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

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Keywords
Demography, Mental Health, Malawi, HIV, Stress, Con-Communicable Diseases. Sub-Saharan Africa, Adults, Global Burden of Disease, Malawi Longitudinal Study of Families and Health

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

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April 21, 2015

Abstract

While a nascent body of research investigates the shift in sub-Saharan Africa's (SSA's) disease burden towards non-communicable diseases (NCDs), very few studies have investigated mental health, specifically depression and anxiety (***DA***), in SSA. Using the 2012–13 Malawi Longitudinal Study of Families and Health (MLSFH), this paper provides a first picture of the demography of ***DA*** among mature adults (= persons aged 45+) in a low-income high HIV-prevalence context. ***DA*** are more frequent among women than men, and individuals are often affected by *both*. ***DA*** are associated with adverse outcomes, such as less nutrition intake and reduced work efforts. ***DA*** also increase substantially with age for both females and males, and mature adults can expect to spend a substantial fraction of their remaining life time—for instance, 52% for a 55 year old woman—affected by ***DA***. The positive age-gradients of ***DA*** are not due to cohort effects, and they are in sharp contrast to the age pattern of mental health that have been shown in high-income contexts where older individuals often experience lower levels of ***DA*** and better subjective well-being than middle-aged individuals. While socioeconomic and risk/uncertainty-related stressors are strongly associated with ***DA***, they do not explain the positive age gradients and gender gap in ***DA***. Stressors related to physical health, however, do. Hence, our analyses suggest that the general decline of physical strength and health with age, as is indicated by hand grip strength, and the interference of poor physical health with daily activities, are key drivers of the rise of ***DA*** with age among mature adults.

1. INTRODUCTION

Depression and anxiety (***DA***) are two important dimensions of mental health with a significant and growing contribution to the global burden of disease (Collins et al. 2013; Jack et al. 2014; Murray et al. 2012; Prince et al. 2007). They are an integral part of global population health (Susser and Patel 2014), and in resource-poor contexts, ***DA*** have been widely recognized as having important implications for individual productivity, individual/family-level well-being, and overall economic development (Bloom et al. 2011; Canavan et al. 2013; Cornwell et al. 2009; Dewa

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et al. 2007; Sorsdahl et al. 2011; Tampubolon and Hanandita 2014; The Lancet 2011). Despite their growing relevance, ***DA*** continue to be poorly documented and inadequately understood in low-income countries (LICs) and sub-Saharan African (SSA) countries affected by HIV/AIDS (Lund 2014; McKinnon et al. 2013; Tomlinson and Lund 2012; WHO 2013). To help fill this research gap, this paper will addresses essential—but under-researched—questions about the demography of ***DA*** among *mature adults*, defined as individuals aged 45 and older, in rural Malawi. For example: In this low-income high-HIV-prevalence context, why does the prevalence of ***DA*** increase markedly with age? Why do women have higher levels of ***DA*** than men across all mature adult ages? How are HIV- and mortality risk perceptions correlated with ***DA***, and to what extent do social or economic shocks explain variation in ***DA*** within this population? And, across the mature-adult life-course, how many persons-years are likely to be affected by ***DA***?

Using innovative data on ***DA*** collected among mature adults in 2012–13 as part of the Malawi Longitudinal Study of Families and Health (MLSFH; Kohler et al. 2014), our analyses show that, despite substantial socioeconomic hardship and often poor physical health, few mature adults reflect severe or moderately-severe levels of ***DA*** as defined by scales that have been predominantly developed for implemented in Western contexts.[1] But mild to moderate levels of ***DA*** are common among mature adults. Even at this modest severity, ***DA*** are systematically associated with adverse outcomes, such as less nutrition intake, less sexual intercourse and substantially reduced work efforts and earnings.

