The Demography of Mental Health Among Mature Adults: Puzzling Patterns in a Low Income High HIV-Prevalence Context

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September 26, 2014

Abstract

While a nascent body of research investigates the shift in sub-Saharan Africa's disease burden towards non-communicable diseases (NCDs), very few studies have investigated mental health, specifically depression and anxiety, as a particularly important subset of NCDs in SSA low-income countries. Using exceptionally-detailed data on mental health in the 2012–13 rounds of the Malawi Longitudinal Study of Families and Health (MLSFH), this paper provides a first picture of the demography of mental health among mature adults (= persons aged 45+) in a low-income high HIV-prevalence area. Our study shows striking gender-differences in both the level and age-pattern of depression and anxiety, and in contrast to findings from high-income contexts, we show sharp increases in mental health disorders with age. Our analyses of the 2006–12 MLSFH mental health transitions also show that mature adults in rural Malawi will spend a substantial fraction (often $> 50\%$) of their remaining life with poor mental health.

EXTENDED ABSTRACT BASED ON PRELIMINARY ANALYSES

1. INTRODUCTION

Depression and anxiety (***DA***) are important dimensions of ***mental health*** (***MH***) with a significant and growing contribution to the global burden of disease.[1–5] ***MH*** is an integral part of population health, and in resource-poor contexts, poor ***MH*** and ***DA*** have also been widely recognized as having important implications for individual productivity, individual/family-level well-being, and overall economic development.[6–24] Despite its growing relevance, ***DA*** continues to be ***poorly documented and inadequately understood*** in sub-Saharan African (SSA) low-income countries (LICs).[25]

To help fill this research gap, this paper will addresses essential—but under-researched—questions about the demography of ***MH*** and ***DA*** in a low income high HIV-prevalence context:

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rural Malawi. Specifically, understanding the demography of mental health is a first and critical aspect that can affect ***MH***-related health policies and international aid efforts in SSA as mental health disorders, especially depression, frequently co-occur with physical disabilities and have enormous consequences for the overall well-being of individuals. The present analysis represents a first attempt to describe the age-patterns of depression and anxiety in Malawi, divergences in the prevalence of mental health disorders by gender among mature adults, and the socioeconomic correlates of poor mental health. We also document the relationship between mental health disorders and HIV infection (objective and subjective), and we investigate the relationship between mental health patterns and physical health. Finally, using longitudinal data on mental health during 2006–12 and a multi-state life table, we estimate the proportion of remaining life that individuals spend with poor mental health in this rural SSA context.

2. Fundamental Gaps in Understanding the Demography of Mental Health in Low Income High HIV-Prevalence Context

While a nascent body of research has started to investigate the shift in SSA's disease burden towards disabling chronic conditions and ***non-communicable diseases*** (NCDs),[26,27] very few studies have investigated ***mental health*** (***MH***), specifically ***depression and anxiety*** (***DA***), as a particularly important subset of NCDs in SSA LICs.[25] The *Lancet Movement of Global Mental Health* accentuated the multiple interrelations between mental and other health disorders and the implications of their frequent co-occurrence.[28] ***DA*** is associated with communicable and non-communicable diseases, and ***DA*** often result in poor health management, higher co-morbidity, poorer disease prognosis, social exclusion, and increased poverty.[21,29] Thus, mental health is an important component of population health that can affect social and economic development.[29,30] In SSA LICs with high HIV prevalence (like Malawi), the importance of ***MH*** is amplified due to the direct effects of HIV on ***MH***, as well as the adverse outcomes due to ***DA*** among people living with HIV/AIDS.[31–45] Adults in resource-constraint SSA settings are not routinely screened for mental problems, and the correlates and ramification of poor mental health for economic productivity and overall well-being are poorly documented on population level in this context. Scholars and NGOs have therefore argued that health research and health policies in SSA LICs devote far too few resources to ***DA***, poor ***MH*** and related NCDs, and the health-care needs of mature adults.[2–4,20,46–72] Leading development economists have also claimed that a poverty trap exists in LICs because ***poverty begets poor mental health and therefore low productivity***.[6,9] Malawi's leading national newspaper recently wrote about the poor mental health of the nation as a "*mental bomb that we are comfortably sitting on, without realizing its consequences in the near future*,"[73] and others have argued for the strengthening of ***MH*** in the National Health Sector Strategic Plan.[74] Yet, research on ***MH*** that could inform ***MH***-related changes in health policy or health infrastructure in SSA LICs is scant,[21] and where it exists, it is mostly based on clinical/convenient samples rather than population-based studies.[75] While the STEPS[63] and SAGE[76–80] surveys measure ***DA*** and other NCDs in SSA, these data are limited because of their cross-sectional nature, lack of data on older individuals and life course information, and/or focus on higher-income SSA countries. Moreover, established knowledge about ***DA*** from high-income contexts is generally not sufficient for

addressing the knowledge gaps about poor ***MH*** in SSA LICs as epidemiological, market, policy and resource contexts differ so much that useful guidance cannot simply be transmitted.[25,26]

Our focus in this paper on the demography of mental health (***MH***) in a high HIV-prevalence LIC context is on ***mature adults***, defined here as adults aged 45+. We focus on ***mature adults*** because ***DA*** are widespread in this sub-population (Section 4.3), and because mature adults will grow more rapidly in the next decades than any younger 10-year age group in many SSA countries.[81,82] Mature adults are an essential subpopulation in SSA LICs not only because of their growing demographic relevance,[81,82] but also because of their almost universal labor force participation (98% at ages 50–64, 90% at age 65+, with virtually no "*retirement*"),[83] their important contributions to intergenerational transfers to both children and elderly parents,[84,85] and their pivotal caretaking roles in families affected by HIV/AIDS.[86–95] While constituting a critical subpopulation in SSA LICs, ***the well-being (WB) of mature adults is often low***. A recent MLSFH study for example showed that 45-year old women in Malawi can expect to spend 58% of their remaining 28 years of life with functional physical limitations affecting their day-to-day activities and work efforts, while 45-year old men can expect to live 41% of their remaining 25.4 years subject to such limitations.[20]. This growth of mature adults will importantly contribute to the rising importance of non-communicable diseases (NCDs) in SSA LICs, and given the strong interdependence between physical and mental health,[21,28,96,97] the often poor physical health of mature adults contributes to the rise and heightened relevance of ***DA*** and poor ***MH*** in SSA LICs.

3. Data: Malawi Longitudinal Study of Families and Health (MLSFH)—Mature Adult Sample

The Malawi Longitudinal Study of Families and Health (MLSFH)[98] is one of very few long-standing publicly-available longitudinal cohort studies in a SSA LICs context with ***eight*** data collection rounds during 1998–2013 for up to 4,000 individuals. A "***Cohort Profile***" of the MLSFH, providing detailed discussion of MLSFH sampling procedures, survey methods, survey instruments and biomarkers, and analyses of attrition has been published in the *International Journal of Epidemiology*.[98] The MLSFH cohorts were selected to represent the rural population, where the majority of Malawians (85%) live in poor health conditions similar to those prevailing in other rural SSA LICs (over 60% of total SSA population lives in rural areas): high morbidity/mortality, over-burdened health facilities, and frequently unmet nutritional needs.[99,100] The rural population predominantly engages in home production of crops (mostly maize) complemented by small-scale market activities. HIV/AIDS is widespread,[101,102] including in the MLSFH study population,[98] and access to ART—reaching 67% coverage in 2010—is expanding. Yet, despite the magnitude of the HIV epidemic, the vast majority of the population—more than 85% of adults aged 15–49, and an even higher fraction among adults aged 50+[51,102]—is HIV negative.

Our analyses will particularly focus on the MLSFH ***mature adults sample***, consisting of respondents aged 45 and older who participated in the 2012 ($N = 1,266$) and 2013 ($N = 1,257$) MLSFH mature adult surveys. Extensive longitudinal MLSFH data is available for this cohort: 65% of 2012 respondents participated in four or more pre-2012 MLSFH rounds, and 40% in all six pre-2012 rounds.[98] Most important for this paper, the 2012 and 2013 MLSFH collected ***extensive***

Table 1: MLSFH 2012–13: Selected *MH*-related measures

Construct Definition	*Measurement/Scales/Items Source*
(1) ***MH 1: overall mental heath, depression and anxiety (DA)***	the depression module and the anxiety module of the Patient Health Questionnaire-9 (PHQ-9)[103–105]; SF12 mental health score (since 2006);[106,107] subjective well-being[108–110]
(2) ***MH 2: cognitive function***	Spatial/temporal orientation and language[111]; visual/constructional tests;[112] visual/verbal memory, attention/working memory, immediate and delayed recall and executive functioning[96]
(3) ***Survival and Disease Perceptions (SDPs)***	Subjective probabilistic expectations, using a interactive elicitation method developed by the MLSFH,[113–115] including about mortality/survival, own HIV infection, local HIV prevalence and prevalence of local AIDS-related morbidity
(4) ***MH risk factors (individual, family and community-level)***	Alcohol and tobacco consumption, income, assets, economic shocks, financial and non-financial transfers, illness/mortality of family members
(5) ***Physical health***	activities of daily living (ADLs);[116–119] hand grip strength;[120,121]; measured height, weight and Body Mass Index (BMI);[122] functional limitations;[20] measured blood pressure (in 2013 only); biomarker-based HIV status
(6) ***Other***	Extensive information on household composition, socioeconomic context, social and human capital using the respective MLSFH modules (see MLSFH Cohort Profile,[98] Table 4).

