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Factors associated with youth competency as lay health promoters of GxE literacy related to Podoconiosis in rural highlands of Southern Ethiopia

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An abstract of A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements for the degree of Master of Public Health in Global Health

Year, 2020

Abstract

Factors associated with youth competency as lay health promoters of GxE literacy related to Podoconiosis in rural highlands of Southern Ethiopia

By Desta A. Alembo

Background: Engaging youth as peer educators is a common approach that has been shown to be effective for improving healthy behavior in a variety of settings. However, this approach has not been considered in the context of promoting literacy concerning conjoint genetic and environmental (GxE) influences on health. This cross-sectional survey explored the youth self-rated competencies and commitment to civic organizations in rural Ethiopia where a heritable form of non-filarial elephantiasis (i.e., podoconiosis) is endemic.

Methods: A cross sectional survey was conducted in the Wolaita zone of Southern Ethiopia. Surveys were administered by trained data collectors. Eligible youth ages 15 to 24 were enumerated. All the respondents (377 youth), randomly selected, completed the survey. Bivariate associations were tested for social and demographic factors associated with willingness to serve as lay health GxE literacy builders. A composite measure of competency was developed and its association with willingness was tested in logistic regression model with other cofactors.

Results: The odds of willingness was 2.3 time higher for the participants with high competency than for those with low competency (OR 2.34; 95% CI, 1.55, 3.54). Males, participants who had attended formal education, who had experience in civic engagement and those who had assumed leadership roles were more willing to volunteer to serve as peer GxE literacy builders than their counterparts OR 1.95 (95% CI, 1.29, 2.94); OR 6.6 (95% CI 1.59, 23.04); OR 1.96 (95% CI, 1.29, 2.96); OR 2.12 (95% CI, 1.10, 4.03) respectively. There was no interaction effect between competency and other variables in predicting high willingness $p>0.05$.

Conclusion: Young volunteers with formal school backgrounds and experience in social activities in the community could be recruited as disseminators of GxE literacy. Interventions should consider these attributes to build the skills of potential peer leaders through training tailored to GxE literacy.

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Acronyms

AD	Aging and Dementia
AIDS	Acquired Immunodeficiency Syndrome
CHWs	Community Health Workers
CI	Confidence Interval
CSA	Central Statistics Authority
DOI	Diffusion of Innovation
FINGER	Finnish Geriatric Intervention Study
GxE	Gene by Environment Interaction
HIV	Human Immunodeficiency Virus
LMICs	Low- and Middle-Income Countries
NTDs	Neglected Tropical Diseases
OR	Odds Ratio
RH	Reproductive Health
SPSS	Statistical Package for Social Science
STI	Sexually Transmitted Infection

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Chapter 1: Introduction

1.1 Background

Over the past three decades, the nature versus nurture debate over disease etiology has given way to more complex models that accommodate a larger number of causal pathways and allow for interactions between risk factors on many levels (Sameroff, 2010). These pathways include both individual and environmental level factors and incorporate the influences of both nature and nurture into a single comprehensive model. The examination of known environmental causes of disease, coupled with the recent scientific advances allowing for rapid and affordable detection of genetic variation is advancing our understanding of the individual and combined roles of genetic predisposition and environmental influences on most chronic diseases(Schnittker, Freese, & Powell, 2000; Wachs, 1992).

Environmental exposures coupled with genetic variation influence disease susceptibility. Deconstructing their respective contributions remains one of the principal challenges in understanding complex diseases(Favé et al., 2018). Such gene-by-environment interactions are thought to be pervasive and may be responsible for a large fraction of the unexplained variance in heritability and disease risk(Franks, Pearson, & Florez, 2013). Yet, disease risk, owing to either environmental exposures and/or their interactions with genotype, remains poorly understood (Rappaport & Smith, 2010).

Studies suggest that understanding the interaction between genetic predisposition and environmental exposure can help identify high-risk subgroups in the population and provide better insight for preventing diseases (Morris et al. 2003; Muin et al. 2005; Brand et al. 2008;

Burke et al. 2010). However, many also highlight the pervasive misconception and incomplete understanding of lay people about gene-environment contributors to health conditions (Condit & Shen 2011; Marsh et al. 2011, Engdawork et al., 2018; Allen et al.2019). This inaccurate perception can cause stigmatization of individuals affected by heritable diseases leading the public to wrongly believe that a genetically influenced health condition is inevitable. This situation remains a potential challenge for engaging the public in genomic research and impedes public health interventions for behavioral risk reduction (Marteau et al. 1997; Mbonu et al. 2009; Angermeyer et al. 2011).

To date, most genetic education interventions have been conducted in developed countries where study populations have relatively high literacy (Whitley, Tueller, & Weber, 2020). The settings in developed countries contrast with low income countries, where target populations have low literacy. The majority of these populations live in rural settings, where educational infrastructures are limited and many do not have formal education (Pang, 2009). Qualitative studies in developed countries have consistently shown that lay audiences tend to view genetic and environmental factors as having equal and parallel contributions to disease risk (Condit & Shen, 2011). Lay audiences find it difficult to conceptualize how G x E influences might work together to impact health outcomes (Condit et al., 2009; Waters, Ball, & Gehlert, 2017). Such pervasive constraints create many challenges to integrate genomics into health promotion interventions. Clearly, efforts to increase understanding of GxE for Low- and middle-income countries (LMICs) will face these and additional challenges. However, such efforts are needed if we are to ensure that public health advances informed by genomics are to reach these populations.

Evidence on the influential roles played by youth in many health literacy activities support the potential benefit of engaging youth as disseminators of gene x environment understanding. Engaging youths is a preferred approach for disseminating health messages on sensitive issues and reaching the hard to reach populations (Fatmeh A. & Masoumeh, 2013). The sensitiveness of the issue of gene by environment risk information with regards to podoconiosis has been documented in our prior and ongoing research (Davey et al. 2006; Tekola et al. 2009; Ayode et al. 2012, Tora et.al, 2014). However, to our knowledge, there are no studies that have evaluated the characteristics of youth and their willingness to play a role as community leaders in GxE literacy in their communities.

The context of podoconiosis- a non-infectious disease caused by exposure of bare feet to volcanic red clay soil offers an ideal opportunity to evaluate the potential contribution of youth as gxe literacy builders. The disease mostly affects subsistence farmers who work barefoot, particularly on red clay soils of volcanic areas (Deribe 2015). Podoconiosis is a chronic, debilitating disorder and a considerable public health problem in Asia, Central America and tropical Africa, including Ethiopia (Price 1990). Evidence to date suggests that walking barefoot in soil with high levels of silica particles leads to lymphatic inflammation among genetically susceptible families (Price 1972; 1990, Davey et al. 2007; Tekola et al. 2012). Recent nationwide mapping (Deribe et al. 2015) suggests overall disease prevalence of 4% and about 1 in 20 people are estimated to be affected by the condition in Wolaita Zone of southern Ethiopia (Destas et al, 2003). Evidence indicates that both genetic and environmental factors are involved in the pathogenesis of podoconiosis and that heightened susceptibility to soil exposure clusters in families, with estimated heritability of 63% (Tekola et al, 2012).

A number of studies have revealed high levels of misconceptions regarding the causes of podoconiosis among the general public and health professionals in endemic areas (Yakob, et al. 2008; Tora et al, 2014; Deribe et al, 2013). Though endemic communities acknowledge that podoconiosis runs in families, many have little awareness about the functioning of genes and modes of inheritance (Yakob et al. 2008; Davey et al. 2006; Tekola et al. 2009; Ayode et al. 2012; Molla et al. 2012). The condition is entirely preventable if genetically high-risk individuals consistently protect their feet by wearing shoes and practicing foot hygiene (Davey et al. 2007; Alemu et.al. 2011; Molla et al, 2013).

