-ancestry populations. Researchers may be intimidated due to documented challenges with health care in Hmong communities; however, as shown by our experience and the experiences of other

researchers presented in this paper, research can be conducted successfully through the use of culturally competent study designs.

The interest in participation and willingness to provide blood samples as observed from the pilot study may be biased due to these individuals experiencing Blastomycosis, having interfaced with the health care system, and having participated in the outbreak investigation. Attitudes toward providing blood for research purposes may differ at the individual level. However, social influence and perspectives regarding benefits of the research for the Hmong community, as observed through community leaders, are also factors that affect participation and willingness to provide a biological sample. Our recommendations for interaction with the community prior to the onset of the study are to develop a positive relationship and to consider biological samples other than blood to address these factors and this limitation.

Summary

Population genetic research has identified a unique genetic makeup of the Hmong-ancestry population, and existing health research has indicated a potential genetic basis for the high prevalence of some diseases affecting this population. As we continue to explore and begin to understand more about the relationship between genetics and health, and as we reach out to diverse populations around the world, we must consider culturally competent study designs to avoid harm to these populations as observed with others in the past. Appreciating the culture of Hmong-ancestry populations will lead to better relationships between researchers and Hmong communities and provide a path for successful future health-related studies, as well as opportunities to reduce health disparities, with this unique population.

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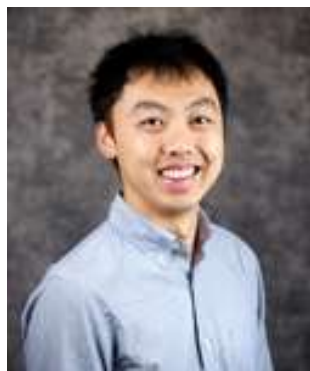
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About the Authors:



Donny Xiong is an Associate Research Specialist in the Department of Medicine at the University of Wisconsin-Madison. His research interests include characterizing the contributors to health disparities within at-risk, understudied populations, and strategies to connect research, public knowledge, and practice.



Dr. Jennifer Meece is the Director of Core Laboratory and a Research Scientist at the Marshfield Clinic Research Foundation. Her research interests include vector-borne infectious diseases and characterizing genes associated with variable susceptibility to pathogens in humans.



Dr. Caitlin Pepperell is an Assistant Professor in the Departments of Medicine and Medical Microbiology and Immunology at the University of Wisconsin-Madison. Her research focuses on the ecology and evolution of infectious diseases, with a particular interest in tuberculosis and the endemic mycoses.

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Appendix I. Summary of reviewed literature and interview responses

Reason for Contacting	Reference	Affiliation ¹	Host ²	Methods/Suggestions ³	Effective?
<i>Genetic Research</i>					
	<i>Population Genetics</i>				
	Listman et al. 2007 Listman et al. 2011	Yale University, United States	TH	Contacted village leader for approval prior to recruitment; central location for study visits; saliva samples collected	Yes
	Li et al. 2007 Wen et al. 2005	Fudan University, China; Yale University, United States	CN	Contacted village leader for approval prior to recruitment; central location for study visits; blood samples collected	Yes
<i>Genetic Disorders</i>					
	Vang et al. 2007	University of Wisconsin-Madison, United States	TH	Electronic mail recruitment; blood samples collected	Yes
	Unpublished Personal Communication, 2012	University of Wisconsin-Madison, United States	US	Clan networks; door-to-door recruitment; collected buccal cells via cheek swabs	Yes
<i>Drug Metabolism</i>					
	Straka et al. 2006	University of Minnesota, United States	US	Posted advertisements; Hmong recruiters on research team; collected buccal cells via mouthwash	N/A
<i>Health Research and Care</i>					
	<i>Attitudes and Perceptions</i>				
	Lor et al. 2013	University of Wisconsin-Madison, United States	US	Contacted community stakeholders and leaders; snowball recruitment; community centers as study visit locations	Yes
	Personal Communication, 2012	University of Wisconsin-Madison, United States	US	Network through community leaders and centers; use visuals to convey medical and scientific concepts; conduct focus groups to gather wide community perspectives	Yes
<i>Education and Social Marketing Intervention</i>					

	Vang 2012	University of Wisconsin-Madison, United States	US	Contacted community leaders; Posted advertisements; recruitment at community events; community centers as locations	No (Posted advertisements were ineffective)
<i>Health Care</i>					
	Personal Communication, 2011	University of Wisconsin Hospitals and Clinics, United States	N/A	Network among clans; coordinate with community leaders and associations; use theories to guide research and dissemination of health information	N/A
	Personal Communication, 2013	Marshfield Clinic, United States	N/A	Collaborate with community associations; many Hmong do not believe their genetic makeup contributes to health outcomes	N/A
Hmong Culture	<i>Genetic Concepts and Language</i>				
	Lee 2007	Concordia University, United States	N/A	No clear concepts and understanding of genetics at the molecular level; published resources (e.g. Hmong-English dictionary) may serve as a useful tools for identifying medical and scientific terminology	N/A
	Personal Communication, 2012	Wausau Area Hmong Mutual Association, United States	N/A	Hmong cultural concept of the "spirit" as an analogy to genetics may be inappropriate	N/A
	Personal Communication, 2013	Hmong Arts, Books, and Crafts, United States	N/A	Several ways to convey concepts of genetics; depending on context, certain phrases may be more appropriate than others	N/A
	Personal Communication, 2013	Center for Southeast Asian Studies, University of Wisconsin-Madison, United States	N/A	Hmong social beliefs include perspective that blood-related children have similar behavioral and physical features; marrying into a family with a history of health or mental disorders will increase the risk of having children with similar conditions	N/A

1. Affiliation at time of study or time of personal communication.
2. Country in which study was conducted. TH = Thailand, CN = China, US = United States
3. Methods used in the study or suggested during personal communication.