HIV status is known for *all* MLSFH respondents (measured in 2012, 2008, 2006, 2004). All MLSFH households are geocoded, and can be linked to health infrastructure and other spatial data. Spouses are linked in the MLSFH, and children reported by respondents are longitudinally linked in the household rosters across waves.[98]

assessments of mental health (***MH***) (Table 1), including (*a*) the ***depression*** and the ***anxiety modules*** of the Patient Health Questionnaire-9 (PHQ-9) that allow to assess both, the presence and the severity of depression and anxiety disorders;[103–105] (*b*) ***assessments of cognitive function and performance***, including spatial/temporal orientation and language,[111] visual/constructional test,[112] recall and executive functioning;[96] and (*c*) the ***SF12*** mental health score.[106,107] These instruments ***measure the different dimensions*** of ***MH***—depression, anxiety, and overall mental well-being—that contribute most to the burden of disease and are emphasized in the literature. Cognitive function is important to measure because it is a more important predictor than schooling or related human-capital/SES measures given the very low levels of schooling and literacy among mature adults in SSA LICs. All MLSFH ***MH*** measures have been pretested, locally validated and are based on instruments widely available in other surveys. Moreover, the 2012–13 measures of ***DA*** significantly *improve upon earlier MLSFH data on mental health* that were restricted to the SF12 score (available in MLSFH since 2006). While useful as an indicator of pre-2012 mental health, the SF 12 score is limited in that provides merely a single summary index that neither measures the separate dimensions of ***MH*** nor indicates the severity of ***DA*** symptoms. The new ***MH*** measures collected in 2012–13 (Table 1), overcome these limitations. Currently no other population-level data exist for SSA LICs that provide a comparably rich assessment of ***MH*** and individual and contextual background information for mature adults.

4. Preliminary Analyses and Results

4.1. Measures of mental health and depression

Information on long-term trends in overall mental well-being for the MLSFH mature adults is provided by the SF-12 mental health scale that respondents has been collected in MLSFH longitudinally since 2006. The SF12-scale is a multipurpose short form survey with 12 questions selected from the SF-36 Health Survey. Higher SF-12 scores reflect better mental health. The SF-12 mental health scale is a widely used measure of overall social/emotional functioning, subjective well-being and overall health-related quality of life that has been implemented and validated in many different contexts.[106,107,123–125] Although the SF-12 mental health instrument provides a good understanding of the overall mental and emotional well-being of individuals, the measure does not allow to assess the presence and severity of clinically defined mental disorders such as depression or anxiety. To overcome this limitation, MLSFH collected in 2012 new measures to assess the mental health of the respondents and administered specifically the depression and anxiety modules of the Patient Health Questionnaire (PHQ), where PHQ refers to the self-administered version of the PRIME-MD diagnostic instrument for making criteria-based diagnoses of common mental disorders encountered in primary care.[103–105] The PhQ-9 used in this analysis is the depression module which scores each of the 9 questions as "0" (not at all) to "3" (nearly every day). The questions were translated into the 3 local languages (Chewa, Yao and Tumbuka) and when necessary adopted to the local context. Similar approach was used for the anxiety instrument of the PHQ that was scored from "0" (not at all) to "2" (more than half of the days).

To assess the mental health of the respondents, we use in the present analysis *"overall depression score"* that refers to the total score calculated from the PHQ-9 instrument, with a range from 0

(no depressive symptoms at all) to 27 (the highest possible score of depressive symptoms). Based on these scores, the PHQ-9 generally allows to assess the clinical significance of depression and classify individuals from none/mildly depressed to severely depressed. However, in the present analysis we assume that mental health does not involve a qualitative discontinuity between depressed and non-depressed status, but the patterns resulting from the quantitative variations on a range of depressive symptoms represent a better picture of the overall mental well-being of the respondents.[126,127] Hence, we use a linear specification of the PHQ-9 depression score, where higher scores indicate that individual experiences higher number of depressive symptoms.[1] Similar approach was used to calculate the *"overall anxiety scores"*, where higher scores indicate the presence of higher number of anxiety symptoms assessed by the PHQ anxiety instruments. In contrast, higher SF-12 mental (and physical) scores indicate better overall mental (and physical) well-being. *"Overall wellbeing"* in the present analysis refers to the general level of well-being and life satisfaction as assessed with the question *"How satisfied are you with your life, all things considered'?"*, with responses ranging from *5, very satisfied* to *1, very unsatisfied*.

Cognitive function and performance of the respondents was assessed using measurements for: (*a*) spatial/temporal orientation and language based on typical questions used in many different mental status examinations;[111] (*b*) visual/constructional test to assess space and object perception;[112] (*c*) visual/verbal memory, attention/working memory, memory/immediate and delayed recall and executive functioning that resemble many clinical tests assessing these functions, but with necessary adaptations to low literacy levels. The total cognitive score was calculated as the sum of the scores from the different cognitive domains measured in 2012, where 30 denotes the maximum possible score and higher scores indicate a better cognitive function/performance.

4.2. MLSFH Mature Adults: Summary statistics

Table 2 reports summary statistics of the analysis sample ($N_{total} = 1,250$). All respondents are 45 years or older. About 90% of the respondents are below age 75, with a larger fraction of women (43%) than men (35%) being 45 to 54 years old. Almost all of the men included in this analysis are currently married in cotrast to only 63% of women. Men are on average better educated than women: while 43% of women above age 45 have no formal schooling, only 18% of men fall into this category. Only 3% of women have completed secondary or higher education versus 9% of men. The majority of the respondents have normal body mass index (BMI), but 16 to 17% of the respondents are underweight. We observe a substantial male-female difference in the risk of being overweight or obese, with more than twice as many women being overweight/obese. Male respondents are more likely to rate their health as very good or excellent compared to women, and only 11% of men and 18% of women rate their health as fair/poor. About same proportions of men and women rate their health as being the same relative to others from the same sex and age in the village, but higher fraction of men rates their health as better or much better compared to women. Only 20% or women and 29% of men have not been sick in the past 12 month before the interview, and 61% of women and 57% of men report being sick for less than 1 month during this period. In addition, 18% of women and 14% of men were sick for more than 1 month in the year

[1] We conducted the analysis using a dichotomous clinical classification of depression, where 0 referred to no/mild depression and 1 to moderate/severe depression. The results obtained from logistic regressions were essentially identical to the results discussed in the paper.

Table 2: Summary statistics for the study population aged 45+ in 2012, Malawi

	Females mean (sd)	**Males** mean (sd)	**Total** mean (sd)
# of observations	713	537	1250
Age	59.07	60.56	59.71
	(11.22)	(10.79)	(11.06)
Age Group			
45-54	0.432	0.354	0.398
55-64	0.290	0.317	0.302
65-74	0.167	0.214	0.187
75+	0.111	0.115	0.113
Married	0.627	0.952	0.766
Muslim	0.288	0.261	0.277
Schooling (completed)			
No educ	0.427	0.182	0.322
Primary	0.539	0.722	0.617
Secondary/higher	0.0345	0.0958	0.0608
Body Mass Index (BMI) (2012)			
Underweight (BMI < 18.5*)*	0.173	0.160	0.167
Normal ($18.5 \leq BMI < 25$*)*	0.589	0.693	0.634
Overweight ($25 \leq BMI < 30$*)*	0.132	0.0764	0.108
Obese ($BMI \geq 30$*)*	0.0631	0.00745	0.0392
BMI missing	0.0435	0.0633	0.0520
Grip strength (mean both hands)	19.46	25.28	21.96
	(5.119)	(6.486)	(6.426)
Subjective health			
Poor	0.0547	0.0372	0.0472
Fair	0.135	0.0875	0.114
Good	0.429	0.335	0.389
Very good	0.295	0.395	0.338
Excellent	0.0870	0.145	0.112
Relative health to others in village			
Much worse	0.0281	0.0243	0.0264
Worse	0.196	0.160	0.181
Same	0.464	0.425	0.448
Better	0.273	0.315	0.291
Much better	0.0379	0.0746	0.0536
Illness in past 12 months (duration)			
None	0.202	0.292	0.241
< 1 month	0.614	0.568	0.594
1+ months	0.184	0.140	0.165
Functional limitations due to physical health			
None (healthy)	0.489	0.717	0.587
Moderate limitations	0.369	0.203	0.298
Severe limitations	0.142	0.0801	0.115
Number of recent socioeconomic shocks	2.741	2.601	2.681
	(1.066)	(1.076)	(1.072)

Table 3: Summary statistics for mental health indicators, respondents age 45+ in 2012, Malawi

	Females mean (sd)	**Males** mean (sd)	**Total** mean (sd)
# of observations	713	537	1250
PHQ-9 score	3.605	2.603	3.176
	(3.968)	(3.599)	(3.845)
PHQ-9 categories			
No depression	0.236	0.380	0.298
Minimal depression	0.470	0.424	0.450
Mild depression	0.201	0.135	0.173
Moderate depression	0.0670	0.0437	0.0570
Moderately severe depression	0.0199	0.00951	0.0155
Severe depression	0.00570	0.00760	0.00651
Anxiety score	2.892	2.197	2.594
	(2.652)	(2.445)	(2.587)
Anxiety categories			
No anxieties	0.220	0.341	0.272
Some anxiety symptoms	0.530	0.482	0.510
Mild anxiety	0.226	0.162	0.198
Moderate/severe anxiety	0.0238	0.0149	0.0200
MCS12	51.99	54.46	53.05
	(10.41)	(9.112)	(9.946)

prior the study. We observe substantial differences in the distribution of functional limitations among men and women, with 71% of men having no functional limitations due to physical health problems versus 49% of women. Almost twice as many women than men (14% vs. 8%) report having severe functional limitations, and higher fraction of women reports moderate limitations (37% vs. 20%). On average, the households of the respondents experienced about 3 significant socioeconomic shocks such as death of an important household member or crop loss during the last 2 years prior the survey.