Our prior manuscript based on the same podoconiosis-endemic community published previously (Kibur et al, 2018), we reported that youth could be competent disseminators of GxE information about podoconiosis. However, we found that this potential could be diminished because youth held contradictory beliefs about the causes of podoconiosis. For example, youth who strongly endorsed GxE contributors to podoconiosis were also significantly more likely to endorse contagion as a causal factor than those who did not endorse GxE contributors.

Whether engaging youths who have better competence to volunteer as disseminators of GxE information could help to eliminate this contradictory endorsement is hardly explored. The purpose of this study is therefore to characterize young people who might potentially be competent and willing to diffuse GxE literacy related to podoconiosis among their peers in these rural communities.

1.2 Research Questions

In this paper, I pose the following research questions:

i) What attributes are associated with youths' competency to disseminate GxE explanations of podoconiosis?

ii) What attributes are associated with youths' willingness to disseminate GxE explanations of podoconiosis?

iii) Do attributes moderate associations between competency and willingness?

Chapter 2: Literature Review

2.1 Gene x Environment Contributors to Health

Advances in human genomics over the past decades has led to the burgeoning research interest in relation to the joint contribution of gene and environment for many chronic and non-communicable diseases.(Hirvonen, 2009) Over the past three decades, the nature versus nurture debate over disease etiology has given way to more complex models that accommodate a larger number of causal pathways and allow for interactions between risk factors on many levels. These pathways include both individual and environmental level factors, and incorporate the influences of both nature and nurture into a single comprehensive model.(Flowers, Froelicher, & Aouizerat, 2011). The examination of known environmental causes of disease, coupled with recent scientific advances allowing for rapid and affordable detection of genetic variation, is advancing our understanding of the individual and combined roles of genetic predisposition and environmental influences on chronic disease. Interactions, including those occurring between an individual's psychosocial and physical environment and their unique genetic "makeup," are now accepted to have an important role in nearly all cardiovascular disease conditions and underlying biological processes(Hunter, 2005).

As defined by Kabesch, gene by environment interaction is often interpreted as an action -reaction mechanism where the genes define the potential and limitations of the human body to react to environmental conditions.(Kabesch, 2006) According to this definition, the concept of gene × environment interaction assumes that genes and the environment interact in a multiplicative way on complex traits. The combined examination of both factors might therefore be more informative for the understanding of etiology of disease than their separate

investigation. Susceptibility to many heritable health conditions and in consequence treatment response is likely the result of a mutual interplay between genetic and environmental factors which are – on their own –neither necessary nor sufficient for the development of the disease (Sullivan, Neale, & Kendler, 2000).

Recent advances in neuroscience demonstrate that genetic and environmental factors do not act in isolation. Effects of environmental factors depend on the genetic background and any impact of genetic variation on behaviour is contextualized by environment.(Uher, 2008) Such findings are causing a paradigm shift from single-factor-deterministic to a multi-factor-contextual perspective.

Promoting intervention strategies that consider individual and environmental factors is not new (McLeroy et al. 1988; Sallis and Owen 2002; Stokols 1992). Increasingly, public health practitioners and researchers have advocated for the need to use frameworks for both evaluating and addressing health inequalities that consider biological, social, behavioral, and environmental factors to assess risks and explain health outcomes in populations. While the acknowledgement that both individual and social factors play an important role in explaining health outcomes does not necessarily translate to widespread acceptance of the impact that genetic factors may have on health inequalities, there have been recent calls to better integrate genetic and environmental factors into our understanding of health and disease (Burke et al. 2010; Khoury et al. 2011; McBride et al. 2010). Stoltenberg (2005), for example, suggests that considering genetic factors in population health studies that focus on environmental causes could add a greater level of "precision to disease etiology research."

A positive family history of disease captures the underlying complexities of gene-gene and gene-environment interactions by identifying families with combinations of risk factors

(both measured and unmeasured) that lead to disease expression. In their 2003 review of strategies to prevent heart disease, (Ramos & Olden, 2008) stated that even when family members share a family history of heart disease, they also share other risk factors (e.g., diet, activity). Additionally, (Olden & Wilson, 2000) reported that a sizable majority of individuals with fatal or non-fatal coronary heart disease events have at least one major risk factor. The two studies highlight the importance of the synergy between genes and the environment with respect to chronic disease morbidity and mortality, and further emphasize the need to assess all risk factors when assessing the prevalence of complex disease phenotypes.

Characterization of GxE interactions will provide critical insight to disease mechanisms, personalized intervention strategies, and pave the way toward precision medicine. Currently, multi-scale intervention strategies like the Finnish Geriatric Intervention Study (FINGER) trial for Aging and Dementia (AD) are underway to reduce dementia incidence in at-risk individuals by altering lifestyle factors that are known to modulate AD risk, such as diet and physical activity (Ngandu et al., 2015). Identifying those genetic factors that regulate the beneficial effects of these lifestyle interventions will better help us to identify the patients who will benefit the most from such an intervention, as well as exclude patients who are expected to be non-responders or poor responders based on their GxE profile.

Individuals are likely to vary in how they use information about genetic makeup to reduce or manage uncertainty about their health, with the lay public holding a wide range of beliefs about the role of genes in health (Henderson & Maguire, 2000). Genetic determinism "identifies genes as a sole relevant causal features of an individual 's characteristics and life courses"(Condit & Shen, 2011) . Alternatively , from the perspective of genetic relativism, it is believed that genes contribute only partially to human condition, including health (Parrott, Kahl,

Ndiaye, & Traeder, 2012). Taken together, this suggests that communicating about the role of gene and environment interaction and its impact on health may be influenced by lay peoples' understanding and varied belief systems.

2.2 Gene x Environment Education Studies

Genetic variation has become increasingly recognized as a factor modifying the effects of environmental exposure on health outcomes(Hernández-Valero, Herrera, Zahm, & Jones, 2007). As the role of genetic susceptibility to environmentally induced disease is increasingly understood, the scope of public awareness of genetics needs to be broadened beyond single-gene disorders to include almost all human diseases. To this effect, providers of health care and health institutions will need to expand public awareness about the role of gene-environment interactions in health and disease to begin translating gene discovery to effective personal and public health action. (Morris, Gwinn, Clyne, & Khoury, 2003). Despite the importance of such knowledge for adequate preventive behavior, little research has focused on the general public's knowledge of genetic risk factors and how and why these factors affect health (Smerecnik, Mesters, de Vries, & de Vries, 2008). However, future health promotion programs intended to increase public knowledge of genetic risk factors for multifactorial diseases are likely to be unsuccessful if they disregard the public's prior knowledge(Kardia & Wang, 2005).

Existing scarce body of literature on gene-environment education indicate that to effectively implement genomic medicine at different levels of healthcare delivery, strategies for establishing training in core competencies of genetics and genomics targeted at diverse populations need to be in place(de Abrew, Dissanayake, & Korf, 2014; Houwink et al., 2011; Sirisena & Dissanayake, 2018; N. D. Sirisena & V. H. Dissanayake, 2019). Several approaches have been adopted in Western countries to ensure that their healthcare workforce is adequately

trained and competent to effectively use information on gene-environment interaction in their professional practice. However, this is not the case in most low- and middle-income countries (LMICs) (N. D. Sirisena & V. H. W. Dissanayake, 2019). In many of the low-income countries, this necessity has been plagued by numerous challenges stemming from the lack of local capacity to plan and carry out the required training of the healthcare workforce. The other contributory factors are the scarcity of adequate funding for training as well as establishing core facilities needed for deliveri ng these services around which such training programs could be implemented and delivered (Sirisena and Dissanayake, 2018).

