How Social Interaction Shapes the Prevalence and Knowledge of Hypertension: A Longitudinal Analysis of Mature Adults in Rural Malawi

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Abstract

Hypertension has been a rising burden that influences the health of Malawians. The World Health Organization (WHO) predicted that the health burden of hypertension will double between 2000 and 2025 in this poor country. Faced with challenges brought by high blood pressure, understanding mechanisms behind the prevalence and knowledge diffusion of this disease becomes essential. This study focuses on mature adults (age 45 and above), and analyzed the association between social interaction and the prevalence and knowledge of hypertension, from the perspective of social engagement and upward intergenerational transmission. Meanwhile, the duration of the association is also tested. Using data from the latest three waves (2012, 2013 & 2017) of Malawi Longitudinal Study of Family and Health (MLSFH), I find that the association between social interaction and the prevalence of hypertension is short-term. The frequency of social activity participation is negatively associated with being hypertensive while the number of adult children living in urban areas is positively associated with having high blood pressure. An interesting gender effect of adult children with the highest education is found: when a mature adult has a female child with the highest education level in the household, this mature adult is more likely to be hypertensive. On the other hand, I find that the association between social interaction and mature adults' knowledge of hypertension is long-term and mainly comes from adult children's education, which is positively associated with mature adults' knowledge of high blood pressure. The gender effect of adult children with the highest education observed in the analysis of prevalence is also found in knowledge. If a mature adult has more than one adult child with the same high level of education and the gender of the adult children are opposite, this mature adult will be likely to list more number of correct symptoms of hypertension.

1. Background

1.1. Social Interaction Theory

Human beings, as social animals, are embedded in various networks and other structures of social relationships (Granovetter 1985). Interactions within social groups generate influence that shapes individual's thoughts and behaviors (Montgomery & Casterline 1996). As a result, individuals do not make decisions about demographic and social behaviors independently, but with people in their social networks who share information, resources and a common understanding of norms (Kohler et al. 2015). The influence of social interaction is particularly important when innovation or environmental changes emerge in social and economic circumstances and individuals are not clear about what is the best response (Kohler et al. 2007). Under this condition, information diffusion may take place when the adoption of innovative ideas and corresponding behaviors by individuals influences the likelihood of such adoption by others in their social networks (Montgomery and Casterline 1996).

Two main mechanisms through which changes in social environments and information diffusion within social networks influence personal behaviors are well defined: social learning and social influence (Montgomery and Casterline 1996). Social learning refers to behaviors changes caused by prevailing opinions and attitudes in individuals' social networks. Within these social networks, the exchanges and evaluations of information and ideas are frequent, and the approval and disapproval of other members of the network is particularly meaningful (Bongaarts and Watkins 1996). Social influence means individuals collect information from social interaction to cope with uncertainties in social environment changes. Social influence can be formed among families and peers, and sometimes can be expressed as a form of social conformity when the influence comes from individuals in high social hierarchies (Montgomery and Casterline 1996).

Due to the importance of community in people's everyday life, those contextual factors may influence the individual through two pathways: (a) via a direct effect on individuals through social engagements, and (b) via an indirect effect by shaping and changing the structures and contents of social institutions and systems of interaction such as family (Esser,1996). Furthermore, the durations of social interaction effects may also vary. It is plausible to hypothesize that some factors of social interaction may affect people's thoughts and behaviors longer while others shorter. A study looking at how fertility behaviors spread among friends found that the effects of social interaction are strong only within a certain period of time and then gradually decrease (Balbo and Barban, 2014). However, variations in the duration of social interaction effects have not been well studied.

The study of how social interaction shape people's thoughts and health behaviors has started since the past several decades, and covers various topics in demography. For example, it helps to analyze changes in fertility level and the global promotion of family planning. When modern contraception was just introduced, many couples were uncertain about the risks and results of using new contraception methods. Social interaction played the role of diffusing information about opinion about modern contraception and experiences of early adopters in social networks (Kohler 1997). Social influence mechanism was dominant as the social interaction normally here took place in the form of informal talks among women about family planning and family size, and information that women gained from these informal discussions influenced their fertility-related behaviors (Montgomery and Casterline 1993; Entwisle et al. 1984; Rutenberg and Watkins 1997; Watkins 2000; Kohler et al. 2001).

On the other hand, the effects of social interaction were studied to explain changes in individuals' knowledge of new diseases and corresponding health-related behaviors. For example, HIV/AIDS is a relatively new life threat to human beings. People's knowledge of infection risks and prevention prescriptions is unambiguous and has large variation, especially those living in sub-Saharan Africa where economic development is low while HIV/AIDS prevalence is high. In this case, interaction among partners in social networks may help diffuse knowledge of this new disease and spread practical prevention strategies. A study using fixed effects analysis based on longitudinal data collected in 1998 and 2001in Malawi shows that social interaction on the subject of HIV/AIDS has significant and substantial effects on the respondents' knowledge of the risk of HIV/AIDS, even after controlling for unobserved factors that affect the selection of social networks (Helleringer & Kohler 2005). Another study using longitudinal data collected in rural Kenya and Malawi found that social networks had strong influence on probability of spousal communication about HIV/AIDS risks and might amplify the effects of programs that aim at increasing individual's information about HIV/AIDS and their assessment of their own risks (Kohler 2007).

1.2. Social Interaction and Hypertension

1.2.1. Hypertension in Malawi

Hypertension is defined as systolic blood pressure equal to or above 140 mm Hg and/or diastolic blood pressure equal to or above 90 mm Hg. Normal levels of both systolic and diastolic blood pressure are particularly important for the efficient function of vital organs such as the heart, brain and kidneys and for overall health and wellbeing. Hypertension contributes to the burden of heart disease, stroke and kidney failure and premature mortality and disability (WHO, 2013).

In sub-Saharan Africa (SSA), the burden of infectious diseases is still high and outweighs that of non-communicable diseases (NCD). But even in this region, NCDs are now major sources of morbidity and mortality (Greenberg et al. 2011; United Nations, General Assembly 2011) and the burden will overtake that of infectious diseases by 2035. These burdens are also more common in rural communities (Nyirenda, 2016). Hypertension is one of the main NCDs that disproportionately affects populations in SSA where health systems are weak. A national survey from 2009 revealed that the prevalence of hypertension was 33% in Malawi. This condition is likely to be even more common because of the lifestyle changes resulting from population transition and urbanization (Msyamboza et al, 2011; World Health Organization 2010; Yach et al. 2004). The World Health Organization predicted that the health burden of hypertension will double between 2000 and 2025 (WHO, 2013). Therefore, hypertension has become a rising burden that influences the health of Malawian people.