Table 3 reports summary statistics for three mental health indicators collected in 2012. Specifically, the results reveal a persistent male-female difference across all indicators with women reporting higher number of depressive and anxiety symptoms and lower scores on the SF-12 mental health indicator compared to men. The distribution of the PHQ-9 and anxiety scores reveals that most respondents (around 60% for both genders) experience minimal (1-4 reported depressive symptoms) to mild (5-9 depressive symptoms) depression. Similarly, most respondents report 1 to 9 anxiety symptoms and thus fall into the range of experiencing some anxiety to mild anxiety.

Table 4 shows that the relationship between the different measures of mental health (overall depression score, overall anxiety shore and SF12 mental health score) is relatively strong, with correlation coefficients of about 0.6. Respondents who score high on the depression index are thus also more likely to report higher number of anxiety symptoms and have lower SF-12 mental scores. The correlations of mental health measures with measures of physical health are weaker but statistically significant at the 5%-level, suggesting that respondents with higher number of depressive or anxiety symptoms report more functional limitations and have lower grip strength. Although the patterns are very similar for men and women, some sex-specific differences are

Table 4: Correlations between mental and physical health measures in 2012 (MLSFH)

Table 1a: Correlations between different mental and physical health measures in 2012 for women age 45+, Malawi.

	Overall depression score	Overall anxiety score	SF-12 mental score	Overall cognitive score	Overall wellbeing	SF-12 physical score	Functional limitations	Grip strength (mean both hands)
Overall depression score	**1** 702							
Overll anxiety score	0.6617* 702	**1** 713						
SF-12 mental score	-0.5727* 698	-0.6627* 709	**1** 709					
Overall cognitive score	-0.2253* 702	-0.2434* 713	0.2471* 709	**1** 713				
Overall wellbeing	-0.2938* 702	-0.3128* 713	0.3091* 709	0.1654* 713	**1** 713			
SF-12 physical score	-0.4727* 698	-0.5434* 709	0.3186* 709	0.2885* 709	0.3547* 709	**1** 709		
Functional limitations	0.4840* 702	0.5493* 713	-0.4136* 709	-0.2599* 713	-0.3499* 713	-0.7916* 709	**1** 713	
Mean grip strength (both hands)	-0.2512* 690	-0.2814* 701	0.2564* 697	0.4254* 701	0.1517* 701	0.3291* 697	-0.3365* 701	**1** 701

Notes:
p-value: * (p<0.05); Number of observations shown below the correlation coefficients.

Table 1b: Correlations between different mental and physical health measures in 2012 for men age 45+, Malawi.

	Overall depression score	Overall anxiety score	SF-12 mental score	Overall cognitive score	Overall wellbeing	SF-12 physical score	Functional limitations	Grip strength (mean both hands)
Overall depression score	**1** 526							
Overll anxiety score	0.6826* 526	**1** 537						
SF-12 mental score	-0.4950* 523	-0.6295* 534	**1** 534					
Overall cognitive score	-0.1926* 526	-0.2299* 537	0.1991* 534	**1** 537				
Overall wellbeing	-0.2777* 526	-0.2535* 537	0.2807* 534	0.1640* 537	**1** 537			
SF-12 physical score	-0.4258* 523	-0.4708* 534	0.2413* 534	0.2255* 534	0.2995* 534	**1** 534		
Functional limitations	0.4853* 526	0.5503* 537	-0.4075* 534	-0.2470* 537	-0.2878* 537	-0.7769* 534	**1** 537	
Mean grip strength (both hands)	-0.3087* 518	-0.2949* 529	0.2560* 526	0.3413* 529	0.1830* 529	0.3550* 526	-0.3823* 529	**1** 529

Notes:
p-value: * (p<0.05); Number of observations shown below the correlation coefficients.

noteworthy; for instance, the correlations of the overall depression scores with the overall anxiety scores, the SF-12 mental health scores and the total cognitive scores are somewhat weaker for men than women; in contrast, the correlation between depression and grip strength is stronger for men (-.31) than for women (-.25).

4.3. Age patterns of mental health

Next, we investigate the variation of mental well-being by age and sex, which represents an important aspect for understanding the patterns of mental well-being among adult and elderly men and women in rural Malawi, especially in view of current findings documenting psychological well-being in the United States and globally. Specifically, Stone *et al.*[128] have shown that mental well-being in the U.S. improves from middle age onward, even in the presence of physical health limitations. Moreover, it has been shown that this pattern is neither attributable to cohort effects nor specific to Western cultures.[109]

Figure 1 shows the age patterns of depression (upper panel) and anxiety (lower panel) for men and women age 45 and older in 2012. Specifically, we plot the mean of the PHQ-9 total scores and anxiety scores by single age groups. The age pattern is estimated using a local polynomial regression (LPOLY in STATA) along with the 95% confidence interval. Both indicators of mental health problems, depression and anxiety, exhibit remarkably similar age patterns for both sexes. Men and women differ not only in the levels of depression and anxiety, but also in the changes of these two indicators with age. Specifically, women experience higher depression and anxiety over the entire age range 45-80, and this difference is statistically significant between ages 55 to 70, where the confidence intervals do not overlap. Depression and anxiety increase steadily with age for women from age 45 onwards, however the increase is less steep for men and occurs only after age 65 for depression and 60 for anxiety.

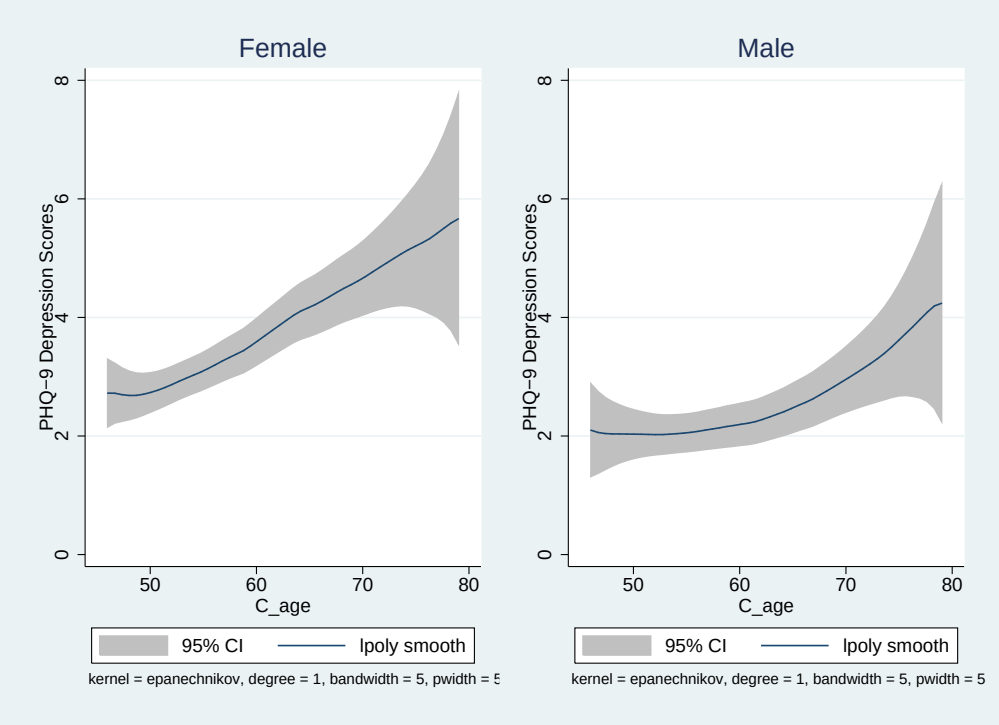
In Figure 2 we look at mental health of the respondents from the opposite perspective and investigate how the SF-12 mental health scores and overall well-being change with age. The patterns are consistent with the observations for depression and anxiety: both SF-12 and overall well-being decrease with age (as depression and anxiety increase), and this decrease occurs at younger ages and is steeper for women than for men. The decrease in SF-12 mental health scores is observed for men only after age 65, while at younger ages below 65 there are no changes in SF-12 by age. The difference in the age patterns of SF-12 is statistically significant for men and women in the age range 50-75 years. In contrast, the age patterns of overall well-being are strikingly similar for both sexes and men and women differ in level of well-being (although the confidence intervals overlap), but not in the slope of change with age.