DA are more frequent among women than men, and individuals are often affected by *both*. ***DA*** also increase substantially with age for both females and males, along with substantial declines in overall mental health and subjective well-being. Mature adults can also expect to spend a substantial fraction of their remaining life time—for instance, 52% for a 55 year old woman—affected by ***DA***. The positive age-gradients of ***DA*** observed in the cross-sectional 2012–13 MLSFH data are not due to cohort effects, as a marked increase in ***DA*** with age is also found in fixed-effect analyses using up to 5 waves of MLSFH data from 2006–13. These positive age-gradients of ***DA*** in our Malawi mature adult population are therefore "*real*," and it is consistent with patterns found in another low-income population, the Tsimane forager-farmers in Bolivia (Stieglitz et al. 2014). This positive age-gradient of ***DA*** in our study population, however, is in sharp contrast to the age pattern of mental health that have been shown in high-income contexts where older individuals often reflect lower levels of ***DA*** and better subjective well-being than middle-aged individuals (Blanchflower and Oswald 2008; López-Ulloa et al. 2013; Steptoe et al. 2015; Stone et al. 2010).[2]

The marked gender gap and the positive age-gradients in ***DA*** are not explained by a differential exposure to socioeconomic stressors. While the experience of a recent income loss, household-

[1] In a review of the epidemiology of depression across cultures, Kessler and Bromet (2013) point out that major depression is often found to have a lower prevalence in middle- and low-income countries than in high-income countries (although the review did not include any data from low-income countries such as Malawi). Possible explanations include that depression is, to some extent, an illness of affluence; but more likely, the review concludes, this pattern is due to differences in reporting of depressive symptoms, which we discuss in more detail below (Sections 3 and 4.2).

[2] Based on a similar U-shape pattern of well-being in great apes, Weiss et al. (2012) also argue that this U-shape in human well-being may not be not uniquely human; while partially explained by aspects of human life and society, its origins may lie partly in the biology we share with great apes.

level morbidity/mortality or other socioeconomic shock is associated with higher levels of ***DA***, individuals across all mature adult ages are exposed to these shocks. Exposure to such shocks therefore does not explain the age-gradient or gender gap in ***DA***. A similar pattern prevails for stressors related to risk perceptions and uncertainty: while worries about HIV, elevated risk-perceptions of mortality, exposure to HIV mortality, etc., are all associated with increased levels of ***DA***, these health stressors do not explain the significant increase of ***DA*** with age, and neither do they explain why women have higher levels of ***DA*** than men. Instead, our analyses suggest that declining mental health with age among mature adults in Malawi is importantly related to declines in physical health. A weak hand grip strength and limitations in daily activities resulting from poor physical health are strongly associated with ***DA***. Moreover, due to their gender differentials and increasing prevalence with age, these factors explain a substantial part of the positive age-gradient and gender gap in ***DA***. Most strikingly, given that it is an indicator of physical strength that is measured rather than self-reported, the decline in grip strength with age among Malawian mature adults explains 32–35% of the age-gradient in ***DA***. While our analyses cannot identify the causal direction, it seems likely that in a Malawian context the relatively poor physical health of mature adults is importantly related to the long-term exposure to disease and poor nutrition that mature adults have experienced. If this is the case, our analyses suggest that the general decline of physical strength and health with age and the interference of poor physical health with daily activities are key drivers of the rise of ***DA*** with age among mature adults.

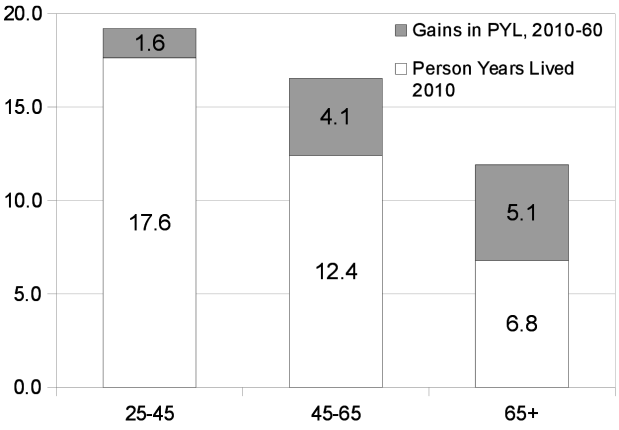
Prior to this study, no large-scale population-based data on ***DA*** using established clinical scales was available for a poor rural sub-Saharan African mature-adult population. The 2012–13 MLSFH mature-adult surveys provide an important resource for understanding mental health in such contexts. Our analyses highlight that ***DA*** is an important aspect in the life of mature adults in contexts such as Malawi, and that increased attention to ***DA*** in the broader global health agenda has the potential to substantially improve the health and well-being of older individuals in contexts such as Malawi. This study has also documented that the collection of commonly-used survey-instruments for identifying for ***DA*** is possible even in a subsistence-agriculture population that is characterized by high levels of poverty, low levels of schooling, high levels of illiteracy, and often poor health.