As stated above, the effects of social interaction processes will be particularly important when an individual is uncertain about the best response to an innovation or environmental change or to new social and economic circumstances (Kohler *et al.*, 2007). Therefore, faced with hypertension, a relatively new disease in Malawi, individuals are very likely to seek information about it through social interaction to increase knowledge of this disease and develop preventive behaviors to reduce the risks of being hypertensive.

1.2.2. Empirical Findings

Unlike people who suffer from diseases with obvious symptoms, most hypertensive patients do not have any obvious symptoms. Most symptoms of hypertension can be easily confused with other chronic diseases (WHO, 2013). Ostchega et al. (2007) found that in U.S., a quarter of people who have high blood pressure are not aware of their conditions and more than half are uncontrolled. The asymptomatic nature of hypertension makes individuals less likely to seek treatment because of discomfort or declining function (Cornell & Waite, 2012). Therefore, daily interaction with members in social networks by going to social places and communicating with families may be important sources of information for people to gain a better understanding of hypertension and pay attention to their own blood pressure levels.

As defined in the theoretical framework in the previous section, social interaction shapes individuals' thoughts and health behaviors through two pathways: (1) social engagement, and (2) changes within social institutes such as family (Esser, 1996). Many studies have documented the association between social engagement and people's blood pressure conditions as well as knowledge of hypertension. Although how changes in social institutes shape hypertension have not been well documented, many related studies use upward intergenerational transmission as a measure of social institutional changes and demonstrate that adult children's socioeconomic outcomes are good predictors of their older parents' health outcomes, which provides valuable empirical foundation for this analysis.

In terms of social engagement, frequencies of communicating with friends and going to social places are directly associated with blood pressure level (Beaglehole et al. 1977; Gorman & Sivaganesan 2007). Lack of social interaction will lead to loneliness and people's loneliness predicts significant increase in systolic blood pressure in the long run (Hawkley et al. 2010). For people who have already been hypertensive, active social engagement has positive impacts on the knowledge of high blood pressure. Frequency of contact with family and friends or neighbors is related to self-awareness of being hypertensive (Redondo-Sendino et al. 2005). The risks of undiagnosed and uncontrolled hypertension are lower among hypertensive people with larger social networks (Cornwell & Waite 2012).

As for upward intergenerational transmission, a growing body of literature started to look at how adult children's socioeconomic status (SES) is associated with older parents' health outcomes. Adult children constitute a significant aspect of their parents' social network, and the structural conditions facilitate transmissions of resources between the generations (Torssander 2013). Adult children's education attainment is the most analyzed indicator for their SES. As mentioned earlier, even though many of the studies did not use blood pressure as a measure of health outcome, possible associations between adult children's SES and their parent's hypertension conditions can still be inferred. Using data from multiwave Survey of Health and Living Status of the Elderly in Taiwan, Zimmer et al. (2007) found that the education of adult children was positively associated with their parents' survival and hypertension was included as one of the main causes of mortality in this study. Many other studies also found the positive association between adult children's education and parents' health and mortality (Torssander 2013; Friedman and Mare 2014; Yahirun et al. 2016). Highly educated children might provide parents with informational support (Torssander, 2013), which could include advice about specific health-care services and health-related behaviors (Yahirun et al. 2016). Högberg et al (2012) found that adult children's risk of being hypertension was associated with low parental socioeconomic status but that it could be modified by children's social status later in life, and the reduction in risks could be attributed to public health or political interventions. In many cases, those interventions will be more accessible if the children have higher education or live in urban areas. In turn, children who have lowered their risks of hypertension may influence their parents' hypertensive conditions by diffusing the information and knowledge they get from the interventions. Whether this influence exist in the rural Malawi context is an important question that this paper aims to answer.

1.2.3. Gaps in the Literature

Most previous studies focused on populations in developed countries and few of them were conducted in the context of developing countries. However, different socioeconomic conditions may limit the generalization of empirical findings in low-income settings. For studies that were conducted in SSA, they researched on the whole population of all ages, and few of them used people in older age groups as the subject. However, with an increasing number of people in Malawi living to older ages and higher prevalence rate of hypertension among older adults, studying the older population will be essential to understand prevalence and knowledge of hypertension. In addition, most of prior studies used cross-sectional data, which makes measuring the duration of the association between social interaction and hypertension impossible. However, based on the results of previous study, it is reasonable to think that the length of the associations between different social interaction factors and hypertension will be different. Finally, the association between upward intergenerational transmission and hypertension has not been well studied, as most of previous literature mainly focused on social engagements and those studied upward intergenerational transmission did not directly use blood pressure as a measure of health outcome.

1.2.4. Research Goals

This paper seeks to fill these gaps. In the first place, the background of this study is set in rural Malawi, one of the poorest developing countries that is ranked 174 of 187 in terms of the human development index (UNDP 2014). This context offers a unique perspective to look at how social interaction shapes people's health outcomes and knowledge of NCDs in a low-income setting. Secondly, not only social engagement but also upward intergenerational transmission is examined in the analysis, which aims to contributing to the insufficient literature. Thirdly, the research subject in this study are mature adults (aged 45+). Because of the shorter life expectancy and earlier onset of morbidity, 45 is used as a cut-off age for defining people who start to face fragile health and potential chronic conditions. Last but not least, attributed to the longitudinal nature of data, the durations of social interaction are also examined, which will serve to enrich the literature of long- and short-term association between social interaction and the prevalence and knowledge of hypertension.

There are three main research questions in this study. First of all, how Malawian mature adults' social engagement is associated with the prevalence and knowledge of hypertension? Second, what is the role of upward intergenerational transmission from adult children in shaping the prevalence and knowledge of high blood pressure among mature adults in Malawi? Third, is the association between social interaction and hypertension, either from social engagement or upward intergenerational transmission, short-term or long-term?

2. Data and Method

2.1. Data

This study uses data from the Malawi Longitudinal Study of Family and Health (MLFSH), a nationally representative, longitudinal cohort study of rural population in Malawi. Started in 1998, MLFSH collected data about health, family dynamics, social networks, and HIV prevalence in rural sub-Saharan Africa (SSA), which is characterized by poor health conditions, over-burdened and under-staffed health facilities and schools, low living standards and unmet nutritional and elderly care needs. MLFSH is now one of a very few long-standing longitudinal cohort studies in a poor SSA context and provides information about demographic, socioeconomic and health conditions in one of the poorest countries over a decade (MLSFH 2013). The analysis for this study includes data from three survey waves that include information of social interaction and blood pressure: 2012, 2013 and 2017. Blood pressure was measured in 2013 and 2017 and information of social interaction were captured in 2012 and 2017.