4.4. Mental health and functional limitations

A possible reason underlying the age-specific decline of mental health observed for adult men and women in rural Malawi is the worsening of physical health and accumulation of functional limitations with older age. Specifically, Payne *et al.*[20] have shown that the risks of experiencing an onset of functional limitations due to poor physical health is very high in this population and disabilities begin to develop at early life. As a result men and women expect to spend a substantial fraction of their adult life with strained physical health. For instance, a 45-year old woman can

Figure 1: Age patterns of depression and anxiety for men and women age 45+ in 2012, Malawi

(A) Age patterns of depression (PHQ-9)



(B) Age patterns of anxiety

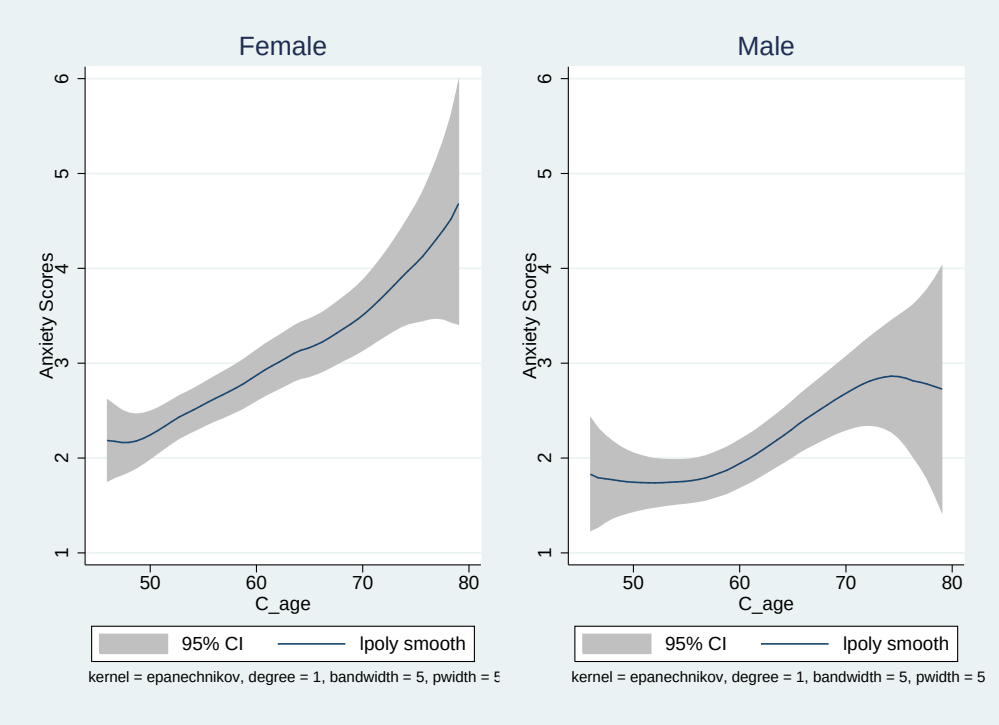
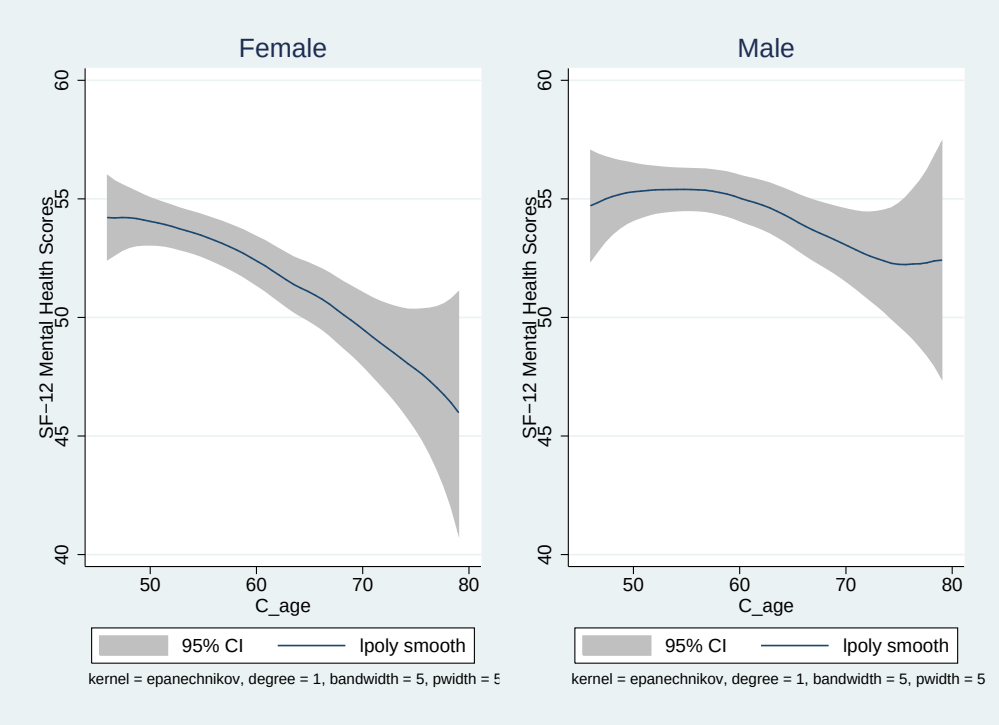
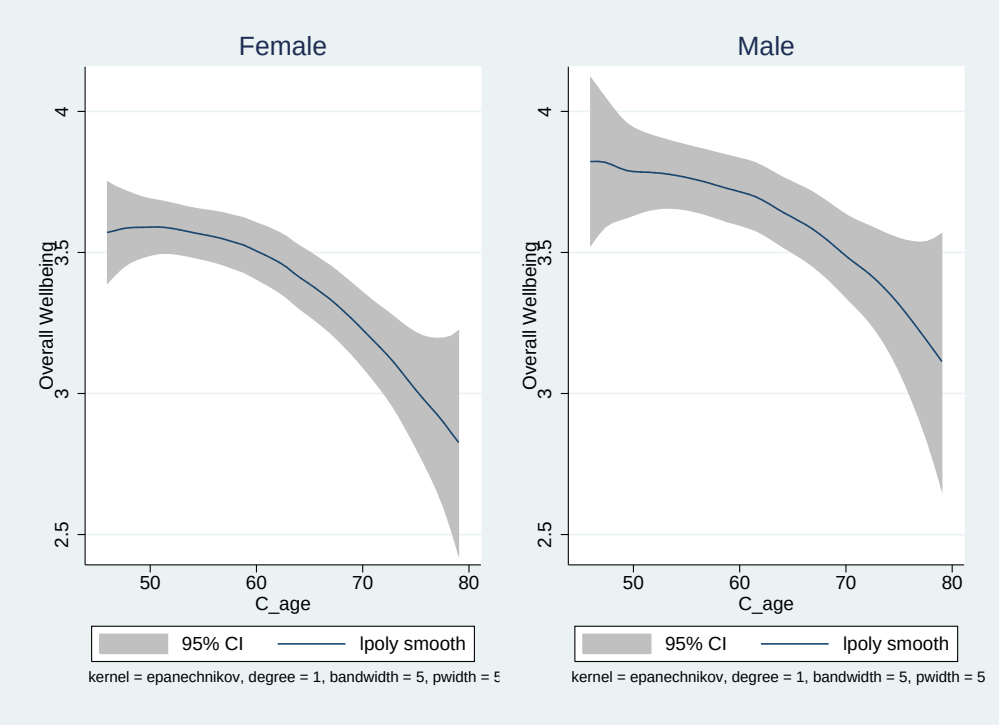


Figure 2: Age pattern of mental well-being for men and women age 45+ in 2012, Malawi

(A) Age patterns of SF-12 mental health scores)



(B) Age patterns of overall well-being



expect to spend 58% of her remaining 28 years of life with functional limitations, and a man at the same age is expected to spend 41% of the remaining 25.4 years of life with different degrees of physical disabilities.[20] To investigate the link between physical health and mental well-being we estimate a set of OLS regression models with PHQ-9 total scores as a dependent variable.[2] Table 5 shows the associations of different indicators of physical health with the total depression scores reported by the respondents.

In accordance to the age patterns described in Section 4.3, age is a statistically significant predictor of depression in all models but Model (3). Men report significantly lower depression scores compared to women in all models but Models (3) and (9) controlling for the presence of functional limitations and grip strength. The results also suggest an intriguing regional difference in depression across regions: while there is not difference in the distribution of depression between the Central and South region, respondents residing in the North region exhibit consistently lower depression scores compared to the reference Central region. Model (2) shows that depression scores do not vary by educational attainment of the respondents, but married individuals experience significantly lower depression compared to those who are not married/divorced/widowed.[3]

Model (3) reveals strong associations of functional limitations with depressive scores. Respondents who are moderately limited report 2.3 points higher, and those who are severely limited report 5 points higher depression scores compared to adults who are healthy. These differences could be due to more symptoms or same symptoms experienced more frequently. We are aware of the fact, that functional limitations are not necessarily permanent and respondents transition from one health state into another and their health status changes over time but also in the short term. To account for this, in Model (6) we investigated if functional limitations reported in the past (2 years before the survey) predict current mental health outcomes. The results show that being moderately or severely limited in 2010 is strongly associated with depressive symptoms 2 years later.