2. Fundamental Gaps in Understanding the Demography of Depression and Anxiety in SSA LICs

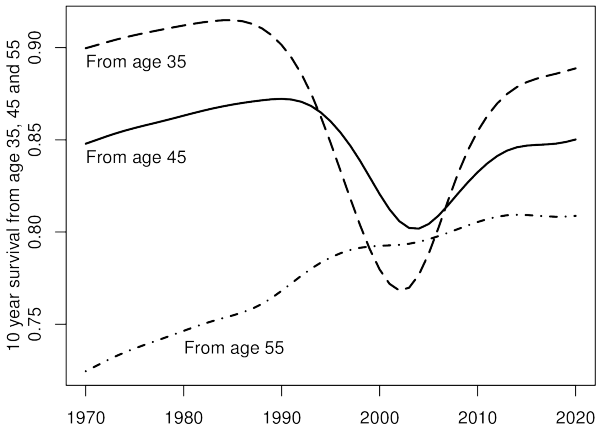
Our focus in this paper on the demography of ***DA*** is on *mature adults*, defined here as adults aged 45+, who represent an increasingly important subset of societies in SSA. The population of mature adults will grow more rapidly in many SSA countries than any younger 10-year age group in the next decades (own calculations based on UN Population Division 2012). By 2060, the fraction of the population in SSA aged 45–65 is expected to exceed that of 15–24 year olds, and the 65+ population alone is expected to represent more than 5% of the SSA population after 2040. In the

Figure 1: Gains person years lived by age group 2010–60 (Malawi), survival probability from age 35 to 65 1970–2020 (Malawi)

(A) 2010 Person-Years Lived (PYL) above age 25, and PYL gained above age 25 during 2010–60 (Malawi)



(B) 10-year survival probability (males, Malawi) from 35, 45, 55



Notes: Based on UN Word Population Prospects (UN Population Division 2012) period life tables; Panel A is based on Arriaga (1984) decomposition of changes life expectancy at age 25 (e_{25}) during 2010–60.

next 50 years 80% of the additional persons-years lived among adults as a result of increasing life expectancies (LE) in SSA LICs such as Malawi will occur among individuals aged 45+ (Figure 1A): 4.1 additional years, or 38% of the overall adult LE gain, will occur among individuals aged 45–64, and 5.1 years, or 47% of the adult LE gain, will occur among individuals aged 65+. These recent and projected future improvements in the life expectancy of adults in high HIV-prevalence SSA LICs have reversed the previous trend of *declines* in adult survival chances during the 1990s and early 2000s when the HIV/AIDS epidemic caused large declines in life-expectancy (Ortblad et al. 2013; UNAIDS 2012) (Figure 1B). The recent and projected future gains in adult survival are importantly driven by the continued roll-out of antiretroviral treatment (ART) that has reduced the mortality and morbidity consequences of HIV infection (Bor et al. 2013; Floyd et al. 2012), reductions in malaria infections and improved treatment of malaria (WHO 2010), and gains in the treatment of selected non-communicable diseases (NCDs) (Msyamboza et al. 2011; Ntsekhe and Damasceno 2013).

Despite these gains, however, the overall well-being of mature adults is often low (McKinnon et al. 2013; Mills et al. 2011; Zimmer and Das 2014; see below), and the growth of mature adults will importantly contribute to the rising importance of non-communicable diseases (NCDs) in SSA LICs (Aboderin 2010; Maharaj 2013). 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 (Payne et al. 2013). Mature adults are also frequently affected by ***DA*** (McKinnon et al. 2013; Thapa et al. 2014). A better understanding of the health of mature adults, including how it is affected by ***DA*** and other NCDs, is therefore critical (Daar et al. 2014). Among other reasons, also because mature adults

constitute an economically important subset of society. They have an almost universal labor force participation in Malawi (98% at ages 50–64, 90% at age 65+, with virtually no "*retirement*") (Malawi National Statistical Office 2010), make important contributions to intergenerational transfers to both children and elderly parents (Kohler et al. 2012; Lee and Mason 2011), and have pivotal caretaking roles in families affected by HIV/AIDS (Floyd et al. 2007; Hosegood and Timaeus 2006; Merli and Palloni 2006; Nyasani et al. 2009; Reijer 2013; Zagheni 2011; Zimmer 2009).