2.2 Analytic Sample

In 2013, 1124 respondents were measured for blood pressure. Among these respondents, 1079 of them were followed up in 2017. Because this analysis requires both current and past blood pressure, only 1079 observations are kept. In addition, as mature adult is the research subject, 25 observations who are aged below 45 are dropped. This step yields a sample size of 1054. Meanwhile, as one of the research goals is to examine the duration of the association between social interaction and hypertension, the sample is also restricted to observations who participated in both 2012 and 2017 survey to ensure that social capital information in two different years are captured. This step further refines the sample size to 1010. Among these 1010 observations, 18 of them have incomplete information in key variables of interest and thus are deleted. Therefore, the final sample size is 992 (N=992).

2.3 Measures

2.3.1. Outcome Variables

This analysis includes two key outcome variables to measure the prevalence and knowledge of hypertension among mature adults: current blood pressure, and correct symptoms of hypertension listed. Blood pressure was measured by using an upper arm automated blood pressure Omron HEM-780N monitor and following the procedures of Health and Retirement Study (HRS) in the United States. Each respondent's blood pressure was measured for a total of three times. Both systolic and diastolic blood pressure is calculated based on the average of the three blood pressure measurements (Kohler et al 2016). The threshold of hypertension is based on WHO standard: systolic blood pressure equal to or above 140 mm Hg and/or diastolic blood pressure equal to or above 90 mm Hg (WHO 2013). As mentioned in the previous section, blood pressure was measured in 2013 and 2017. Therefore, two dummy variables are generated: whether being hypertensive in 2013 (Yes =1) and whether being hypertensive in 2017 (Yes =1). What needs to note is that only 'whether being hypertensive in 2017' is used as an outcome variable and 'whether being hypertensive in 2013' will be used to further group respondents based on blood pressure history and estimate whether the impacts of social interaction vary between people who have different blood pressure histories.

Another important outcome variable, correct symptoms of hypertension listed, is based on the 2017 survey question "Can you tell me some symptoms of hypertension?" and options are "Hypertension doesn't have any symptoms", "Headaches", "Shortness of breath", "Nosebleeds", and "Other, specify". The first four symptoms are correct. No specific information about "Other, specify" is recorded in the data. Therefore, we take it as not answered if the respondent had already listed one correct symptoms and as wrong if the respondent did not choose any of the correct symptoms. Therefore, the number of correct symptoms each respondent can list is among 0, 1, 2 ,3 and 4. Based on the distribution of the variable, no respondent listed all 4 correct symptoms and only 6 of them listed 3. As a result, this variable is categorized into three groups: 0, 1, 2 or more.

2.3.2. Explanatory Variables

2.3.2.1. Social Engagement

This study includes two measures of social engagement: frequency of participating in social activities in the last month and membership of village committees. These two variables are included in the 2012 and 2017 survey. The assumption is that higher frequency of social activity participation and being a member of village committees will help mature adults collect information and knowledge about hypertension and learn experiences from individuals who are diagnosed and treated in their social networks. "Frequency of attending social activities during the past month" is measured in the survey by asking "How many times in the last month have you been to?" and options include "A funeral", "A drama performance", "A beer place", "A place where people dance", "A market" and "A political meeting". "Membership of village committees" comes from the survey question "Are you a member of the following village committees?" and options include "Village development committee", "Health committee", "Funeral support committee", "Market development committee", "Village organization committee", "Local development committee", "AIDS committee" and "Other, specify".

I construct a categorical variable "Total number of social activity attendances" for both survey years by summing up the frequency of going to different social places during the past month for each respondent in that year and then dividing it into four groups at approximate quantiles (1 = 0-2 times, 2 = 3-5 times, 3 = 6-8 times, and 4 = greater than 9 times). For membership committees, a dummy variable “Whether being a member in any village committee” (Being a member of at least one village committees =1) is generated for both survey years, as the descriptive analysis shows more than half of the respondents (68%) were not members of any village committees in 2017 and the proportion is 86% in 2012.

2.3.2.2. Upward Intergenerational Transmission

This study includes two key measures of upward intergenerational transmission: highest education level of adult children in each household, the residential location of adult children. These two variables are included in the 2012 and 2017 survey. The assumption is that higher education and living in an urban area may give adult children more exposure to knowledge of hypertension and in turn shape their older parents’ thoughts and behaviors towards hypertension. Observations for these two variables are restricted to those whose relationships with respondents are “Son” or “Daughter” and are aged over 18 years old. “Highest education level of adult children in each household” is based on the survey question “What is [Name]’s highest schooling level?” and options include “Never attended school”, “Finished school, standard”, “Finished school, form”, “Finished school, higher”, “Still in school, standard”, “Still in school, form” and “Still in school, higher”. In Malawian education system, standard school equals to primary school, form school represents middle and high school, higher refers to college and above. “Residential location of adult children” comes from the survey question “Where are [Name] living?” and options are “Same household”, “Same compound”, “Same Traditional Authority”, “Same district”, “Lilongwe”, “Blantyre”, and “Elsewhere”. Since the MLSFH data is collected in the context of rural Malawi, we can assume that “Same compound”, “Same Traditional Authority” and “Same district” mean adult children are living in a rural area. “Elsewhere” is assumed to be rural as well. “Lilongwe” and “Blantyre” are two main cities in Malawi and represent urban areas.

I firstly constructed a categorical variable “Highest level of education of adult children in the household” for both survey years by combining adult children at the same education level, regardless of finished or attending (e.g. combine “Finished school, standard” and “Still in school, standard” as “Standard”). Therefore, there are four categories for this variable (0 = “Never attend school”, 1 = “Primary school”, 2 = “Middle school”, 3 = “College and above”). However, after looking at the distribution of this variable, very few observations are in the first and last group. Therefore, I further construct a binary variable (1= “Middle school or below”, 2= “College and above”) by combining the first two groups and the last two groups. Meanwhile, I also look at the gender of the adult children with highest education (0 = Male, 1 = Female, 2 = Both – more than one adult child has the same highest education level and their genders differ), and the total number of adult children in each household. In terms of adult children’s residential location, a categorical variable “Number of adult children living in urban areas in the household” (0 = No adult children living in urban areas, 1= Have one adult child living in urban areas, 2= Have two adult children living in urban areas, 3= Have three or more adult children living in urban areas) is generated for both survey years.

2.3.2.3. SES and Demographic Characteristics

The study utilizes several indicators of respondents’ SES. Education attainment is involved as a dummy measure (Ever attended school =1), considering the overall low education level of the respondents. Income is estimated by the question “During last completed week, did you spend any time doing something to earn income” and a dummy measure is generated (Yes =1). Moreover, respondents’ marital status is also included as a dummy (Married =1) and all other status except married are categorized into one group. There are some basic demographic variables as well. Age is included as a categorical variable. Based on the distribution of respondents' age, I divided them into five age groups based on the approximate quintile of age distribution (1 = 45-49, 2 = 50-64, 3 = 65-69, 4 = 70-74, and 5 =75 and above). Gender (female =1) and region (1 = Mchinji, 2 = Balaka, and 3 = Rumphi) are also included.