The report of current illness predicts higher depression scores, and the magnitude of this association varies with illness duration and is more than 3 times larger if the respondent was ill for a longer period during the last 12 months before the study compared to being sick for a short period, i.e. less than one month.

BMI is often seen as a reliable proxy for energy reserves. We hypothesized that for respondents who are underweight, BMI may reflect the presence of current underlying health problems or limited access to nutritional resources. Model (5) however shows that being underweight is not associated with the presence of depressive symptoms. In contrast, a second indicator of physical abilities and physical strength, grip strength, is significantly associated with the mental well-being of the respondents, so that weaker respondents report higher number of depressive symptoms (Model 9). In addition, in Model (8) we investigated the relationship of depression with another index of physical health, the SF-12 physical scores. This indicator shows also a strong inverse relationship with respondents' mental well-being. In similar manner, Model (7) reveals that depression and cognitive abilities are inversely related and cognitive abilities significantly predict

[2]We pooled the regressions for male and female respondents since we did not find significant interactions of health indicators with sex of the respondents.

[3]Due to small number of observations, we grouped respondents who are not married, divorced or widowed into one category.

Table 5: OLS regressions for the association of PHQ-9 depression scores with indicators of physical health for respondents aged 45+ in 2012, Malawi

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Age	0.083	0.072	0.012	0.053	0.075	0.058	0.065	0.025	0.046
	(6.55)**	(5.91)**	(1.09)	(5.20)**	(6.37)**	(4.42)**	(4.72)**	(2.30)*	(3.87)**
Male	-1.112	-0.899	-0.243	-0.794	-1.189	-0.929	-0.861	-0.449	-0.268
	(5.39)**	(4.01)**	(1.39)	(3.74)**	(5.74)**	(4.26)**	(4.47)**	(2.56)*	(1.08)
Region (ref.=Central)									
South region	-0.310	-0.221	0.060	-0.416	-0.387	-0.308	-0.390	-0.011	-0.434
	(0.77)	(0.55)	(0.15)	(1.07)	(0.95)	(0.79)	(0.97)	(0.03)	(1.11)
North region	-1.063	-1.095	-1.016	-0.919	-1.024	-1.043	-0.988	-0.983	-1.092
	(2.94)**	(2.78)**	(3.24)**	(2.72)**	(2.88)**	(2.79)**	(2.72)**	(2.88)**	(3.29)**
Education (ref.= no educ.)									
Primary		0.388							
		(1.28)							
Secondary/higher		-0.291							
		(0.65)							
Married		-0.776							
		(2.61)*							
Functional limitations (ref.=none)									
Moderately limited			2.361						
			(9.44)**						
Severely limited			5.523						
			(10.55)**						
Illness in last 12 months (ref.=none)									
< 1 month				1.485					
				(7.87)**					
1+ months				4.830					
				(11.72)**					
BMI (ref.=not underweight)									
underweight					0.419				
					(1.56)				
Functional limitations in 2010 (ref.=none)									
Moderately limited in 2010						0.586			
						(2.69)**			
Severely limited in 2010						2.234			
						(5.31)**			
Total cognition score							-0.080		
							(3.33)**		
SF-12 physical score								-0.173	
								(10.80)**	
Grip strength (mean both hands)									-0.135
									(5.86)**
Constant	-0.805	0.082	1.566	-0.875	-0.435	0.097	1.705	10.227	3.969
	(1.09)	(0.10)	(2.32)*	(1.37)	(0.63)	(0.13)	(1.55)	(9.78)**	(4.25)**
Observations	***1228***	***1198***	***1228***	***1227***	***1172***	***1197***	***1228***	***1221***	***1208***
R-squared	0.09	0.10	0.27	0.24	0.09	0.12	0.10	0.24	0.12

Notes: Robust t-statistics in parentheses; * significant at 5% level; ** significant at 1% level

mental health: respondents who have higher cognitive scores report significantly lower depressive symptoms.

In summary, the results in Table 5 reveal the presence of a strong relationship between physical and mental well-being. This association is persistent across different indicators of physical health and suggests that mental well-being of men and women above age 45 in rural Malawi is strongly dependent on their physical health and performance. Moreover, the lagged functional limitations measured in 2011 continue to be associated with depression (as are some related measures of physical health observed in 2010), although the association is significantly weaker than that with contemporaneous functional limitations.

4.5. Mental health, HIV and subjective expectations

Although not primarily affecting adults aged 45 and older, HIV/AIDS is widely spread in Malawi and the epidemics has increased uncertainty among individuals about their current and future health status and their survival, and as a consequence, we expect that the high risk disease environment prevailing in rural Malawi and other SSA contexts would negatively impact on the mental well-being of individuals. For example, Delavande & Kohler[114] have shown that prime-aged adults in rural Malawi perceive their own mortality risks not only to be high, but higher than might be expected based on measured mortality rates, which may translate into overly pessimistic perceptions about future life expectancy, health trends with age, earnings and future consumption. In addition, epidemiological research in the U.S. and SSA shows that psychological co-morbidities—most often depression—frequently accompany HIV+ infection. Often both pathophysiological and behavioral mechanisms associated with depression may lead to adverse outcomes in people living with HIV/AIDS.[37,38,40–45] Moreover, HIV affects the central and peripheral nervous systems and neurological complications are common among patients despite the success of ART and general improvements in health and survival and SSA.

To investigate the association of depression with HIV and subjective expectations of the likelihood of HIV infection as well as mortality expectations, we utilize a new interactive elicitation technique for subjective expectations that was based on asking respondents to allocate up to ten beans on a plate to express the likelihood that an event will be realized.[113] In particular, after a short introduction to subjective beliefs and uncertainty assessments, respondents were asked their subjective expectations about a wide range of health and economic outcomes, including the subjective likelihood of being currently infected with HIV. Respondents were instructed that one bean reflects one chance out of 10, and that allocating zero (or ten) beans reflects certainty that a specific event does not (or does) occur. To measure respondents' subjective probability of being infected with HIV, for example, respondents were asked, *"Pick the number of beans that reflects how likely you think it is that you are infected with HIV/AIDS now."* The response to this and related questions can be interpreted as a subjective probability after dividing the number of allocated beans by ten.[129]

Table 6 shows the results obtained from OLS regression for the association of PHQ-9 depression scores with HIV+ status, subjective probabilities of HIV infection and subjective probabilities of survival. Model (1) shows that although not statistically significant (because of small number of HIV+ cases), there is a positive relationship between being HIV+ and experiencing higher number of depressive symptoms. Moreover, respondents who estimate higher likelihood to be

Table 6: OLS regressions for the association of PHQ-9 depression scores with HIV and subjective probabilities of survival for respondents aged 45+ in 2012, Malawi

	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.087	0.093	0.086	0.081	0.078	0.077
	(7.19)**	(7.39)**	(6.22)**	(6.32)**	(6.05)**	(6.05)**
Male	-1.234	-1.074	-0.734	-1.107	-0.972	-1.001
	(5.87)**	(5.19)**	(3.53)**	(5.32)**	(4.56)**	(4.59)**
Region (ref.=Central)						
South region	-0.340	-0.420	-0.561	-0.307	-0.481	-0.434
	(0.84)	(1.06)	(1.36)	(0.76)	(1.19)	(1.07)
North region	-1.064	-1.002	-0.916	-0.962	-0.917	-0.881
	(2.93)**	(2.86)**	(2.65)**	(2.65)**	(2.56)*	(2.57)*
Respondent is HIV+	0.918					
	(1.38)					
Subj. probability of being HIV+		0.227				
		(4.38)**				
Subj. probabilit of partner being HIV+			0.303			
			(5.58)**			
Subj. probability that:						
Person same age/sex in same community will die within 1 yr.				0.114		
				(2.56)*		
Respondent will die within 1 year					0.242	
					(5.14)**	
Respondent will die within 5 years						0.198
						(5.61)**
Constant	-1.052	-1.788	-1.860	-1.095	-1.416	-1.660
	(1.50)	(2.39)*	(2.30)*	(1.46)	(1.77)	(2.24)*
Observations	1172	1224	976	1223	1214	1186
R-squared	0.10	0.11	0.10	0.09	0.11	0.11

Notes: Robust t-statistics in parentheses; * significant at 5% level; ** significant at 1% level;

All models controll for clustering within villages.

HIV+ themselves or their partner/spouse being HIV+, are more depressed compared to respondents who rate the likelihood of their own or partner's HIV infection as lower. A 10% increase in the subjective probability of being HIV+ (=1 additional bean), corresponds to .22 higher PHQ-9 depression scores, and 10% increase in the subjective probability that the respondent's partner is HIV+ positive results in .30 higher PHQ-9 depression scores. In addition, we also find a strong positive association of subjective survival probabilities within 1 and 5 years and depression (Models 4 to 6), so that a 10% increase in the respondent's own subjective probability off death within 1 and 5 years results respectively in a .24 and .20 higher PHQ-9 depression scores.