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) (Dalal et al. 2011; Ebrahim et al. 2013), very few studies have investigated *depression and anxiety* (***DA***) in SSA middle- and low-income countries (recent exceptions include Canavan et al. 2013; He et al. 2012a; McKinnon et al. 2013; Okeke and Wagner 2013; Sweetland et al. 2014; Thapa et al. 2014). There continue to be important gaps in the literature (Daar et al. 2014), especially for mature adults in SSA LICs that are among the most rapidly growing subpopulations on the continent. The *Lancet Movement for Global Mental Health*, for example, accentuated the multiple interrelations between mental and other health disorders, and the implications of their frequent co-occurrence (Patel et al. 2008). ***DA***, for example, are associated with communicable and non-communicable diseases (including HIV/AIDS), and ***DA*** often result in poor health management, higher co-morbidity, poorer disease prognosis including more HIV risk behaviors and lower ART treatment adherence, social exclusion, and increased poverty (Lund 2010; Mayston et al. 2012; Prince et al. 2007). Scholars and NGOs have argued that health research and health policies in SSA LICs devote far too few resources to ***DA*** and poor ***MH*** (Aboderin 2010; Andrade et al. 2014; Beard et al. 2012; Daar et al. 2014; Jack et al. 2014; Lund 2014; Maharaj 2013). Leading development economists have also claimed that a poverty trap exists in LICs because *poverty begets poor mental health and therefore low productivity* (Banejee and Duflo 2007; Case and Deaton 2005) and because there is "*no health without mental health*" (Prince et al. 2007). 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*,"(The Nation 2012) and others have argued for the strengthening of mental health in the National Health Sector Strategic Plan (Bandawe 2010). Yet, research on ***DA*** that could inform mental-health-related changes in health policy or health infrastructure in SSA LICs is scant, and where it exists, it is often based on clinical/convenience samples, rather than population-based studies, and uses often uses measures that have unknown sensitivity and specificity in relation to a clinical diagnosis (Lund 2014). While the STEPS (Msyamboza et al. 2011) and SAGE (He et al. 2012b; Kowal et al. 2010; Ng et al. 2010; Peltzer and Phaswana-Mafuya 2013; Phaswana-Mafuya et al. 2013) surveys measure ***DA*** and other NCDs in SSA, these data lack information on older individuals and/or are only available for higher-income SSA countries (the findings of which do not necessarily generalize to the LIC context studied here).

3. CONTEXT, DATA AND MEASURES

Malawi is one of the poorest countries in the world, ranked 174 of 187 in terms of the human development index (UNDP 2014), with about 15% of its population considered "ultra-poor", i.e., with an estimated food consumption below the minimum level of dietary energy requirement (UNDP 2010). Life expectancy at birth is estimated to be 51 for men and 55 for women in 2010, and healthy life expectancy at birth is estimated at 44 years for males and 46 years for females (Salomon et al. 2012). In rural areas, where our study population is based, the majority of individuals engage in home production of crops, complemented by some market activities. Tuberculosis, malaria, and endemic parasites have a relatively high prevalence, as do chronic-disease risk factors such as tobacco use and alcohol consumption among mature adults (Guebbels and Bowie 2006; Msyamboza et al. 2011). HIV/AIDS is clearly widespread, as are worries about HIV and the household-level experience of AIDS-related mortality and morbidity. However, the vast majority of the population—more than 85% of adults aged 15–49, and an even higher fraction among adults aged 50 and over—is HIV negative (Freeman and Anglewicz 2012; Malawi DHS 2011). Yet, HIV-negative individuals also confront a high disease-risk environment characterized by high levels of poverty, episodic malnutrition, poor sanitation, a high prevalence of infectious diseases and endemic parasites, and limited access to health care facilities.

The Malawi Longitudinal Study of Families and Health (MLSFH) (Kohler et al. 2014) is one of very few long-standing publicly-available longitudinal cohort studies in a SSA LIC context with ***eight*** data collection rounds during 1998–2013 for up to 4,000 individuals. The MLSFH is collected in three regions: Balaka in the south, Mchinji in the center, and Rumphi in the north. The MLSFH cohorts were selected to represent the rural population, where the majority of Malawians (85%) live. A "*Cohort Profile*" of the MLSFH, providing detailed discussion of MLSFH sampling procedures, survey methods, survey instruments, and analyses of attrition has been published in the *International Journal of Epidemiology* (Kohler et al. 2014). Additional information on the MLSFH sample is also provided in Appendix A1.