2.4 Method

Logistic regression models are used to analyze the association between social interaction and the prevalence of hypertension, and ordered logistic regression models are used to examine the association between social interaction and the knowledge of hypertension. The way how models are constructed is the same for both regressions. In order to compare long-term association and short-term association between social interaction and the prevalence and knowledge of hypertension, two sets (three for each set) of logistic regression models are built. Model 1-3 look at the short-term association by only involving social interaction measures in 2017. More specifically, Model 1 only includes social engagement: frequency of participating in social activities in the last month, and membership of village committees. Model 2 only includes upward intergenerational transmission: highest education level of adult children in each household (gender and number of siblings of the most educated adult child are also included), and the residential location of adult children. Model 3 includes both social engagement and upward intergenerational transmission. All these three models control for respondent's age, gender, marital status, region, education attainment and income (N=912). Model 4-6 are constructed in the same way but look at the long-term association of social interaction by only involving social interaction measures in 2012. After determining the association between social interaction and current blood pressure level is long-term or short-term, two additional logistic regression models (Model 7 and Model 8) are constructed to test if this association (either short-term or long-term) vary between respondents who were and were not hypertensive in 2013. Model 7 only includes respondents who were hypertensive in 2013 while Model 8 includes those who were not hypertensive in 2013.

3. Results

3.1. Descriptive Statistics

Table 1 displays the descriptive statistics of the sample (N=992). The mean age of the sample is 63, which satisfies the research object of studying hypertension among mature people who face higher risks. Females consist 59% of the sample. Proportions of observations from each survey region are approximately the same, which ensures that the sample is regionally representative. 71% of observations in the sample are currently in marriage and 69% of them have attended school. The sample is characterized as low-income, as only 27% of observations earned money by any form of work during the past week.

Table 1 also shows social interaction in both 2012 and 2017, and results of Pearson's chi squared test shows that it is significantly different between these two years. Compared with that in 2012, the proportion of respondents were members of at least one village committee in 2017 is significantly higher (p-value=0.027). The distribution of social activity attendance level between two survey years is also significantly different ($p<0.001$). From 2012 to 2017, the proportion of lower frequency groups all increased and that of the highest frequency group (≥ 9times) dropped from 36% to 23%. In terms of upward intergenerational transmission, the highest level of adult children's education significantly improved (p=0.001). The proportion of middle school and above increased from 56% to 58% and that of primary school or below decreased from 44% to 42%. Male adult children are more likely to be the one with the highest education in both survey years and the probability of having adult children of opposite sex with the same highest education level significantly decreased ($p<0.001$). The total number of adult children in each household between 2012 and 2017 significantly increased from 3.78 to 4.75 ($p<0.001$). As for the number of adult children living in urban areas in each household, between 2012 and 2017, the proportion of households have two adult children living in urban areas significantly increased and that of households have no adult children living in urban areas significantly decreased ($p<0.001$).

In terms of hypertension prevalence, 43% of the observations in the sample were hypertensive in 2017 while the number in 2013 is 40%. However, z-statistics (not shown) displays that the different in prevalence rate between these two years is not significant at 95% confidence level ($p=0.11$). As for the total number of correct symptoms of hypertension listed, the mean is 0.84 and 33% of the sample cannot list any correct symptoms.

3.2. Prevalence of hypertension

3.2.1. Short-term Association

In Model 1, being a member of at least one village committee in 2017 is positively associated with being hypertensive, as the odds ratio is greater than 1. However, the positive association is not statistically significant ($\alpha=0.05$). In terms of levels of social activity participation frequency, comparing with respondent who participated in social activities 0-2 times during the past month, those who participated 3 or more times were less likely to be hypertensive and the difference is marginally significant for group 3-5 times and statistically significant for group 6-8 times and greater than 9 times. As we can see, odds ratios of three groups with higher social activity participation are quite close and thus the strength of association between social activity participation and whether being hypertensive in 2017 in these groups are similar.

In Model 2, the number of adult children living in urban areas in each household is positively associated with being hypertensive. Particularly, comparing with respondents who have no adult children living in urban areas, those with three or more adult children living in urban areas are significantly more likely to be hypertensive, increasing the odds by 62%. As for the highest education attainment of adult children in each household, it is also positively associated with being hypertensive. Comparing with respondents having adult children whose highest level of education is primary school or below, those having adult children whose highest level of education is middle school and above are significantly more likely to be hypertensive, increasing the odds by 45%. An interesting finding is that the gender of adult children with the highest education attainment has significantly positive association with being hypertensive when the gender is female ($\alpha=0.01$). In other words, comparing with respondents with son as the adult child with highest education level, those with daughter as the adult child with highest education level are significantly more likely to be hypertensive, increasing the odds by 67%. The total number of adult children in the household is not significant.

In Model 3, when controlling social engagement and upward intergenerational transmission in 2017 together, the positive association between being a member of at least one village committee and being hypertensive is still not significant. The negative association between being hypertensive and frequency of participating in social activities is significant at 95% confidence level for group 6-8 times and greater than 9 times. As we can see from the odds ratios, the association between social activity participation and prevalence of hypertension is slightly strengthened in this model. The positive association between the number of adult children living in urban areas and being hypertensive is mildly attenuated but is still significant for respondents who have 3 or more adult children living in the city. The positive association between highest education attainment of adult children and being hypertensive becomes only marginally significant but the association is only slightly attenuated. The interesting gender effect from adult children with the highest education attainment remains (α=0.01), and the total number of adult children is still not significant.

In Model 1-3, respondents' age level is positively associated with being hypertensive and the association is significant across all age groups, which means the prevalence of hypertension increases with age and being female is positively associated with being hypertensive. These results are consistent with findings of many previous studies. Meanwhile, whether spent some time working to earn money during the past week is also negatively significant, which is plausible as people with better health conditions will have higher chance to go out and earn money.

3.2.2. Long-term Association

In Model 4, being a member of at least one village committee in 2012 is also positively associated with the being hypertensive. However, the positive association is not statistically significant. No statistically significant results are found in the frequency of social activity participation neither.

In Model 5, the number of adult children living in urban areas in each household in 2012 is negatively associated with the probability of being hypertensive. However, the negative association is not statistically significant. As for the highest education attainment of adult children in each household in 2012, it is positively associated with being hypertensive as we observed in Model 2 but the association is not significant. The gender effect of the adult children with the highest level of education is not observed and the total number of adult children in the household is still not significant.