As stated earlier, it is increasingly clear that most human diseases are the product of complex interactions of genes with environmental factors. (Daar et al., 2007; Kingsmore et al., 2012) However, communicating such complex interaction issues to lay audiences when they have limited genetic literacy is very challenging. It also has been documented that beliefs about the inevitability of genetic diseases can negatively affect preventive health behaviors and aggravate social stigma among patients (Ayode et al., 2012; Yakob, Deribe, & Davey, 2008). In our previous research on dual perspectives of stigma, we found that levels of experienced and enacted stigma were influenced by respondents' beliefs about the causes of podoconiosis, a neglected tropical disease with high heritability. Beliefs that the condition was hereditary were positively associated with reports of stigma experienced by those affected with podoconiosis and stigma enacted by those unaffected (Ayode et al., 2016). In addition, our intervention trial done in communities in southern Ethiopia where podoconiosis is endemic, we showed that provision of GxE education to unaffected families was associated with decreased enacted stigma. For unaffected households, the inclusion of information about GxE was associated with

unaffected care-givers' reporting increased confidence to explain the causes of podoconiosis and short-term improvements in shoe-wearing relative to usual care(McBride et al., 2015).

Dissemination of accurate information about gene and environment interaction is a key component of proactive health care and is crucial to cost-effective preventive strategies (Starkey, et al, 2009; (Hingorani, Shah, Kumari, Sofat, & Smeeth, 2010). Many programs have involved youth in prevention activities as peer health educators to improve health knowledge and behaviors among youth. Peer-led programs has been used to address preventable health conditions such as HIV/AIDS, STI, reproductive health, and smoking cessation (Mason-Jones et al, 2010, Price & Knibbs, 2009, Borgia et al, 2005). Peer-led education can be defined as a sharing of information, values, and behaviors by members of similar age, culture or status group (Sweifach & Laporte, 2007). However, empirical evidence is limited about whether youth could be influencers for building gene-environment literacy.

Evidence from systematic reviews on the effectiveness of peer-delivered health promotion for young people are largely positive. For example, a systematic review by (Fatmeh & Masoumeh 2013) showed that youth -led education is an effective tool for promoting healthy behaviors among Iranian youths and used successfully to treat alcohol and substance abuse disorders. In other findings a systematic review of interventions to prevent the spread of STIs among young people indicated that peer-led interventions were more accepted, and thus more successful in improving sexual knowledge, than teacher-led interventions (Lazarus et al., 2010). A meta-analysis result of youth education programs for HIV prevention in LMIC showed that peer education interventions were associated with increased HIV knowledge, reduced equipment sharing among IDUs, and increased condom use. They also suggest that peer education can be an

effective strategy for changing behavior among hard-to-reach, hidden populations such as commercial sex workers. (Amy et al, 2009).

Research also suggests that young people are more likely to hear and personalize messages, and thus to change their attitudes and behaviors, if they believe the messenger is similar to them and face the same concerns and pressures (Milburn, 1995, Wolf & Bond, 2002). They can influence their peers by using their own codes, languages, and communication channels, thereby enhancing the impact of the prevention message (James-Traore et *al, 2002*).

Similarly, numerous studies have been conducted in developing countries and shown that youth-led education interventions can influence youth's health behaviors in regards to sexuality, violence and substance use (Stone & Zimer, 1993, Milburn, 1995). For instance, as part of the "young multipliers" project in Lima, Peru Peruvian adolescents (aged 15 to 17) were trained to design and disseminate messages promoting healthy lifestyles among their peers. (Diez-Canseco et al, 2011). Participation in 16 training modules was associated with significant improvement in the adolescents' reproductive health knowledge (Diez-Canseco et al, 2011). A study conducted in fifteen high schools (n=2339 Grade 10 learners) in South Africa to implement a peer education HIV prevention program found that the use of volunteer peer leaders in school health promotion activities was both feasible and acceptable (Mason-Jones et al, 2010). A peer health education program in Cameroon also showed increased use of modern contraceptive methods and increased condom use at most recent sex among participants versus comparison youth (James-Traore *et al, 2002)*

A recent quasi-experimental study in Ethiopia on the effects of peer education intervention on HIV/AIDS-related sexual behaviors of secondary school students in Addis Ababa revealed significant changes in measures of knowledge about HIV and willingness to go

for HIV counseling and testing among students in the intervention group. In another study on Reproductive Health (RH) in Ethiopia, Scholl et al (2004), found that in locations where youth-led education interventions were made available, RH service users considerably increased and unsafe abortions declined. The services also provided a rewarding opportunity for peer educators in developing their leadership skills and increasing their knowledge base about RH.

Studies also suggest that attention to the specific personal characteristics of peer education disseminators is important. A systematic review in the field of school-based peer education intervention found that the selection of peers with leadership skills was important(Shepherd et al., 2010). In their study of peer education, Flanagan *et al* (1996) found that identifying and selecting peer disseminators with confidence, technical competency, communication skills and compassion were crucial in affecting program success. Scholl, *et al* (2 004) identified reproductive health peer educators who demonstrated an interest in health and a commitment to help others in need, had participated in health clubs and exhibited willingness to foster change through allocation of their time to voluntary peer education service.

Evidence suggests that one's self-assessment of competency is important for performance and willingness to make decisions (Maddox, Halsall, Hall, & Tully, 2016; Shava & Chinyamurindi, 2019; Wei & Yang, 2010). The generally accepted view of what constitutes competency is very limited. Competency is almost universally perceived as being comprised exclusively of skills, knowledge, and attributes (Langdon & Whiteside, 2004). For example, findings on the association between self-perceived competency in communication among Micronesian students and their willingness to communicate in second language showed that students who viewed themselves as less communicatively competent, were less willing to

communicate. (Burroughs, Marie, & McCroskey, 2003). In another study examining willingness of Swiss young people to continue further education, it was found that competencies such as achievement motivation, self-efficacy and collaborative ability were attributes predicting their willingness (Wolter & Ryan, 2011). However, little is known about competency as an attribute for determining willingness of youth in peer-led health promotion generally or specific to GxE literacy building.

2.3 Studies on factors influencing youths' competency and willingness

Research conducted on behavioral competencies and willingness of individual to take actions came out with mixed results. For example in the study involving perceived communication competency and willingness of individuals to communicate in second language, Burroughs & Marie (1990) found strong correlations of self-perceived competency with willingness to communicate among individuals across different cultures. A study of secondary school students' (N=1046) in seven Hong Kong schools found that prior experience in community service was a main predictor of the students' willingness to participate in future volunteering (Ling & Chui, 2016) .

An empirical study (Fawole & Ozkan, 2019)was conducted between October, 2015 and March, 2016 to determine the factors influencing the willingness of youth in Ibiono Ibom Local Government Area of Akwa Ibom State, Nigeria to participate in agricultural activities. With the aid of questionnaire, primary data were obtained from 150 youth using the multi-stage sampling procedure. Data were analyzed using the univariate probit regression model. Results of analysis revealed that youths' age was positively associated with willingness to participate in agricultural activities and programs. Findings also showed that household income and membership in social

groups were significant and directly associated with youths' willingness to participate in agricultural activities.

In another study, Joseph and Ciarrichi (2001) assessed the association of emotional competence (i.e., skill at emotion perception, managing self-relevant emotions, and managing others' emotions), hopelessness, willingness to seek help from health professionals (e.g. counselor) and nonprofessionals (friends, family), and perceived usefulness of past help-seeking experience with willingness to seek help for emotional problems and suicidal ideation among 300 university undergraduates Those who reported feeling less skilled at managing emotions were less willing to seek help from family and friends for both emotional problems and suicidal ideation and less willing to seek help from health professionals for suicidal ideation. These relationships held even after controlling for hopelessness, sex, and past help-seeking experience.

. A longitudinal study Cemalcilar (2009), investigated the underlying dynamics of adolescents' volunteerism. First time volunteering adolescents were accessed at the time of their initial decision to volunteer on a social responsibility project and their self-perceptions (self-concept, self-esteem) and civic attitudes (social responsibility, community belonging) are compared to their peers' with similar backgrounds who did not volunteer to participate in the project. Results showed that volunteers were more likely to be females, younger and scored higher on all measured individual characteristics compared to the non-volunteers.