4.6. Mental health transition probabilities

The aim of this section is to estimate the amounts of time that individuals spend during their lives subject to mental health problems. For this purpose we utilize the longitudinal MLSFH data that has collected longitudinal data on mental health as part of the SF12 set of questions. These longitudinal mental data are not as detailed as those that were collected in 2012, but they nevertheless allow us to study transitions between different levels of depression and anxiety. Underlying this approach is the fact that mental health in general, and anxieties and depression in particular, are dynamic and subject to temporal fluctuations. These changes in mental health may be triggered by the experience of positive events, or by negative changes in physical health, experience of adverse events and shocks such as death of a family member, loss of income, and they can be of a short duration or persistent over a longer period of time with no recovery to a "healthy" state. To better understand these dynamic aspects of mental health over the lifecourse, we investigate in this section two distinct but interrelated aspects: first, the probabilities of transitioning between different levels of depression and anxiety, and second, the number of years that a mature adult can expend to spend during his/her remaining live subject to different levels of depression and/or anxieties.

Because studying transitions between different mental health states and the health expectancies spent subject to different levels of depression and/or anxiety requires longitudinal data, our indicators of mental health are restricted to those that are captured as part of the longitudinal SF12 questionnaire module. Since we are particularly interested in the lived experience of being in poor mental health status and time spend with depressive/anxiety symptoms, we define 3 states of mental health based on the SF12 questions *"How much time of the time during the past 4 weeks have you felt calm and peaceful?"* and *"How much of the time during the past 4 weeks have you felt downhearted and depressed?"* that capture both anxiety and depression. Both questions were asked to respondents since 2006. Respondents who answered to both questions *"Non of the time"* or *"A little of the time"* were classified as experiencing no symptoms of depression or anxiety (No AD); respondents with responses *"Some of the time"* were classified as experiencing *"mild depression/anxiety symptoms (Mild AD)"*, and those who answered *"Most of the time"* and/or *"All of the time"* were characterized as experiencing *"severe depression/anxiety (Moderate/Severe AD)"* symptoms. Individuals were classified according to these categories in 2006, 2008, 2010 and 2012, and the MLSFH therefore provides up to 4 longitudinal observations of these mental health states and the transitions between them over time.

We then estimate the conditional annual probabilities of experiencing a mental health transition between the three disability states (no AD, mild AD, moderate/severe AD) as function of age

and gender, using a logistic discrete-time hazard model of the form $\log\left(\frac{p_{ij}(age,t)}{p_{ii}(age,t)}\right) = \beta_{0ij} + \beta_{1ij} \times age_t + \beta_{2ij} \times age_t^2 + \beta_{3ij} \times male$, where $p_{ij}(age,t)$ is the transition probability from current health state i (with i = no AD, mild AD, moderate/severe AD) to health state j (with i = no AD, mild AD, moderate/severe AD) over the interval from time $t-1$ to t, β_{0ij} is the intercept, β_{1ij} and β_{2ij} are the coefficients for age and age squared, and β_{3ij} is the coefficient for male.

These age-specific transition probabilities between the three mental health states (healthy/no anxiety/depression, mild anxiety/depression, and moderate/severe anxiety/depression) were then used as input for a mutli-state life table (MSLT) model to estimate the health expectancies for each of these three mental health states, that is, the expected number of years a person can spend in these three mental health states if the transitions probabilities observed in the MLSFH during 2006–2012 were to prevail for the rest of a person's life.

Our estimation methods for these health expectancies are based on an adapted version of the Stochastic Population Analysis for Complex Events (SPACE) program[130]. Specifically, to calculate MSLT functions such as health expectancies (HE), we rely on microsimulation, a well-established tool in demographic research[131–136]. Initially, we create synthetic cohorts of 100,000 45-, 55-, 65-, and 75-year-old individuals with the same initial gender and mental health state distributions as our study population.

We then "age" these individuals forward year-by-year using age- and gender-specific mortality rates and probabilities of transitioning in and out of disability that are estimated from the MLSFH. This process is then repeated at each age until death. The process is essentially the microsimulation equivalent of projecting the initial synthetic cohort population $\mathbf{P}$, disaggregated by age, sex and health status, using $\mathbf{P}_t = \mathbf{Q} \cdot \mathbf{P}_t$, where $\mathbf{Q}$ is a projection matrix $\mathbf{Q}$ containing all age- and gender-specific health transitions rates and mortality rates.[137] After this process has played out for all individuals, the resulting synthetic cohort is analyzed to estimate HEs and other life-course health indicators. Point estimates shown are from transition probabilities and HE's estimated from the full sample. In the microsimulation approach health expectancy estimates are not a deterministic function of the transition rates, and instead result from a complex interplay between disability status, gender, and age as individuals move year-by-year through the simulation. Thus, the confidence intervals from our transition rate calculations are not directly applicable to our health expectancy estimates. Confidence intervals (CIs) for HEs, which reflect both the uncertainty of the estimated parameters and the uncertainty from the microsimulation, were created by re-estimating the above analysis sequence (estimating state-dependent transition probabilities, and applying them to a representative 100,000 person cohort using microsimulation) using 499 bootstrap re-samples of the original dataset, and incorporating stratification by village to account for complex sample design.[138] To obtain our final 95% CIs, we took the central 95% of the distribution of these bootstrapped parameters.

Table 7 reports summary statistics of the analysis sample for estimating the transitions probabilities and the distribution of mental health states since 2006. With the introduction of the parent sample in 2008, the sex composition of the sample shifts towards a majority of women and the mean age of the sample increases by 3.6 years since 2006. From 2006 to 2010, fewer people reported no mental health problems (No AD), and the incidence of mental health problems falling into the categories of mild and moderate/severe depression and anxiety increased this period.

Table 7: Distribution of mental health (anxiety/depression (AD) symptoms for respondents aged 45+ 2006-2012, Malawi

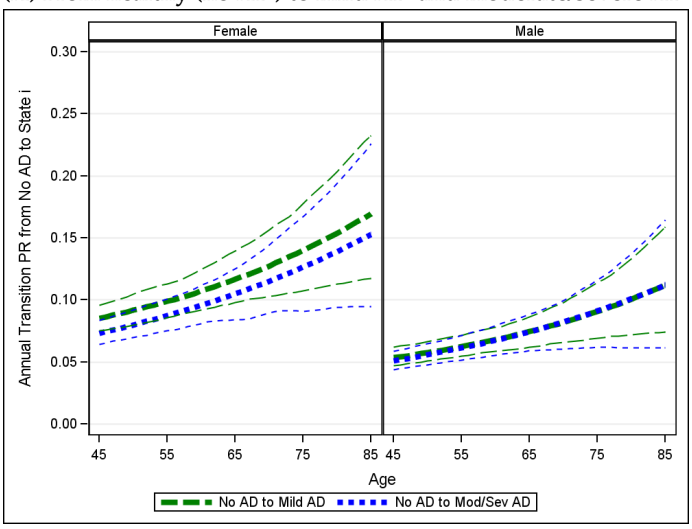
	2006		2008		2010		2012	
	N	%	N	%	N	%	N	%
45-64								
Status								
No AD	451	76.2%	547	69.5%	523	56.9%	544	70.3%
Mild AD	93	15.7%	133	16.9%	191	20.8%	114	14.7%
Mod/Sev AD	48	8.1%	88	11.2%	182	19.8%	103	13.3%
Dead			19	2.4%	23	2.5%	13	1.7%
Male	317	53.5%	363	46.1%	406	44.2%	329	42.5%
65+								
Status								
No AD	42	68.9%	165	55.6%	135	34.5%	178	47.6%
Mild AD	10	16.4%	74	24.9%	115	29.4%	70	18.7%
Mod/Sev AD	9	14.8%	55	18.5%	109	27.9%	98	26.2%
Dead			3	1.0%	32	8.2%	28	7.5%
Male	42	68.9%	145	48.8%	183	46.8%	182	48.7%
Average Age	56.1		59.7		59.7		61.2	

This longitudinal trend reversed in the most recent period of observation 2012. These observations pertain for both, younger mature adults aged 45-64 as well as to the oldest respondents aged 65+. The distribution of observed transition between mental health states since 2006 is shown in Table 8 and it clearly illustrates that individuals in this population experience a relatively large number of transitions between the different mental health states and death during the period of observation since 2006.

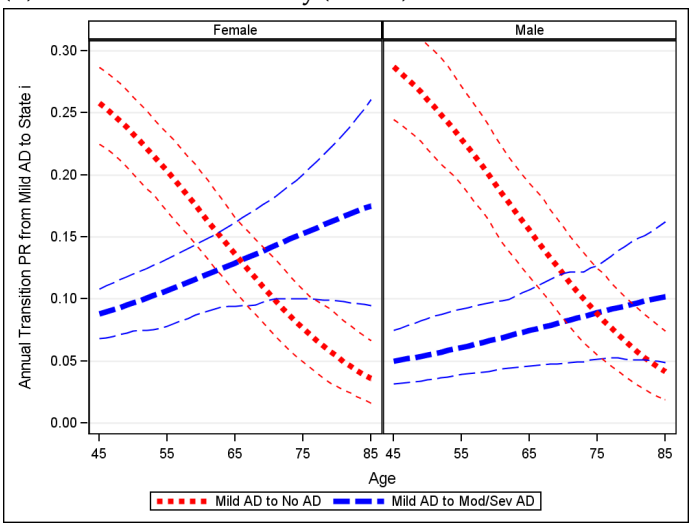
To better understand the dynamics of mental health in this population, we model the underlying age- and gender-specific annual transition probabilities between states of mental health. Figure 3A shows the annual transition probabilities out of healthy states (i.e., no mental health problems) by sex, along with the 95% CIs (represented as the thin lines) based on 499 bootstrap re-samples. Above age 75, the confidence intervals around the point estimates become quite large, primarily as a result of limited sample sizes at older ages. Consistent with the prior estimates of the age patterns of mental health indicators, the transition probabilities towards increased mental health problems rise with age, and the transition probabilities from healthy state into mild AD and healthy state into moderate/severe AD are almost identical. For example, a men without mental problems at age 45 has less than a .06 probability of having any anxiety/depression symptoms at age 45, but a men at age 75 has about 8% chance of remaining "mentally healthy" at age 76. Women, however, experience substantially higher transition probabilities into a state with mental health problems compared to men. From healthy status, women are significantly more likely to enter into a state with mild AD symptoms at all ages than are males, and are also significantly more likely to become severely depressed until about age 80.