In Model 6, when controlling social engagement and upward intergenerational transmission in 2012 together, all indicators of both social engagement and upward intergenerational transmission are not statistically significant as we observed in Model 4 and Model 5.

In Model 4-6, respondents' age level in 2012 is positively associated with being hypertensive and the association is significant across all age groups, which is the same as the result we observed in Model 1-3. Meanwhile, whether spent some time working to earn money during the past week in 2012 also shows negative significance across all three models.

3.2.3. Additional test based on respondents' blood pressure level in 2013

From the analysis of Model 1-6, we can see that the association between social interaction and being hypertensive is short-term, as social activity participation, highest education of adult children and number of adult children living in urban areas in 2017 are significantly associated with being hypertensive. In contrast, none of the measures of social interaction in 2012 show statistical significance. Based on this analysis result, I further investigate whether this short-term association vary among people who have different blood pressure history. Table 3 displays the results of Model 7 and Model 8, which includes respondents who were and were not hypertensive in 2013 respectively.

In Model 7, for those who were already hypertensive in 2013, being female is positively associated with continuing being hypertensive, increasing the odds by 70%. The association is marginally significant. Marginally statistical significant association is also observed for marital status, as being currently marriage is positively associated with being hypertensive, increasing the odds by 76%. Meanwhile, having female adult child with the highest education in the household is also positively associated with being hypertensive, increasing the odds by 92%. The association is marginally significant.

In Model 8, for those who were not hypertensive in 2013, comparing with respondents who had no adult children living in urban areas and were not hypertensive in 2013, those have 3 or more adult children living in the city are significantly more likely to be hypertensive in 2017, increasing the odds by 2.16 times. The association is significant at 99% confidence level. Meanwhile, respondents who were not hypertensive in 2013 will face more risks of being hypertensive after they reach age 70, increasing the odds by 3.12 times. The positive association is significant at 99% confidence level as well.

3.3. Knowledge of hypertension

3.3.1. Short-term Association

In Model 1, being members of at least one village committee is positively associated with the total number of correct symptoms listed. However, this positive association is not statistically significant. In terms of social activity participation, the frequency is positively associated with the outcome variable. But the association is also not significant across all subgroups.

In Model 2, highest education of adult children is positively associated with the total number of correct symptoms listed. However, this positive association is not statistically significant. Gender of the most educated adult children is not significantly associated with the total number of correct symptoms listed. Similarly, the positive association between total number of adult children in the household and the outcome variable is not significant neither. Meanwhile, I don't observe any statistically results in the number of adult children living in urban areas.

In Model 3, when controlling both social engagement and upward intergenerational transmission in 2017, the association between being members of village committees and the number of correct symptoms listed is slightly attenuated while that of social activity participation are mildly strengthened. However, neither of the associations are statistical significant. The positive association between adult children's highest education attainment and the number of correct symptoms listed is slightly attenuated. The gender of the adult child with highest education attainment and total number of adult children are still not significant. Neither does the number of adult children living in the urban areas.

In Model 1-3, in terms of socioeconomic and demographic variables, Blaka has an interesting regional advantage. More specifically, comparing with respondents who are from Mchinji, those who come from Blaka are likely to list more correct symptoms of hypertension. In the full model (Model 3), it increases the odds by 87%. All other variables are not statistically significant.

3.3.2. Long-term Association

In Model 4, being members of at least one village committee is positively associated with the total number of correct symptoms listed. However, this positive association is not statistically significant. In terms of social activity participation, the frequency is negatively associated with the outcome variable in group 3-5 times, and positively associated with the dependent variable in group 6-8 times and 9 times or more. But these associations are not significant neither.

In Model 5, highest education of adult children is positively associated with the total number of correct symptoms listed. Meanwhile, this positive association is statistically significant. Comparing with respondents having adult children whose highest education attainment is primary school or below, those with adult children whose highest education is middle school and above are more likely to list more correct symptoms of hypertension, increasing the odds by 51%. Gender of the most educated adult children is also significant and shows a positive association. More specifically, the respondents have more than one adult child with the same highest education attainment and their genders differ, they will be more likely to list more correct symptoms of hypertension, increasing the odds by 52%. Total number of adult children in the household only has slight influence as the odds ratio is very close to 1 and is not statistically significant. Total number of adult children living in urban areas is not significant neither.

In Model 6, when controlling both social engagement and upward intergenerational transmission in 2012, the coefficients of social engagement are slightly attenuated. The positive association between adult children's highest education attainment and the number of correct symptoms listed is still significant. The significant positive gender effects of adult children with highest education attainment persist and total number of adult children in the household is still not significant.

In Model 4-6, in terms of socioeconomic and demographic variables, the regional advantage we observed in Model 1-3 still exists: comparing with respondents from Mchinji, respondents from Blaka are more likely to list more correct symptoms of hypertension. The association is significant at 99% confidence level throughout these three models.

3.3.3. Additional test based on respondents' blood pressure level in 2013

From the analysis of Model 1-6, we can see that the association between social interaction and being hypertensive is long-term, and mainly comes from the education attainment of adult children, as none of the measures of social interaction in 2017 show statistical significance and only highest education of adult children in 2012 are significantly associated with the total number of correct symptoms listed. Based on this analysis result, I further investigate whether this long-term association vary among people who have different blood pressure history. Table 5 displays the results of Model 7 and Model 8, which includes respondents who were and were not hypertensive in 2013 respectively.

In Model 7, among respondents who were already hypertensive in 2013, being members of at least one village committee is positively associated with the number of correct symptoms of hypertension listed, increasing the odds by 80%. The association is statistically significant. Meanwhile, being female is positively associated with the number of correct symptoms listed, increasing the odds by 68%, which is statistically significant. In addition, comparing with those having adult children whose highest level of education is primary school and below, respondents having adult children whose highest education attainment is middle school and above are more likely to list more symptoms of hypertension, increasing the odds by 75%, which is marginally significant.

In Model 8, among respondents who were not hypertensive in 2013, respondents' education attainment is marginally significant. Comparing with respondents who never attended school, those who have ever attended school are more likely to list more correct symptoms of hypertension.

4. Discussion

This study has contributed to a small but growing literature on the association between social interaction and hypertension. I measure social interaction from the aspects of both mature adults' own social engagement and the upward intergenerational transmission, which is seldom measured in existing literature. Meanwhile, taking advantage of longitudinal data, I am able to test whether the association between social interaction, and prevalence and knowledge of hypertension is long-term or short-term, which is also a gap in current studies. What is more, the unique setting of this study, rural Malawi, offers a different perspective to look at how social interaction shape people's thoughts and health behaviors. In addition, choosing mature adults (aged 45+) instead of the whole population as the research subject may give more practical policy implications for the government, as people in these age groups face higher risks of being hypertensive.