Lee and colleagues conducted a study to identify factors associated with willingness to participate in anti-tobacco community activities in 4–7th grade students in Florida. Telephone interviews assessed socioeconomic status, tobacco use, knowledge, and attitudes, and exposure to anti-tobacco school education and media campaigns. Factors associated with willingness included: parental discussion of tobacco use, exposure to school courses with anti-tobacco

curricula and a belief that youth could convince their friends to stop smoking. Students who felt they possessed the ability to convince a friend to avoid smoking or quit once they started were more likely to report willingness to participate in anti-tobacco activities than their less confident (i.e., less 'empowered') counterparts. However, gender, ethnicity, parental education levels and geographic region were not associated with willingness to participate in anti-tobacco activities(Lee, Trapido, Weatherby, & Rodriguez, 2001).

2.4 Theoretical framework: Diffusion of innovation theory

The contents and intervention structure of the present study is informed by the Diffusion of Innovations Theory (DOI). This theory mainly informs the concept related to communication channel of the intervention process and characterizing adopters of the innovation (in this case behavior change thorough inclusion of the GxE literacy). It also explains the importance of peer to peer conversations and social networks in adopting innovations (Ramseyer Winter, 2013).

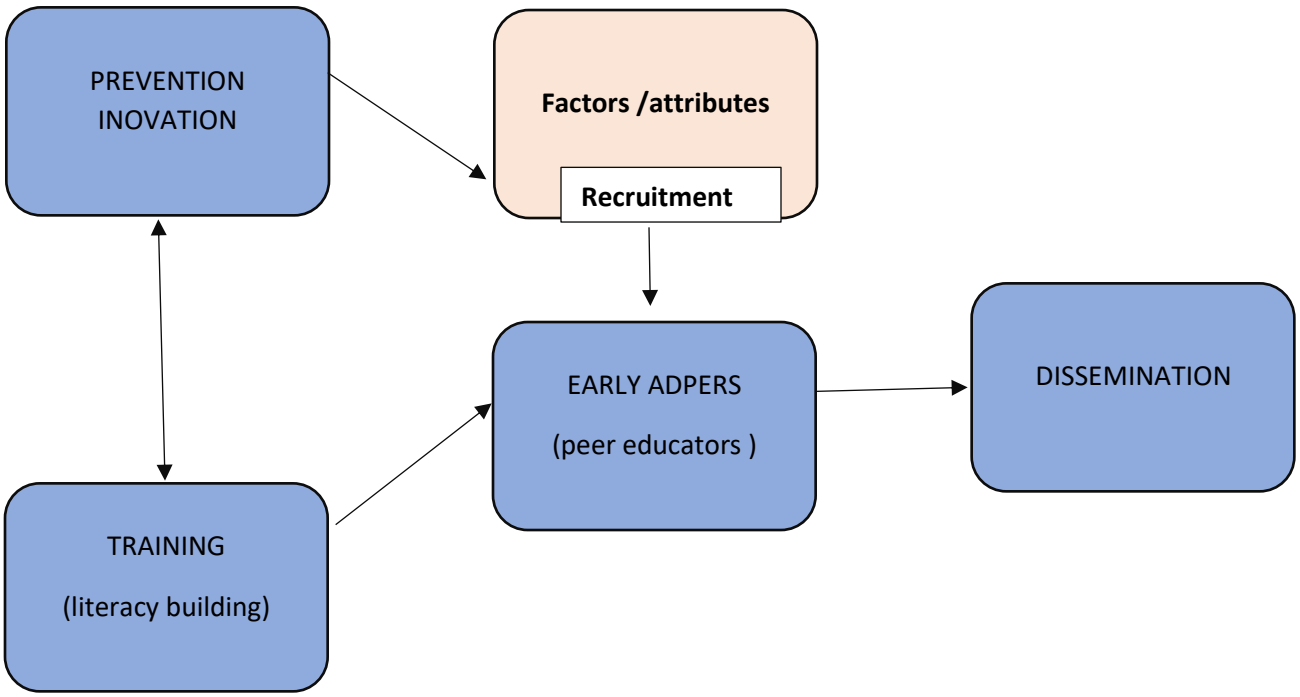

Figure 1: Conceptual framework for peer education

2.4 1 Core concepts

According to DOI, diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1995, p. 10). Four DOI concepts are essential for the diffusion process: innovation, communication channels, time, and the social system (Rogers, 1995). An innovation is an idea, concept, practice, or object that an individual views as new. In an article applying DOI to prevention work, Rogers (2002) defined a prevention innovation as "new ideas that require action at one point in time in order to avoid unwanted consequences at some future time" (p. 991).

Communication about an innovation can occur between two or more people and requires that at least one person has knowledge about the innovation and/or personal experience with the innovation and at least one person who does not have this information or experience. Rogers (1995) described this communication process as very social. Because diffusion is such a social process, it is important that those communicating the innovation are similar to those they hope will adopt the innovation.

Time is required for the diffusion process, particularly because it takes time for individuals to make decisions about whether or not to adopt an innovation. Diffusion of innovations refers to this as the innovation-decision process, in which individuals move through knowledge, persuasion, decision, implementation, and confirmation. Some members of a social system will decide to adopt an innovation more quickly than other members. This is referred to as innovativeness. Adopters are classified as innovators, early adopters, early majority, late majority, and laggards, depending on when they make the decision to adopt the innovation (Rogers, 1995). Initiating the process of diffusion relies on innovators and "early adopters", individuals who are quick to gain knowledge about and experience with the innovation.

The final concept required for the diffusion of innovations is the social system, "a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal" (Rogers, 1995, p. 23). The structure of the social system impacts the diffusion process. For example, opinion leaders play a large role in diffusion. These leaders are typically not the most innovative members of the social system but instead are individuals who are informal leaders with influence over others in the social system.

2.4.2 Relevance and Application of DOI to Peer Education Programs

Diffusion of innovations provides a framework for peer education programs that seek to achieve fewer risky behaviors and more protective behaviors among both the peer educators and those they educate. Using DOI language, the adoption of improved understanding of GxE influences on health is the prevention innovation. In fact, DOI concepts can be applied throughout peer education programs, from peer educator recruitment and selection to evaluation.

Recruitment and Selection of Peer Educators

Several DOI concepts directly relate to the recruitment and selection of peer educators. First, opinion leaders may be optimal peer educators. These opinion leaders in the ideal would be motivated to use their influence to make a difference for their peers. Smith and DiClemente (2000) provide an example of how peer education recruitment and selection can be done to ensure peer educators are opinion leaders.

Peer Educator Training

The initial peer educator training begins the diffusion of prevention innovation to the peer educators. In order for the peer educators to effectively convince their peers that engaging in no

or low risk behaviors is advantageous (relative advantage), they must have a solid understanding of the subject matter and they must have adopted the prevention innovations themselves. Thus, achieving relative advantage requires in-depth training for the peer educators. Peer educator training also needs to be interactive and hands-on. These hands-on experiences will assist the peer educators in their own innovation-decision processes and help them convince their peers of the relative advantage of these behaviors once they begin educating them.

Education Curriculum Developed and Provided to Peers

Based on DOI, peer educators should be perceived to be similar to the peers they are educating. Thus, in the ideal, peer educators should "share common meanings, a mutual subcultural language, and are alike in personal and social characteristics" (Rogers, 1995, p. 19). Further, firsthand knowledge of their social system culture will allow them to understand how their peers are likely to respond to an emerging innovation.

2.5 Chapter Summary

In this chapter, the relevant literature on factors influencing youths' willingness to participate as peer communicators in various aspects of social activities was discussed. The challenges of genomic literacy in low income countries and the joint contribution of gene and environment have been explored to better understand the importance of GxE literacy on prevention of heritable diseases such as Podoconiosis. In most of the literature reviewed, the role of engaging youths in preventive programs had inconsistent findings. However, little has been documented about the role of engaging youth in preventive actions as GxE message disseminators in the context of podoconiosis disease. The conceptual framework of the study was designed using the diffusion of innovation theory and the rational was provided for its use in this

study. The diffusion of innovation theory suggests that diffusion relies on effective communication channels and on early adopters (in this case, peer educators). Along the line of this framework, the study introduces attributes for recruiting peer educators to optimize diffusion of GxE knowledge related to podoconiosis. Therefore, the current study emphasizes answering which attributes influence competency and willingness of youths to participate in dissemination of GxE messages related to podoconiosis; and whether these attributes moderate the association between competency and willingness.