Figure 3B describes the annual transition probabilities for individuals with mild AD symptoms

(A) From healthy (no AD) to mild AD and moderate/severe AD



(B) From mild AD to healthy (no AD) and moderate/severe AD



(C) From moderate/severe AD to healthy (no AD) and mild AD

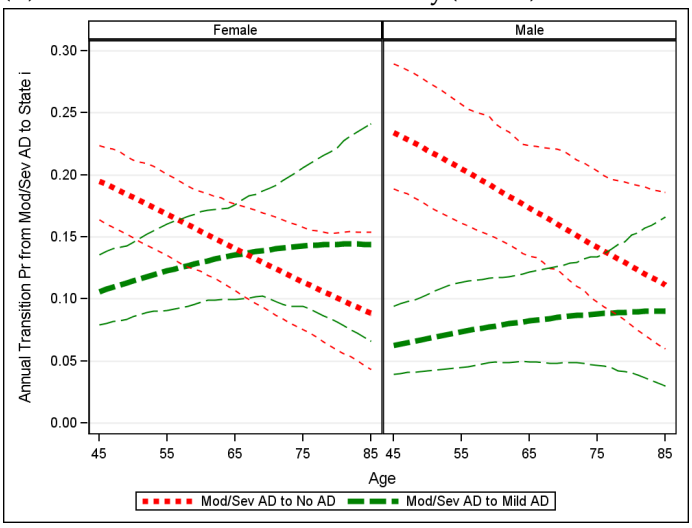


Figure 3: Estimated annual transition probabilities. Panel A: From healthy (no AD) to mild AD and moderate/severe AD; Panel B: From mild AD to healthy (no AD) and moderate/severe AD; Panel C: From moderate/severe AD to healthy and mild AD

Table 8: Distribution of observed transitions between mental health states (No AD, mild AD, Moderate/Severe AD) for respondents aged 45+ 2006-2012, Malawi

Observed distribution among disability states (no AD/mild AD/mod-sev AD) and death	Number of transitions	% among all transitions
No AD at both interviews	963	40.5%
No AD to mild AD	223	9.4%
No AD to mod-sev AD	211	8.9%
No AD to dead	58	2.4%
Mild AD to no AD	243	10.2%
Mild AD at both interviews	128	5.4%
Mild AD to mod-sev AD	107	4.5%
Mild AD to dead	30	1.3%
Mod-sev AD to no AD	201	8.4%
Mod-sev AD to mild AD	81	3.4%
Mod-sev AD at both interviews	105	4.4%
Mod-sev AD to dead	30	1.3%
Total	2380	

at ages 45–85, along with the 95% confidence interval around these estimated probabilities. The mental health state defined by mild AD symptoms is characterized by relatively high rates of entry and exit for both sexes, though the probability of the direction of these transitions (upwards to a state with moderate/severe AD, downwards to mentally healthy with no AD symptoms) changes substantially with age. At younger ages, both women and men are relatively likely to recover from mild mental health problems, however this probability of recover declines sharply with age. By age 65 women are more likely to enter a state with moderate to severe mental health problems than to recover to healthy life, while the corresponding cross over for men is delayed by 10 years and occurs at about age 75. Women are also significantly more likely to become moderately to severely depressed at almost all ages.

Transition probabilities from a mental health state with moderate/severe depression and anxiety symptoms is shown in Figure 3C and suggests that this is a somewhat tenacious state characterized by low probabilities for full recovery that decline with older age. Moreover, this probabilities are significantly lower for women than for men. In addition, after age 65 women are more likely to enter a state with moderate/severe depression and anxiety symptoms rather than to recover, a cross over that is not observed for the male respondents who have higher probabilities to fully recover to a healthy state than to move from having severe mental problems to a state characterized by mild AD.

Moving from the transition probabilities in Figure 3 to the corresponding *health expectancies* (HE) (Table 9 and Figure 4) allows us to understand how these age- and sex-specific annual probabilities of transition between mental health states translate into years lived with different levels of anxiety and/or depression. Specifically, the estimated health expectancies in Table 9 and Figure 4 show that that mature adults in rural Malawi are expected to live a substantial number of their remaining life years—and thus a significant fraction of their remaining LE—subject to some anxiety and depression. For example, our analyses show that the average 45 year old woman

Table 9: Microsimulation-estimated average remaining life expectancy (LE) at ages 45–75, by sex

Age	45		55	
	LE	95% CI	**LE**	95% CI
Female				
Life Expectancy	**28.61**	(25.76–31.18)	**21.98**	(19.75–24.03)
No anxiety/depression (no AD)	**12.93**	(11.52–14.72)	**8.24**	(7.08–9.72)
Mild anxiety/depression (mild AD)	**8.10**	(6.68–10.26)	**7.12**	(5.79–8.86)
Moderate/severe AD	**7.59**	(6–8.8)	**6.63**	(5.15–7.7)
Male				
Life Expectancy	**26.03**	(23.78–28.71)	**20.07**	(18.23–22.41)
No anxiety/depression (no AD)	**15.37**	(13.99–17.03)	**10.55**	(9.38–11.95)
Mild anxiety/depression (mild AD)	**5.51**	(4.27–6.73)	**5.03**	(3.83–6.24)
Moderate/severe AD	**5.15**	(3.89–6.54)	**4.48**	(3.38–5.76)
Age	**65**		**75**	
	LE	95% CI	**LE**	95% CI
Female Life Expectancy	**15.52**	(14.13–21.06)	**8.90**	(8.36–12.08)
No anxiety/depression (no AD)	**4.56**	(3.6–6.48)	**2.45**	(1.87–3.89)
Mild anxiety/depression (mild AD)	**5.90**	(4.71–8.4)	**3.20**	(2.34–4.37)
Moderate/severe AD	**5.06**	(3.87–6.68)	**3.26**	(2.35–4.37)
Male				
Life Expectancy	**26.03**	(23.78–28.71)	**20.07**	(18.23–22.41)
No anxiety/depression (no AD)	**15.37**	(13.99–17.03)	**10.55**	(9.38–11.95)
Mild anxiety/depression (mild AD)	**5.51**	(4.27–6.73)	**5.03**	(3.83–6.24)
Moderate/severe AD	**5.15**	(3.89–6.54)	**4.48**	(3.38–5.76)

Notes: Estimates were obtained from synthetic cohorts of 100,000 45-, 55-, 65-, and 75-year olds created via microsimulation, based on observed transition rates from 2006–2010 MLSFH data.