In this study, hypertension is researched from two aspects, prevalence and knowledge. Prevalence is measured by respondents' blood pressure collected in the latest wave of Malawi Longitudinal Study of Family and Health (MLSFH) in 2017. Knowledge is estimated by the total number of correct symptoms of hypertension that respondents listed in the 2017 survey. These two outcome variables provide a big picture of the current health burden of hypertension and people's comprehension of this emerging disease.

In terms of hypertension prevalence, my analysis results show that prevalence of high blood pressure increases with age and females are more likely to be hypertensive, which is consistent with many previous studies (Cutler et al. 2008; Kearney 2004; Martins et al. 2001; Ong et al. 2007; Reckelhoff 2001). Gender difference in being hypertensive persist over time regardless of blood pressure history. The association between social interaction and the prevalence of hypertension is short-term, as none of the odds ratios from 2012 social interaction are observed to be statistically significant while many key variables of interest in 2017 are significant. More specifically, frequency of social activity participation is negatively associated with being hypertensive. Similar results are also shown in previous studies (Beaglehole et al. 1977; Gorman & Sivaganesan 2007; Hawkley et al. 2010). Meanwhile, I observe significant influence of adult children's education attainment and residential location on their parents' hypertension conditions. Particularly, higher education level and urban residence of adult children are positively associated with being hypertension for their older parents. It can be explained by that adult children living in urban areas may have more access to knowledge of hypertension but they are also more exposed to urbanization and corresponding lifestyles, such as unhealthy diet and physical inactivity. Previous literature has documented that life style changes resulting from population transition and urbanization is one of the main causes of hypertensive prevalence in sub-Saharan Africa countries (Msyamboza et al, 2011; World Health Organization 2010; Yach et al. 2004). Therefore, when diffusing the knowledge of hypertension, they may also pass unhealthy urban lifestyles to their older parents and thus increased the prevalence of hypertension. In addition, I also find that when the gender of the adult child with the highest level of education is female, the respondent is more likely to be hypertensive. A valid explanation for this gender puzzle cannot be provided in this study but it can be a direction for future research.

As for knowledge, my analysis shows that the association between social interaction and mature adults' knowledge of hypertension is long-term and is mainly contributed by adult children's education attainment. None of the social interaction variables in 2017 is significantly associated with the total number of correct symptoms of hypertension that respondents can list. Among measures of social interaction from 2012, adult children's education level is positively associated with the outcome variable and the association is significant. This finding matches the results of some other studies showing that adult children with high education will provide information support to their older parents (Friedman & Mare, 2014; Torssander, 2013; Yahirun 2016). The gender puzzle that reported before also exists in this model but takes a different form. More specifically, if a respondent has more than one adult child with the same high level of education and the gender of the adult children are opposite, this respondent will be likely to list more correct symptoms of hypertension. A straightforward explanation might be more sources of health information since these respondents have more adult children with high education attainment. But it still does not provide a reasonable explanation for the gender effect and this finding may offer inspiration for future studies. Furthermore, by categorizing respondents into two groups based on their blood pressure in 2013, I find that for village committee membership is associated with increasing knowledge of hypertension among respondents who were already hypertensive in 2013. It can be explained by that after knowing themselves being hypertensive in 2013, these respondents consciously join village committees and acquired knowledge of hypertension through various health-related activities. Meanwhile, marriage is observed to be positively associated with knowledge of hypertension, which may be a result of spousal communication (Lipowicz & Lopuszanska 2005, Baker et al. 2003). For respondents who knew themselves as hypertensive in 2013, they might be more likely to talk about hypertension with their spouses. Finally, female respondents who were hypertensive in 2013 are likely to list more correct symptoms of hypertension, which can be explained by that women are more willing to talk about their health conditions.

This study unavoidably has some limitations. Firstly, the sample size is relatively small, which may constrain the statistical power of regression models and limit the generalization of analysis results. However, the data that I used from MLSFH is nationally representative. As seen in the descriptive statistics, respondents in my analytic sample are evenly drawn from three survey areas and the average age and gender are very close to the those of the original dataset. Therefore, the sample should be representative given the relative small sample size. Secondly, there is no information about the past usage of antihypertensive medication in the dataset. As a result, people who took medication before 2013 and had their blood pressure under controlled before the 2013 survey are taken as not being hypertensive in 2013, which may lead to an underestimate of being hypertensive in 2013. However, even in 2017, the proportion of antihypertensive medication use is less than 10%. The proportion would be lower in 2013 and those who had blood pressure controlled because of medication would be even lower. Therefore, this underestimation will not significantly influence the analysis results. Finally, for social engagement, the possibility of reversal causality cannot be ruled out, as being already hypertensive in 2013 might constrain social activity participation in 2017 and thus lead to the negative association between the frequency of participating in social activities in 2017 and being hypertensive.

In sum, this paper analyzes how social interaction shapes prevalence and knowledge of hypertension among Malawian mature adults. Hypertension has been a rising burden of health in Malawi, and thus more research on this topic is urgently needed to help Malawian governments increase people’s knowledge and decrease the prevalence of this emerging disease. This study provides two main policy implications. On one hand, the government should encourage mature adults to actively participate in social activities. Joining village committees is helpful for those who have already been hypertensive. On the other hand, intergenerational commutation with adult children who live in cities or have higher education levels should also be promoted to help spread knowledge of hypertension to older parents.

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Appendix

Table 1 Sample descriptive statistics (percentage or mean with standard deviation)

VARIABLES	N=992		
Outcome variables			
Prevalence of hypertension			
Being hypertensive in 2017 (Yes=1)	0.43 (0.50)		
Knowledge of hypertension			
Total number of correct symptoms listed	0.84 (0.69)		
0	0.33		
1	0.51		
≥ 2 (2,3)	0.16		
Explanatory variables			
Being hypertensive in 2013 (Yes=1) (N=878)	0.40 (0.49)		
Respondents' characteristics			
Age	62.93 (10.58)		
45-54	0.27		
55-59	0.22		
60-64	0.17		
65-69	0.15		
70-80	0.19		
Gender (Female=1)	0.59 (0.49)		
Region			
Mchinji	0.32		
Balaka	0.34		
Rumphi	0.34		
Marital Status (Married=1)	0.71 (0.45)		
Education Attainment (Ever attended school=1)	0.69 (0.46)		
Income (Get paid during the past week=1)	0.27 (0.44)		
Respondents' social engagements, 2012 & 2017			
	2017	2012	*p*-value
Whether being members of any village committee	0.32 (0.47)	0.14 (0.35)	0.027
Social activity attendance during the past month			
0-2 times	0.25	0.15	
3-5 times	0.32	0.30	<0.001
6-8 times	0.20	0.19	
≥ 9times	0.23	0.36	
Adult children's characteristics, 2012 & 2017			
Highest level of adult children's education			
Primary or lower	0.42	0.44	<0.001
Middle or higher	0.58	0.56	
Number of adult children living in urban areas			
0	0.39	0.40	
1	0.27	0.27	<0.001
2	0.18	0.16	
≥ 3	0.16	0.17	
Gender of most highly educated adult child			
Male	0.30	0.24	
Female	0.17	0.08	<0.001
Both	0.53	0.68	
Total number of adult children in each household	4.75 (2.44)	3.78 (2.43)	<0.001