Chapter 3: Methods

3.1 Study overview:

I analyzed data from a cross sectional survey that assessed youth beliefs about the causes of podoconiosis, GxE knowledge levels, self-rated confidence to explain the disease causes, demographic characteristics, engagement in community activities and willingness to participate in GxE literacy building activities. Ethical approval was obtained from the Institutional Review Board of the College of Health Sciences, Addis Ababa University and from Emory University.

3.2 Study settings and population

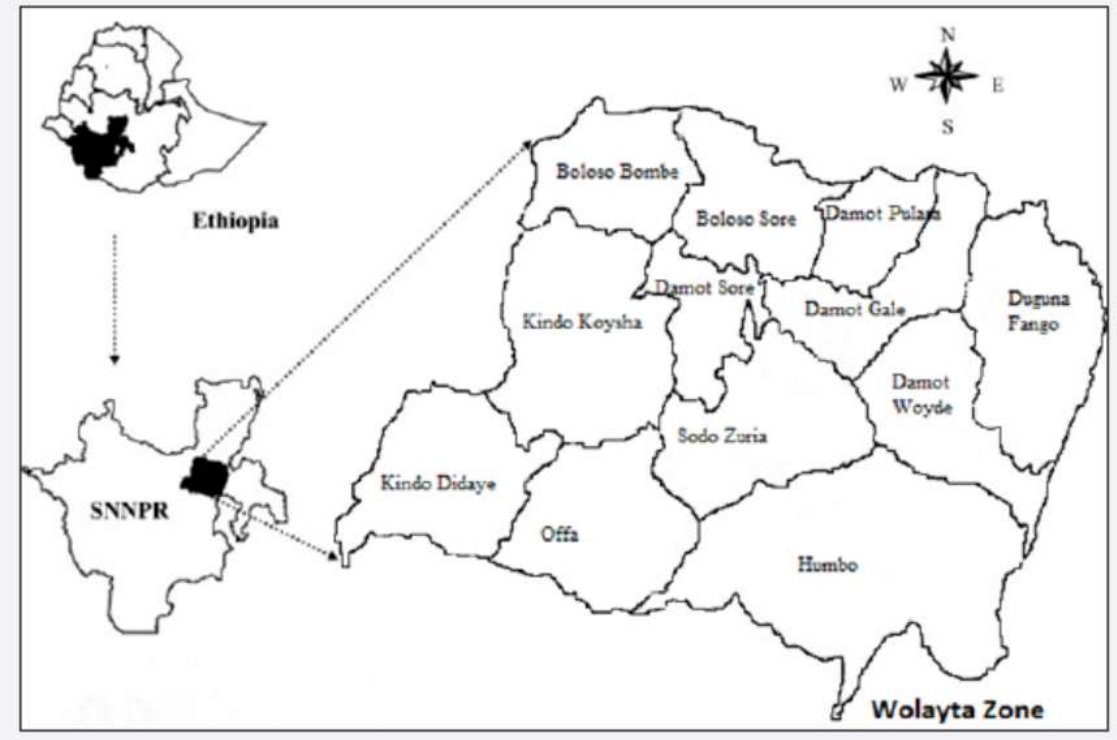

Figure 2: Map of Wolaita Zone

The survey was conducted in the Wolaita zone of Southern Ethiopia, an area where podoconiosis is endemic. The prevalence of podoconiosis was 5.5% in 2002 (Desta et al, 2003). The total population of the zone is estimated to be 1.7 million with 88% living in rural settings. Residents are largely of Wolaita ethnicity, a homogenous cultural and religious (Christian) background (CSA, 2007). Most people earn their living from subsistence farming. The zone is divided into 15 administrative districts or communities. Two communities (in Sura Koyo and Tome Gerera districts) that had not been included in a previous intervention trial (McBride, et al 2015) were purposively selected for the study.

Households with young people in the age range 15-24 (as defined by World Health Organization) were used as the sampling frame. These households were identified from a list collected from records at the local administration office. One youth from each household was selected, for a total of 377 participants. Forty-one were recruited from families affected by podoconiosis and 336 from unaffected families. Written informed consent was obtained from all participants. Thumbprints were taken from those who were not able to sign the information sheet and consent forms. For youths under the age of 18, consent was obtained from their parents or guardians. Data collectors were trained on key ethical issues, including how to ensure informed consent, as part of their initial briefing. All the data were anonymized, and personal identifications of the respondents were coded and stored separately.

3.3 Instruments

Items included in the survey were developed based on identified gaps between expert- and lay- explanations of causes of podoconiosis described elsewhere (Allen, et al., 2017). These

gaps included: accurate beliefs about the causes of podoconiosis (e.g., soil exposure, inherited susceptibility), general knowledge of GxE interactions (e.g., having genetic susceptibility does not mean that a condition is unpreventable), misconceptions about causes of the condition (podoconiosis is contagious), self-rated confidence to explain the causes of the condition and willingness to participate in health literacy building. The survey questionnaire was prepared in English, then translated into the local language (Wolytigna), pilot tested and administered by trained data collectors.

3.4 Data collection

Data collection was conducted between August 7 to September 2, 2016. The data were collected by 12 local professionals (6 in each community) who were fluent in Wolaytigna (the main language of the participants) and graduates with diploma and degree level of education. . The data collectors received three days' training covering the basics of podoconiosis, the objectives of the study and its possible impacts; the details of the questionnaire to ensure common understanding; sampling techniques; taking informed consent; and interviewing techniques with mock exercises. Two supervisors oversaw the data collection process, answered queries, reviewed questionnaires for missing data and inconsistencies, and re-administered the questionnaire in a subset of participants. Checks demonstrated that the answers were broadly the same, and the reliability of data collection was not considered to be a problem.

3.5 Measures

Willingness: was measured using four indicators with three scale response categories (1=not willing, 2=undecided, 3=willing e.g., *How willing would you be to volunteer to educate the community about the causes of podoconiosis?*). The total score for each respondent was recoded into dichotomous variable where 0 represents not willing and 1 represents more willing using the

median (11) as a cut point. Cronbach alpha was computed to measure internal consistency among the willingness items with reliability score r=0.95.

Competency score: competency was a composite score drawn from the sum of three variables i.e., high accuracy in GxE knowledge (0-4), low endorsement of misconceptions (0-11), and high score on confidence to explain (9-27). *G x E knowledge* variable was measured using four indicators (four items with true or false responses and scores ranging from 0-4; e.g., *A person who has relatives with podoconiosis will certainly get the disease –(1 point given for having 2 or more correct responses*). Higher score means high knowledge on gene-environment interaction. *Misconception endorsement:* was assessed using 11 indicators with "true" or "false responses *e.g., did not agree with contagion as cause,* with total scores ranging from 0-11. *Confidence to explain* was also measured with 9 items on 3 point scale (agree-1 undecided-2 and disagree-3, e.g., *I am confident that I could explain to other people why some individuals develop podoconiosis and others do not*), *1 point given for agree and 0 for disagree and undecided response.* Thus, the final score of competency variable was measured by adding the three scores ranging from 0 to 24. Competency also was dichotomized into binary values of 0 and 1 (0 for lower competency and 1 for higher competency) at the median point of 13.

Other variables included were self-reported responses on gender (male and female) age (15-24) educational levels (no formal education, and formal education), affected status (yes or no) engagement in extracurricular activities (ye or no), assumed leadership role (yes or no) and contact with health extension workers over the past 12 months (yes or no).