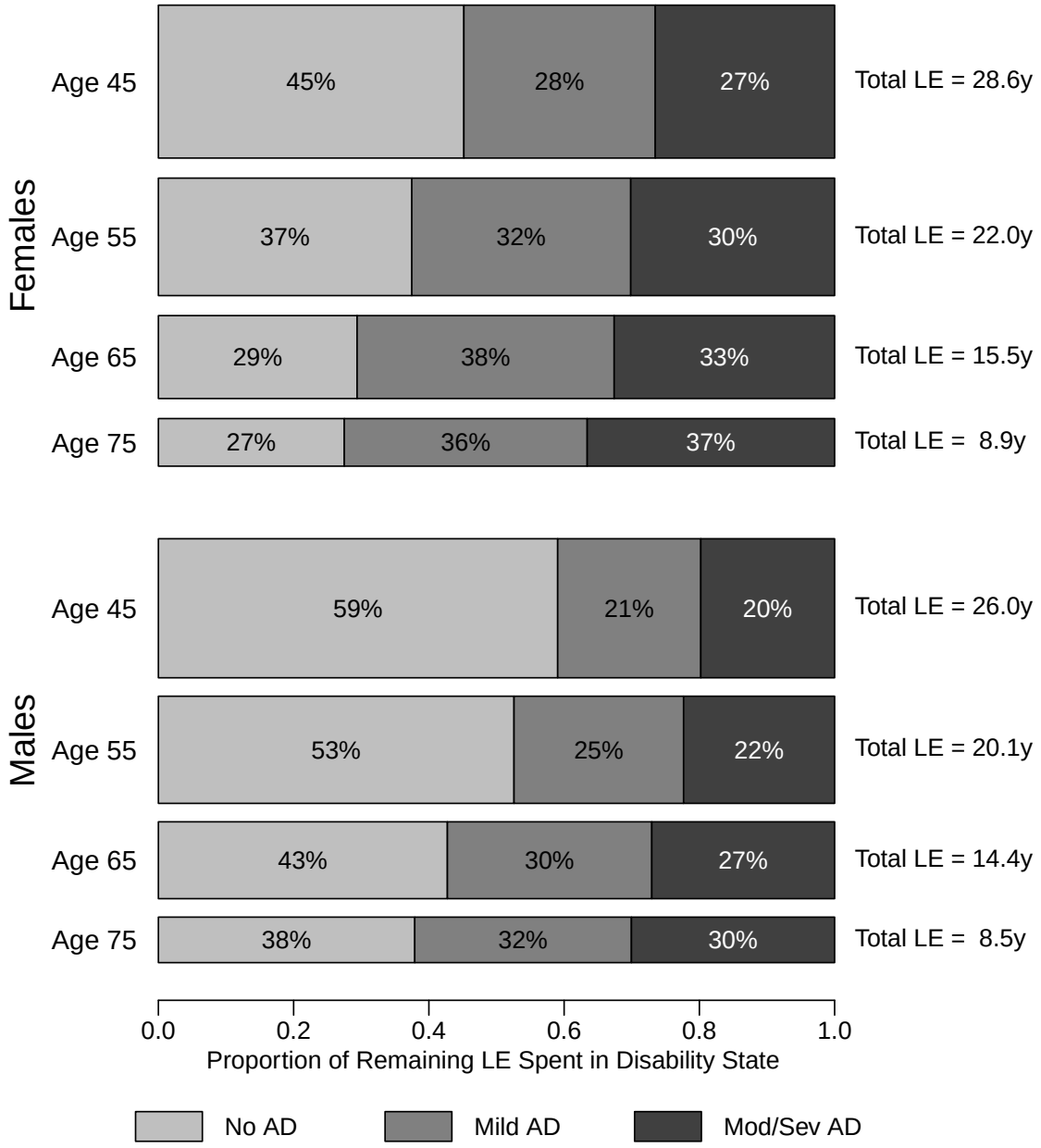


Figure 4: Distribution of remaining life expectancy (LE) by mental health: no anxiety/depression (No AD), mild anxiety/depression (Mild AD), moderately or severe anxiety/depression (Mod/Sev AD)

The figure shows the proportion of remaining life an average individual will spend with no, mild or moderately severe anxiety/depression at age 45, 55, 65, and 75. Top panel is for females, bottom panel is for males. The height and area of each bar is proportional to the overall remaining life expectancy of the synthetic cohorts with initial ages of 45, 55, 65 and 75 years, and the differently shaded areas represent the distribution of the remaining life expectancy across the three mental health states: no anxiety/depression (No AD), mild anxiety/depression (Mild AD), moderately or severe anxiety/depression (Mod/Sev AD). The bars do not necessarily reflect the ordering of these life-years by disability states as individuals in our analysis can recover and relapse between disability states, so not all years of limitation are spent at the end of life.

is expected to live about 28.6 additional years, making her expected age at death above 73 (the corresponding LE estimates for men are 26 and 71) (Table 9). These remaining life expectancies correspond broadly with other estimated life expectancy at these mature adult ages[20,139,140].

The key insight of the multi-state life table analyses is that a significant proportion of this remaining LE is subject to living with mild to severe anxieties and/or depression. Our estimates suggest that, on average, a 45 year old woman will live almost 55% of her remaining life with some anxieties or depressive symptoms, while an average male will live with anxieties or depressive symptoms for about 40% of his remaining life. About have of the time lived with depressions and anxiety are subject to moderate to severe depression and/or anxiety, that is, levels of anxiety and depression that have likely substantial impacts on individuals well-being and social/economic lives. It is important to point out, however, that the high rates of transition between mental health states across the life-course mean that time spent with anxieties or depressive symptoms does not occur solely at the end of life; instead, as we have discussed before, these mental health states are dynamic, and especially at younger mature adult ages, invividuals will often recover from anxieties or depression.

Figure 4 displays the proportions of remaining life expectancy spent in each mental health state by age, showing a clear and progressive increase in the amount of remaining life spent with anxieties/depression. By 75, women are expected to live about 73% of their remaining life with some anxieties/depression (this figure is 62% for men). Again, about half of this time with anxieties/depression is subject to moderate to severe levels of anxiety and/or depression.

5. Summary and Discussion

Most of the research investigating the distribution and determinants of mental disorders is conducted in the industrialized countries and mental health represents a neglected health dimension in low-income and resource-constraint settings such as the countries in sub-Saharan Africa. The patterns and the determinants of mental health are poorly understood albeit the increasing public health relevance and urge to understand and document mental well-being of the populations in this region. Specifically, understanding the demography of mental health is a first and critical aspect that can affect ***MH***-related health policies and international aid efforts in SSA as mental health disorders, especially depression, frequently co-occur with physical disabilities and have enormous consequences for the overall well-being of individuals. The present analysis represents a first attempt to describe the age-patterns of depression and anxiety in Malawi, divergences in the prevalence of mental health disorders by gender among mature adults, and the socioeconomic correlates of poor mental health. We also document the relationship between mental health disorders and HIV infection (objective and subjective), and we investigate the relationship between mental health patterns and physical health. Finally, using longitudinal data on mental health during 2006–12 and a multi-state life table, we estimate the proportion of remaining life that individuals spend with poor mental health in this rural SSA context.

Our results reveal a persistent male-female difference across all indicators with women reporting higher number of depressive and anxiety symptoms and lower scores on the SF-12 mental health indicator compared to men. The distribution of the PHQ-9 and anxiety scores reveals that

most respondents (around 60% for both genders) experience minimal (1-4 reported depressive symptoms) to mild (5-9 depressive symptoms) depression. Similarly, most respondents report 1 to 9 anxiety symptoms and thus fall into the range of experiencing some anxiety to mild anxiety. The correlation between the different measures of mental health (overall depression score, overall anxiety shore and SF12 mental health score) is relatively strong, with correlation coefficients of about 0.6. Respondents who score high on the depression index are thus also more likely to report higher number of anxiety symptoms and have lower SF-12 mental scores. The correlations of mental health measures with measures of physical health are weaker but statistically significant at the 5%-level, suggesting that respondents with higher number of depressive or anxiety symptoms report more functional limitations and have lower grip strength. Although the patterns are very similar for men and women, some sex-specific differences are noteworthy; for instance, the correlations of the overall depression scores with the overall anxiety scores, the SF-12 mental health scores and the total cognitive scores are somewhat weaker for men than women; in contrast, the correlation between depression and grip strength is stronger for men (-.31) than for women (-.25).

Both indicators of mental health problems, depression and anxiety, exhibit remarkably similar age patterns for both sexes. Men and women differ not only in the levels of depression and anxiety, but also in the changes of these two indicators with age. Specifically, women experience higher depression and anxiety over the entire age range 45-80, and this difference is statistically significant between ages 55 to 70, where the confidence intervals do not overlap. Depression and anxiety increase steadily with age for women from age 45 onwards, however the increase is less steep for men and occurs only after age 65 for depression and 60 for anxiety. The age-patterns of subjective well-being are consistent with the observations for depression and anxiety: both SF-12 and overall well-being decrease with age (as depression and anxiety increase), and this decrease occurs at younger ages and is steeper for women than for men.

Our analyses of the longitudinal 2006–12 MLSFH mental health data also show that mature and older adults in rural Malawi will spend a substantial fraction of their remaining life in a "unhealthy" mental health status. The proportion of life spend with mild to severe anxiety and depression increases with age. Although the pattern applies to both sexes, women are substantially more affected by depression than men and spend larger fractions of their remaining life with some mental problems with a different degree of severity. For instance, a 45 years old women is expected to spend about half of her remaining life with some mental problems, and at age 75 this fraction increases to about 73%. For men, the respective figures are 41% and 62%.

These findings are striking in the context of the research documenting mental well-being in industrialized countries. It has been well established that after age 50 Americans show increasing levels of emotional and mental well-being and decline in negative emotions.[128] In contrast, we document the exactly opposite pattern in rural Malawi. This finding is not an artifact because of measurement problems, but our multidimensional measurement approach shows that independent of how mental health is measured (i.e., depression, anxiety, SF-12 mental scores, or overall mental well-being) the findings are consistent across measures showing decline in mental health among men and women above age 45.

Among the various possible explanations about this pattern, the link to physical health and deteriorating health with age is particularly important given the high load of communicable and

non-communicable diseases that burden the elderly population in Malawi. Our findings show that physical health is a strong predictor of mental being among our respondents. The link between mental well-being and physical functioning may be particularly strong since it reflects decline in productivity, economic opportunities, dependence on others, and reduced economic and social productivity. Moreover, additional analysis based on our sample (not reported here) showed that mental health is indeed a significant predictor of economic productivity and outcomes, independent of physical functioning and status, but these effects are again gender specific and somewhat stronger for women than for men. For instance, independent of physical functioning, depression independently predicts reduced hours of work on own household/farm.

In summary, this analysis represents a first step to understand the demography of mental health—and in particular depression and anxiety—among mature and elderly individuals in a high-risk HIV/AIDS environment. Given the current state of the literature that provides only a very poor understanding of the prevalence, patterns and determinants of poor mental disabling chronic health outcomes in sub-Saharan context, our analyses will make an important contribution to the emerging literature on mental health and physical well-being in high-HIV prevalence contexts in sub-Saharan Africa.

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