Table 2 Odds radio from logistic regression models for being hypertensive in 2017

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Social engagement: social activity participation & village committee membership						
Being a member in at least one village committee in 2017	1.174 (0.179)		1.180 (0.183)			
Being a member in at least one village committee in 2012				1.377 (0.316)		1.344 (0.308)
Social activity participation during the past month in 2017						
3-5	0.728* (0.132)		0.761 (0.141)			
6-8	0.628** (0.130)		0.657** (0.137)			
≥9	0.613** (0.127)		0.636** (0.133)			
Social activity participation during the past month in 2012						
3-5				0.783 (0.167)		0.782 (0.168)
6-8				1.019 (0.241)		1.030 (0.245)
≥9				0.748 (0.163)		0.762 (0.167)
Upward intergenerational transmission: highest education level & residential location of adult children						
Highest education of adult children in household in 2017						
Middle school or higher		1.449** (0.266)	1.413* (0.261)			
Highest education of adult children in household in 2012						
Middle school or higher					1.348 (0.277)	1.338 (0.276)

Table 2 Odds radio from logistic regression models for being hypertensive in 2017 (cont'd)

Gender of the most highly educated adult child in 2017				
Female	1.674** (0.356)	1.665** (0.355)		
Both	1.247 (0.225)	1.238 (0.225)		
Total number of adult children in household in 2017	1.006 (0.0360)	1.008 (0.0362)		
Gender of the most highly educated adult child in 2012				
Female			1.123 (0.306)	1.095 (0.300)
Both			1.233 (0.249)	1.236 (0.251)
Total number of adult children in household in 2012			1.042 (0.0370)	1.042 (0.0372)
Number of adult children living in urban areas in 2017				
1	1.038 (0.179)	1.021 (0.177)		
2	0.985 (0.198)	0.987 (0.199)		
≥3	1.619** (0.364)	1.596** (0.361)		
Number of adult children living in urban areas in 2012				
1			0.940 (0.160)	0.945 (0.162)
2			0.939 (0.195)	0.948 (0.197)
≥3			1.074 (0.228)	1.071 (0.229)

Table 2 Odds radio from logistic regression models for being hypertensive in 2017 (cont'd)

Socioeconomic and demographic factors						
Age						
55~59	1.537**	1.469*	1.435*	1.552**	1.459*	1.431*
	(0.317)	(0.309)	(0.303)	(0.320)	(0.308)	(0.304)
60~64	2.130***	1.891***	1.892***	2.144***	1.935***	1.945***
	(0.472)	(0.433)	(0.436)	(0.473)	(0.453)	(0.456)
65~69	2.718***	2.421***	2.350***	2.779***	2.389***	2.364***
	(0.627)	(0.591)	(0.577)	(0.639)	(0.596)	(0.593)
70~80	4.083***	4.189***	3.901***	4.368***	3.751***	3.715***
	(0.869)	(0.940)	(0.888)	(0.926)	(0.895)	(0.895)
Gender (Female=1)	1.400**	1.421**	1.367*	1.452**	1.406**	1.402**
	(0.228)	(0.229)	(0.226)	(0.236)	(0.227)	(0.231)
Region						
Balaka	1.218	1.224	1.234	1.160	1.294	1.238
	(0.212)	(0.225)	(0.229)	(0.208)	(0.229)	(0.228)
Rumphi	1.078	0.975	0.955	1.122	1.029	1.043
	(0.185)	(0.173)	(0.171)	(0.193)	(0.184)	(0.188)
Marital status (Married=1)	1.372*	1.271	1.291	1.369*	1.265	1.284
	(0.240)	(0.226)	(0.231)	(0.239)	(0.223)	(0.228)
Education attainment (Ever attended school=1)	0.991	0.917	0.918	1.015	0.933	0.949
	(0.172)	(0.163)	(0.164)	(0.177)	(0.165)	(0.169)
Income (Get paid during the past week=1)	0.714**	0.704**	0.731*	0.689**	0.701**	0.702**
	(0.113)	(0.112)	(0.118)	(0.109)	(0.112)	(0.112)
Constant	0.324***	0.175***	0.229***	0.272***	0.186***	0.207***
	(0.114)	(0.0636)	(0.0890)	(0.0997)	(0.0695)	(0.0850)
Observations	992	992	992	992	992	992

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 Odds ratio from logistic regression models for whether being hypertensive in 2017 (categorized by whether being hypertensive in 2013)

VARIABLES	Model 7	Model 8
Social engagement in 2017		
Being a member in at least one village committee	1.250 (0.367)	1.295 (0.307)
Social activity participation during the past month		
3-5 times	1.022 (0.346)	0.817 (0.232)
6-8 times	0.715 (0.267)	0.588 (0.195)
≥9	0.623 (0.222)	0.611 (0.201)
Upward intergenerational transmission in 2017		
Highest education of adult children in household		
Form school or above	1.663 (0.577)	1.079 (0.313)
Number of adult children living in urban areas		
1	0.816 (0.259)	1.476 (0.404)
2	0.590 (0.212)	1.448 (0.453)
≥3	0.788 (0.328)	3.161*** (1.088)
Gender of the adult child with the highest education		
Female	1.923* (0.750)	1.503 (0.486)
Both	1.695 (0.564)	0.856 (0.240)
Total number of adult children in 2017	1.090 (0.0764)	0.977 (0.0528)

Table 3 Odds ratio from logistic regression models for whether being hypertensive in 2017 (categorized by whether being hypertensive in 2013) (cont'd)

Socioeconomic and demographic factors		
Age		
55~59	0.742 (0.301)	1.792* (0.580)
60~64	1.213 (0.557)	1.889* (0.671)
65~69	1.251 (0.540)	1.670 (0.689)
70~80	1.900 (0.803)	4.122*** (1.453)
Gender (emale=1)	1.699* (0.514)	1.638* (0.430)
Region		
Balaka	1.273 (0.395)	1.140 (0.344)
Rumphi	1.480 (0.528)	1.161 (0.317)
Marital Status (Married=1)	1.758* (0.562)	1.268 (0.353)
Education attainment (Ever attended school=1)	1.042 (0.305)	0.993 (0.302)
Income (Get paid during the past week=1)	0.664 (0.182)	0.919 (0.234)
Constant	0.442 (0.313)	0.0854*** (0.0527)
Observations	386	567