3.6 Data analysis

Data was encoded into SPSS version 20 and imported to SAS 9.4 for analysis. The data entry and quality control of the data was performed prior to conducting the analysis. The data were then reviewed and cross-checked by data analysts. Bivariate associations between predictor variables and dependent variables (competency and willingness) were tested using bivariate tests and correlations. Binary logistic regression model was also used to test the main and interaction effects of covariate with outcome- high willingness.

Chapter 4: Results

4.1. Description of sample participants

A total of 377 youth with age range (15-24) participated in the study with 100% response rate. As presented in Table 1, the mean age of the study participants was 17.7 and standard deviation (SD) 2.3. One hundred eighty-one (52%) of the participants were female. The majority (95%) had formal education. Forty-one participants (10.9%) were affected by podoconiosis or had at least one first degree relative affected. Over half of the respondents (58.6%) reported that they had participated in extracurricular/civic activities and 12% had played a leadership role in civic activities in their community. Forty-four participants (11.7%) reported that they had friends who were affected by podoconiosis while the majority had no friends affected by podoconiosis. Majority (79.8%) said they had been visited by Health Extension workers over the 12 months period.

Table 1: Frequency distribution of the characteristics /participants N=377

Variables		**N**	**%**
Age*	15-16	146	38.73
	17-18	121	32.10
	19-24	110	29.18
Gender	Male	181	48.01
	Female	196	52.0
Educational status	No formal education	19	5.04
	Grade 1-6	81	21.41
	Grade 7-12	264	70.03
	Vocational/college education	13	3.45
Affected status	Affected	41	10.90
	Unaffected	336	89.12
Civic engagement	Yes	221	58.62
	No	156	41.38
Assumed leadership role	Yes	48	12.73
	No	329	87.27
	Yes	44	11.67

Friendship with affected persons	No	333	88.33
Visit by HEWs	Yes	301	79.84
	No	76	20.16

***Mean age = 17.7, Standard deviation (SD) =2.3**

4.2. Which attributes are associated with youths' competency to disseminate GxE explanations of podoconiosis?

Bivariate analysis was done to test differences in competency by each attribute using an independent t-test for binary independent variables and analysis of variance (ANOVA) for three level categorical age. As reported in Table 2, regarding gender, mean competency of males was higher than females by 1.89 units (95% CI, 1.10, 2.68). With regards to educational status, participants who had no formal education had lower competency mean than those who had attended formal schooling (-3.54; 95% CI, -5.35, -1.72). Participants with affected status had lower mean competency than unaffected participants (-1.68, 95% CI -2.99, -0.37). Those who did not participate in civic engagement also had lower mean competency than participants who had experience in civic engagement (-1.85, 95% CI -2.65, -1.05).

As to the leadership role, participants who had not community leadership roles were less competent than those who had experience in playing leadership roles (-1.83; 95% CI -2.11, 0.99). Participants who had no friendship attachment with affected individuals had lower mean competency than those who had friends affected by podoconiosis (-1.63, 95% CI -2.84, -0.38). With regards to contacts with health workers, participants who were seldom visited by the Health extension workers (HEWs) over the prior 12 months period had lower mean competency than those who had contact with HEWs(-2.49 , 95% CI -3.47, -1.42). The overall ANOVA test for age also indicates that competency mean difference among age categories was not statistically significant (F =1.18, P= 0.28).

Table 2: Bivariate association between independent variables and competency

Independent Variables		**Competency Mean (SD)**	**Competency Mean Difference (95% CI)**
Gender	Male	13.66 (3.95)	1.89 (1.10, 2.68)**
	Female	11.77 (3.84)	
Educational status	Formal education	12.85 (3.93)	-3.54 (-5.35, -1.72)**
	No formal education	9.32 (3.83)	
Affected status	Affected	14.51 (3.93)	-1.68 (-2.99, -0.37)**
	Unaffected	12.58 (4.07)	
Civic engagement	Yes	11.59 (3.86)	-1.85(-2.65, -1.05)**
	No	13.43 (3.92)	
Assumed leadership role	Yes	12.04 (5.12)	-1.83 (-2.11, 0.99)**
	No	11.49 (4.18)	
Friendship with affected persons	Yes	10.68 (4.27)	-1.63 (-2.84, -0.38)**
	No	11.68 (4.31)	
Visit by HEWs	Yes	11.77 (4.38)	-2.49 (-3.47, -1.42)**
	No	10.72 (3.94)	
Age	15-16	15.58 (0.49)	(Overall F =1.18 P-value =(0.28)
	17-18	17.56 (0.49)	
	19-24	20.79 1.67)	

****Significant at 0.05 level**.

4.3. Which attributes are associated with youth willingness to disseminate GxE explanations of podoconiosis?

Willingness score was computed using four scale questions which had high internal consistency (Cronbach alpha =0.95). As willingness scores had skewed distributions, a non-parametric Wilcoxon rank-sum (Mann-Whitney U) test was employed to examine associations between independent variables and willingness. As indicated in Table 3, median willingness difference among age categories was statistically significant (overall p= 0.012). Older youth were more willing than younger youth (median older vs median younger, p<0.01). Male participants who attended formal education, those who participated in civic engagement and

assumed leadership roles and participants with high competency were more willing to participate in GxE dissemination p= 0.010, p=0.005, p=0.037, 0.015 and p= 0.001 respectively to other levels of comparison. The finding also showed that median differences on affected status, friendship with affected persons and contact with health extension workers were not statistically significant (p=0.509, P=0.093 and p=0.962)

Table 3: Bivariate association between independent variables and willingness

Variables		**N**	**Median (Q1, Q3)**	**P-value**
Age	15-16	146	10.0 (4.0, 12.0)	0.012**
	17-18	121	12.0 (4.0, 12.0)	
	19-24	110	12.0 (9.0, 12.0)	
Gender	Male	181	12.0 (4.0, 12.0)	0.010**
	Female	196	10.0 (4.0, 12.0)	
Educational status	Formal education	358	11.0 (4.0, 10.0)	0.005**
	No formal education	19	8.0 (4.0, 12.0)	
Affected status	Affected	41	12.0 (4.0, 12.0)	0.509
	Unaffected	336	11.0 (4.0, 12.0)	
Civic engagement	Yes	221	12.0 (4.0, 12.0)	0.037**
	No	156	10.0 (4.0, 12.0)	
Assumed leadership role	Yes	48	12.0 (4.0, 12.0)	0.015**
	No	329	11.0(10.0, 12.0)	
Friendship with affected persons	Yes	44	12.0 (4.0, 12.0)	0.093**
	No	333	11.0 (6.0, 12.0)	
Visit by HEWs	Yes	301	11.0 (6.0, 12.0)	0.963**
	No	76	10.0 (4.0, 12.0)	
Competency	Low	185	10.0 (4.0, 12.0)	0.001**
	High	192	12.0 (4.0, 12.0)	

**** significant at 0.05 level.**

4.4. Do attributes moderate associations between competency and willingness?

4.4.1 Main effects

From results in table 2 and 3, those predictor variables which were significantly associated with competency and willingness were further analyzed using a binary logistic regression model (high vs low willingness) to determine which factors moderate the effect of competency in predicting high willingness. As first step, in this procedure, individual covariates i.e. competency, gender education, leadership role, civic engagement and age category were included in the model to see whether individual main effect of each predictor is significantly associated with willingness. Results in Table 4 showed that the main effects of all predictors were statistically significant ($P<0.05$).

For the main effect, the odds of willingness was 2.3 time higher for the participants with high competency than for those with low competency (Odds Ratio [OR] 2.34; 95% confidence Interval [CI], 1.55, 3.54). Regarding gender, the odds of willingness is 1.95 time higher for males as compared to females (OR 1.95, 95% CI, 1.29, 2.94). For education, the odds of willingness was 6.6 times higher among participants who had attended formal education as compared to those who did not attend formal schooling (OR 6.60; 95% CI 1.59, 23.04). The odds of willingness was 1.96 times higher among participants who had experience in civic engagement as compared to those who had no experience in civic engagement, (OR 1.96; 95% CI, 1.29, 2.96). The odds of willingness is 2.1 time higher among those who had assumed leadership roles as compared to those who did not have leadership roles (OR 2.12; 95%CI, 1.10, 4.03).