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Odds ratio from ordered logistic regression models for total number of correct symptoms listed

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Social engagement: social activity participation & village committee membership						
Being a member in at least one village committee in 2017	1.129 (0.157)		1.111 (0.156)			
Being a member in at least one village committee in 2012				1.150 (0.215)		1.149 (0.215)
Social activity participation during the past month in 2017						
3-5	1.022 (0.172)		1.056 (0.179)			
6-8	1.161 (0.220)		1.187 (0.226)			
≥9	1.076 (0.201)		1.098 (0.206)			
Social activity participation during the past month in 2012						
3-5				0.819 (0.161)		0.803 (0.159)
6-8				1.352 (0.297)		1.349 (0.298)
≥9				1.091 (0.218)		1.076 (0.216)
Upward intergenerational transmission: highest education level & residential location of adult children						
Highest education of adult children in household in 2017						
Middle school or higher		1.293 (0.214)	1.281 (0.213)			
Highest education of adult children in household in 2012						
Middle school or higher					1.510** (0.283)	1.527** (0.286)

Table 4. Odds ratio from ordered logistic regression models for total number of correct symptoms listed (cont'd)

Gender of the most highly educated adult child in 2017				
Female	1.392* (0.266)	1.393* (0.267)		
Both	1.172 (0.192)	1.158 (0.191)		
Total number of adult children in household in 2017	1.009 (0.0334)	1.008 (0.0334)		
Gender of the most highly educated adult child in 2012				
Female			1.366 (0.339)	1.341 (0.334)
Both			1.527** (0.285)	1.555** (0.291)
Total number of adult children in household in 2012			1.011 (0.0332)	1.011 (0.0333)
Number of adult children living in urban areas in 2017				
1	1.049 (0.165)	1.053 (0.166)		
2	0.989 (0.179)	0.992 (0.180)		
≥3	0.995 (0.205)	1.020 (0.211)		
Number of adult children living in urban areas in 2012				
1			1.248 (0.195)	1.256 (0.197)
2			1.224 (0.230)	1.250 (0.235)
≥3			0.860 (0.168)	0.878 (0.171)

Table 4. Odds ratio from ordered logistic regression models for total number of correct symptoms listed (cont'd)

Socioeconomic and demographic factors						
Age						
55~59	1.015	0.988	0.981	1.001	0.994	0.967
	(0.186)	(0.184)	(0.183)	(0.183)	(0.187)	(0.182)
60~64	1.197	1.104	1.114	1.201	1.093	1.107
	(0.238)	(0.228)	(0.231)	(0.238)	(0.232)	(0.235)
65~69	1.099	1.051	1.062	1.090	1.039	1.034
	(0.228)	(0.230)	(0.234)	(0.226)	(0.235)	(0.235)
70~80	0.834	0.787	0.813	0.845	0.745	0.775
	(0.157)	(0.157)	(0.165)	(0.158)	(0.160)	(0.167)
Gender (Female=1)	1.298*	1.226	1.262	1.349**	1.213	1.295*
	(0.193)	(0.179)	(0.189)	(0.201)	(0.179)	(0.195)
Region						
Balaka	1.787***	1.849***	1.869***	1.811***	1.818***	1.865***
	(0.287)	(0.310)	(0.317)	(0.292)	(0.296)	(0.308)
Rumphi	1.266	1.200	1.198	1.244	1.134	1.108
	(0.198)	(0.192)	(0.192)	(0.194)	(0.183)	(0.180)
Marital status (Married=1)	1.316*	1.262	1.249	1.335*	1.248	1.254
	(0.209)	(0.203)	(0.202)	(0.210)	(0.200)	(0.202)
Education attainment (Ever attended school=1)	1.174	1.131	1.124	1.182	1.121	1.116
	(0.187)	(0.184)	(0.183)	(0.190)	(0.183)	(0.184)
Income (Get paid during the past week=1)	1.222	1.234	1.236	1.219	1.188	1.188
	(0.175)	(0.177)	(0.179)	(0.174)	(0.171)	(0.172)
Constant cut1	1.097	1.230	1.379	1.071	1.551	1.696
	(0.346)	(0.387)	(0.470)	(0.351)	(0.514)	(0.622)
Constant cut2	12.16***	13.72***	15.42***	12.02***	17.49***	19.47***
	(3.977)	(4.494)	(5.450)	(4.076)	(6.051)	(7.412)
Observations	992	992	992	992	992	992

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 Odds ratio from ordered logistic regression models for total number of correct symptoms listed (categorized by whether being hypertensive in 2013)

VARIABLES	Model 7	Model 8
Social engagement in 2012		
Being a member in at least one village committee	1.796**	0.842
	(0.519)	(0.219)
Social activity participation during the past month		
3-5 times	1.245	0.585*
	(0.381)	(0.161)
6-8 times	1.475	1.273
	(0.518)	(0.383)
≥9	1.734*	0.824
	(0.552)	(0.228)
Upward intergenerational transmission in 2012		
Highest education of adult children in household		
Form school or above	1.753*	1.392
	(0.553)	(0.344)
Number of adult children living in urban areas		
1	1.477	1.156
	(0.388)	(0.244)
2	1.229	1.182
	(0.372)	(0.299)
≥3	1.184	0.662
	(0.388)	(0.175)
Gender of the adult child with the highest education		
Female	1.522	1.345
	(0.640)	(0.439)
Both	1.628	1.547*
	(0.510)	(0.386)
Total number of adult children in 2012	1.057	0.978
	(0.0561)	(0.0428)

Table 5 Odds ratio from ordered logistic regression models for total number of correct symptoms listed (categorized by whether being hypertensive in 2013) (cont'd)

Socioeconomic and demographic factors		
Age		
55~59	0.704 (0.247)	1.114 (0.267)
60~64	0.935 (0.358)	1.249 (0.336)
65~69	0.791 (0.290)	1.249 (0.398)
70~80	0.751 (0.272)	0.820 (0.244)
Gender (Female=1)	1.679** (0.418)	1.283 (0.262)
Region		
Balaka	1.919** (0.501)	1.724** (0.413)
Rumphi	0.855 (0.242)	1.188 (0.249)
Marital Status (Married=1)	1.704** (0.448)	1.095 (0.238)
Education attainment (Ever attended school=1)	0.954 (0.238)	1.510* (0.357)
Income (Get paid during the past week=1)	1.104 (0.258)	1.339 (0.262)
Constant cut 1	3.650** (2.332)	1.321 (0.639)
Constant cut 2	41.13*** (27.45)	16.50*** (8.266)
Observations	386	567

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1