Table 4: Individual main effects of covariates on willingness

Effect	DF	Wald Chi-Square	P- value	OR (95% CI)
Competency	1	16.19	<.0001	2.34 (1.55, 3.54)
Gender	1	10.16	0.0014	1.951 (1.29, 2.94)
Education	1	8.75	0.0031	6.60 (1.59, 23.04)
Civic Engagement	1	10.01	0.0016	1.96 (1.29, 2.96)
Leadership role	1	5.09	0.0240	2.12 (1.10, 4.03)
Age category	2	18.31	0.0001	**1 vs 0 =** 1.89 (1.16, 3.08) **2 vs 0**= 3.031(1.81, 5.09)

4.4.2 Interaction effect

In the next step, we proceeded to examine whether the effect of a predictor variable on willingness depends on the level of the other covariates by adding to the model an interaction term. Our findings showed no interaction effect between competency and other variables in predicting high willingness $p>0.05$. Although overall interaction effect was not significant, examining the interaction in a 2 x 2 table and the odds ratios presented in table 5 provide some insight about the associations of competency and willingness varying at different levels of the gender and civic engagement.

For those with low competency the odds of being willing was 1.87 times higher for males compared to females. (OR 1.87; 95% CI, 1.02, 3.40). For those with low competency, the odds of being willing was 2.3 times higher for those who had experience in civic engagement as compared to those who did not have experience in civic engagement.

Table 5 : Results of the model on Interaction effect

Odds Ratio	**Estimate**	**95% CI**
▪ Males vs females at low competency	1.866**	1.022, 3.404**
▪ Males vs Females at high competency	1.595	0.881, 2.889
▪ Formal vs Non formal Education at low competency	3.234	0.881, 11.876
▪ Formal vs Non formal education at high competency	>999.999	<0.001 >999.999
• Civic engagement vs No Civic Engagement at low competency	2.301**	1.267, 4.178**
• Civic engagement vs No civic engagement at high competency	1.306	0.704, 2.423
• Leadership role vs No leadership role at low competency	2.696	0.952, 7.638
• Leadership role vs No leadership role at high competency	1.490	0.645, 3.446

Chapter 5: Discussion and Implication

5.1 Discussion

Findings of this study suggest various attributes that could be considered in identifying potential youth innovators/early adopters to serve as peer health educators. The first question assessed factors influencing competency as an important attribute for peer education. Competency, as defined by (Frank et al., 2010) involves a set of demonstrable skills to enable and improve the efficiency or performance of a task. According to the bivariate analysis, other than age, all other personal and social factors such as gender, education, affected status, friendship with a person affected by podoconiosis, civic engagement and exposure to health extension activities were associated with youths' competence to disseminate GxE messages. Age was not associated with youth's competency. This finding contrasts with other studies showing significant differences in competency by age (Adams, Schvaneveldt, & Jenson, 1979; Remington-Doucette & Musgrove, 2015). This lack of significant association by age could be attributed to the fact that the overwhelming majority (95%) of the youth had attained formal education (73.5% were above the junior school level). In the present study association between competency and formal schooling was evident.

In my second research question, I assessed factors influencing youths' willingness take part in GxE communication. All covariates except affected status were significantly associated with willingness. I found that affected youth were less willing to volunteer than unaffected youth. This finding supports our previous qualitative results that showed social stigma related to podoconiosis impeded patients from social interaction and community participation(Ayode et al.,

2012; Tora, Davey, & Tadele, 2011). Nevertheless, this study has not attempted to explore the self-reported barriers or reasons for these youths' unwillingness to participate in GxE literacy building activities. This finding is inconsistent with the findings from other studies showing that having a condition facilitated peer-led education. For instance, the role of people living with HIV in providing peer support has been widely accepted and encouraged in Thailand for many years(World Health, 2004). Therefore, further evidence is needed to make this finding more conclusive.

Logistic regression results showed that gender, experience in civic engagement, education and competency have independent main effects on youths' willingness to participate in GxE literacy building activities. These characteristics may be relevant for identifying peer educators and inform future training in the context of Podoconiosis. As to gender, the result indicates that on average males had higher competency and willingness to participate than females. Similar results have been found on gender differences associated with youths' willingness to participate in agriculture education program in Nigeria (Fawole Wasiu & Ozkan, 2019). Such gender differences could be reflections of the extant patriarchal and male dominated culture in the study communities as it is the nature of many low- and middle-income countries. Limited exposure of women and girls in civic roles compared to their male counterparts may deter women's interest to volunteer for health literacy efforts in their community. Evidence on gender differences with regard to exposure to podoconiosis has also been established (Alemu, Ayele, Daniel, Ahrens, & Davey, 2011; Molla, Tomczyk, Amberbir, Tamiru, & Davey, 2012b). These studies suggest that odds of exposures to podoconiosis are higher for females than males, due in part to less frequent shoe-wearing by girls. Although enlightening both males and females on GxE influences is crucial, encouraging more females on

GxE education platforms may contribute to enforce effective peer communications among high risk girls and women. This implies the need to provide considerations to use efficacious strategies to enhance the capacity of girls in the involvement of literacy building activities. It also points to the importance of pre-deployment training for these groups to building their confidence in GxE literacy building activities.

Educational status was one of these attributes that was independently associated with willingness to serve as peer-educator. Respondents who attended formal schooling were more willing to participate in literacy building activities. This indicates that educated young people are more likely to understand the concepts of health messages and to confidently disseminate information. This finding was consistent with past research about qualities of peer educators for HIV prevention in South Africa (Mason-Jones, 2011; Beatrice et al. 2005). It also indicates the importance of integration of intervention in school setting as alternative pathway to disseminate GxE information. However, in a logistic model, education had no significant association with youths' competency and willingness. This contrasts with other findings (Alainati, Alshawi, & Al-Karaghouli, 2010; Mohsin, Nath, & Chowdhury, 1996). This might be due to dichotomized analysis used (educated and not educated). It might be worth evaluating to see the influence of education on the competency and willingness in primary, secondary, college and vocational training levels.

The positive and strong correlation found between competency and willingness suggest the importance of employing recruitment strategies to identify peer educators who have the motivation and confidence to explain GxE messages to their peers. According to the Social Cognitive Theory, this can be explained by individual's self-efficacy and its association with intent to action (Bandura, 1991). For example, similar results have been documented about the

importance of boosting self-efficacy of the youth to increase their likelihood of taking actions ((Nishisaki, Keren, & Nadkarni, 2007). My finding therefore provides insight to exploit the link between self-efficacy and behavior by building a prevention program that emphasizes skills-building through training about gene-environment interaction in the prevention of podoconiosis, rather than the traditional knowledge-only approach.

Another interpretation of the positive correlation which is apparent in this study relates to the notion that recruiting young people who have the competence in social mobilization gives credence to their willingness to take part in GxE literacy building. Evidence supports the assertion that competency is antecedent to voluntary participation(Charatsari, Kitsios, Stafyla, Aidonis, & Lioutas, 2018). For instance, a recent study by (AlSaif et al., 2020), on participation of medical students on COVID-19 in Saudi Arabia found positive moderate correlation between willingness to work as part of the healthcare workforce during the pandemic and self-perceived competence score. This finding also gives rational evidence for intervention planners in limited resource settings to recruit those willing youths which might be easily accessible where establishing robust competency measures are hardly available. Nevertheless, such a notion needs to be supported by objective measurement of competence and a longitudinal study to establish the direction of the association. Since there is limited evidence about antecedent effect of willingness to competency and vice versa, more research should be done in this aspect to make this assertion more conclusive.

The findings also indicated a positive association between young people's civic experience and their willingness to participate in the dissemination of health messages. This finding is consistent with other research (such as, Nsikak-Abasi A. Etim & Edet J. Udoh, 2018). It implies that participation in civic engagements (extracurricular activities) may give youth the

opportunity to acquire confidence and skills that enhance their willingness to help disseminate GxE messages. Additionally, nearly 60% of youth reported experience in civic engagement that also enhanced willingness. This finding also informs intervention planners to consider attributes of peer educators related to experience in civic engagement such as youths in school club leadership, youth associations, religious group activities, etc. to optimize diffusion of GxE messages for preventing podoconiosis.

5.2 Strengths and Limitations

A notable strength of the study was that 100% of youth identified for the sampling frame agreed to and completed the survey. Survey items related to competency were developed based on a mental model exercise with experts and lay people. This is also the first study to address these questions by designing competency measures in the context of podoconiosis.

Limitations also should be noted. The sample was drawn from only two districts and results may not be generalizable to other settings. The survey also did not assess youths' opinions about the characteristics of potential disseminators – this information might be important in the future, as might triangulation with more comprehensive parent and community data. Additional attributes that we did not assess related to broader socio-economic factors such as: marital status, family economic status, could be explored to get further evidence on characteristics of youth influencing their role in GxE literacy building. Education measures should be improved to measure different academic levels rather than the binary data.

5.3 Implication and recommendation

Improved understanding of factors that influence youth's willingness to participate in efforts to prevent podoconiosis and related stigma can inform local institutions/interventions to

foster youths' voluntary participation in civic engagements with sustainable strategies. However, sustainability is a crucial issue to be considered while using volunteers in resource-limited settings. It is important to recognize the motives driving young volunteers to be willing to take part in community services. Considering structured alternative incentives in the form of training, public recognition, or provision of materials may be essential to minimize volunteer attrition rates. Studies have documented attrition as major problem for voluntary services in LMICs (Kironde and Klaasen, 2002; Cornish, 2006). It will be important to identify and implement appropriate alternative incentives to motivate young people and sustain their participation in the dissemination of information in podoconiosis endemic areas.

Identifying potential attributes that promote literacy-building activities have implications for understanding factors that could undermine youths' willingness to participate as lay health advisors /disseminators. In our study we have not assessed barriers that could affect youths' willingness to play the role of peer health educators in disseminating GxE information on podoconiosis. However, exploring barriers could lend to understanding the context of personal and social determinants influencing the level of participation. It will also inform the intervention partners to take contextually feasible strategies to maximize youths' participation in GxE communication. This needs to be considered for future studies. This assertion is in congruence with the findings of Cano J. & Bankiston J.(1992) regarding determinants of non-participation of minority ethnic youths in 4-H program.

The findings from this research demonstrate that it may be feasible to assess competency of youth as volunteers to disseminate GXE information and inform training. Concurrently with identifying these attributes, it is also worthwhile to pay attention to strategies and procedures to recruit potential youths who would play this role. Evidences suggest that multi -prong

approaches could be used in implementing various community based initiatives for recruitment young volunteers in similar settings including words of mouth procedures, large community awareness meetings and small group meeting with youths to provide specific information about the purpose of recruitment .

Providing potential volunteers with more accurate information [including about potential difficulties] about participation in GxE enables volunteers to make better informed decisions about the necessary commitment and the challenges in participation. Thus, to avoid potential disenchantment, any benefits might be counterbalanced with an honest report of potential challenges. Moreover, identifying essential community settings such as schools' clubs and religious institutions- where extracurricular activities of youth are apparent will give possible access to recruit target youth who have better social skills and leadership roles.

Given the scant body of research on voluntary participation of the youth as lay health advisors to disseminate GxE information in podoconiosis, the present study may shed light on understanding potential attributes required to recruit youth volunteers for similar interventions in other Neglected tropical diseases (NTDs). Studies show that misconceptions about the joint contribution of gene and environmental factors in causing podoconiosis is apparent in the endemic communities(Molla, Tomczyk, Amberbir, Tamiru, & Davey, 2012a; Yakob et al., 2008; Yakob, Deribe, & Davey, 2010). (Ref). This study, therefore, reinforces the existing body of knowledge in on how to engage local youths as purveyors of information in the process of eradicating podoconiosis. It also provides alternative understanding about factors influencing youth's willingness to participate in community-based health education. It also serves as a source of generating hypothesis for future studies on analysis the feasibility of training youths in GXE

communications, identifying Potential enablers and barriers for engaging youth in this endeavor. The study is also specifically beneficial to institutions in the study location as a supporting document /reference to identify youth groups for interventions on podoconiosis prevention in Wolaita Zone.

As way forward for intervention planners, the next step to this study would be designing and evaluating the feasibility of targeted intervention on literacy building training abut GxE communication to capacitate youth volunteers identified through these attributes and recruitment procedures. Piloting the Integration of GxE information with behavior change communication approaches need to be evaluated in small scale intervention and for future upgrading in community-based large-scale program. Applying the DOI's peer education model, this intervention should encompass recruitment of peer disseminators, appropriate curriculum development, literacy building training for peers and evaluation. Lastly, it should also be noted that this study has not exhaustively covered all factors which might influence youths reported competency and willingness to take part in in GXE dissemination. Qualitative study is also recommended to better understand and explore the opinion of peers about the potential attributes of youth disseminators and their preferences. Further assessment might also be needed to identify the role of other socio-economic background attributes such as parental education, economic status, marital status as well as potential motivators to reinforce evidence-base for enhancing efforts in podoconiosis prevention through GxE communication campaign.

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Annex : A 2x2 table showing willingness moderated at various levels of gender and civic engagement

Competency by Gender

Table 1 of comptbinary by Gender

Controlling for willingbinary=0

Frequency
Percent
Row Pct
Col Pct

comptbinary	Gender 0	Gender 1	Total
0	72 40.91 67.92 67.29	34 19.32 32.08 49.28	106 60.23
1	35 19.89 50.00 32.71	35 19.89 50.00 50.72	70 39.77
Total	107 60.80	69 39.20	176 100.00

Table 2 of comptbinary by Gender

Controlling for willingbinary=1

Frequency
Percent
Row Pct
Col Pct

comptbinary	Gender 0	Gender 1	Total
0	42 20.90 53.16 47.19	37 18.41 46.84 33.04	79 39.30
1	47 23.38 38.52 52.81	75 37.31 61.48 66.96	122 60.70
Total	89 44.28	112 55.72	201 100.00

(Row percentage) For those with low competency the odds of being highly willing is 1.87 times higher for males as compared to females. (OR 1.87; 95% CI, 1.022, 3.404)

Column percentage. For females the odds of being high willing is 2.30 times higher for those with high competency compared to low competency.

Competency by Civic engagement

Table 1 of comptbinary by civicengagement2

Controlling for willingbinary=0

Frequency
Percent
Row Pct
Col Pct

comptbinary	civicengagement2 0	civicengagement2 1	Total
0	62 35.23 58.49 70.45	44 25.00 41.51 50.00	106 60.23
1	26 14.77 37.14 29.55	44 25.00 62.86 50.00	70 39.77
Total	88 50.00	88 50.00	176 100.00

Table 2 of comptbinary by civicengagement2

Controlling for willingbinary=1

Frequency
Percent
Row Pct
Col Pct

comptbinary	civicengagement2 0	civicengagement2 1	Total
0	30 14.93 37.97 44.12	49 24.38 62.03 36.84	79 39.30
1	38 18.91 31.15 55.88	84 41.79 68.85 63.16	122 60.70
Total	68 33.83	133 66.17	201 100.00

Raw percentage: For those with low competency, the odds of being highly willing is 3.02 times higher for those who had experience in civic engagement as compared to those who don't have experience in civic engagement.

Column percentage. For participants who had experience in civic engagement, the odds of being highly willing is 2.30 times higher those with high competency as compared to low competency.