Our analyses 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 (see Appendix A2 and Kohler et al. 2014 for additional details). 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 (Kohler et al. 2014). Most important for this paper, the 2012 and 2013 MLSFH collected extensive assessments of mental health (***MH***). These instruments allow us to measure different dimensions of ***MH***—depression, anxiety, and overall mental health—that contribute most to the burden of disease and are emphasized in the literature; they also allow us to assess both the presence and the severity of depression and anxiety disorders. 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.

Specifically, the mental-health related measures available in the MLSFH include: ***SF12 mental health score:*** 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 imple-

mented and validated in many different contexts (Fischer and Corcoran 2007; Ware et al. 2001). Higher SF-12 scores reflect better mental health. The SF-12 scale has been included in the MLSFH since 2006 (yielding 5 rounds of MLSFH SF12 data for mature adults until 2013).

Although the SF-12 mental health instrument provides a good understanding of the overall mental and emotional well-being of individuals (Macran et al. 2003), the measure does not allow an assessment of the presence and/or severity of clinically defined mental disorders such as depression or anxiety. To overcome this limitation, MLSFH collected additional measures of mental health in 2012 and 2013: the ***depression and anxiety modules of the Patient Health Questionnaire (PHQ)***. The 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 (Kroenke et al. 2001; Kroenke and Spitzer 2010; PHQ Website 2011; Spitzer et al. 1994). The ***depression module*** (***PHQ9***) includes nine questions about whether a respondent has been bothered by aspects such as the following during the last two weeks: (*i*) little interest or pleasure in doing things, (*ii*) feeling down, depressed, or hopeless,...(*vi*) feeling bad about yourself—or that you are a failure or have let yourself or your family down,...(*ix*) thoughts that you would be better off dead or of hurting yourself in some way. The ***anxiety module*** (**GAD7**, named so because it was initially developed to diagnose Generalized Anxiety Disorder) includes seven questions about whether a respondent has been bothered by aspects such as the following during the last four weeks: (*i*) feeling nervous, anxious or on edge; (*ii*) not being able to stop or control worrying;...(*vi*) becoming easily annoyed or irritable; (*vii*) feeling afraid as if something awful might happen. Though designed primarily as a screening and severity measure for generalized anxiety disorder, the GAD-7 also has moderately good operating characteristics for other common anxiety disorders (specifically, panic disorder, social anxiety disorder, and post-traumatic stress disorder). Response categories for all questions in the PHQ9 and GAD7 modules range from "0" (not at all) to "3" (nearly every day).[3]

An ***overall depression score*** (PHQ9 score) was computed as the total score calculated from the PHQ9 instrument. This PHQ9 score ranges from 0 (no depressive symptoms at all) to 27 (the highest possible score of depressive symptoms). Based on this PHQ9 score, official guidelines classify the clinical significance of depression as follows (with proposed treatment actions in parentheses): 0–4: none-minimal depression (no treatment); 5–9: mild depression (watchful waiting with repeat PHQ-9 at follow-up); 10–14: moderate depression (treatment plan, considering counseling, follow-up and/or pharmacotherapy); 15–19: moderately severe depression (active treatment with pharmacotherapy and/or psychotherapy); and 20–27: severe depression (immediate initiation of pharmacotherapy and, if severe impairment or poor response to therapy, expedited referral to a mental health specialist for psychotherapy and/or collaborative management) (Kroenke and Spitzer 2010).

[3]The translations of the PHQ9 and GAD7 modules in the local languages (Chichewa, Yao, Tumbuka) were pretested during focus-group interviews and pilot tests, and reverse translations ensured the accuracy of the final instruments. Interviewers were extensively trained in the collection of these scales, and the final surveys included an extensive introduction to the measurement of ***DA*** that familiarized respondents with concepts of ***DA*** and related aspects of mental health.

Similarly, an ***overall anxiety score*** (GAD7 score) was computed as the total score calculated from the GAD7 instrument. This GAD7 score ranges from 0 (no anxiety symptoms) to 21 (most severe anxiety symptoms), and the official guidelines specify scores of 5, 10, and 15 as cutpoints for mild, moderate, and severe anxiety, respectively (Kroenke and Spitzer 2010). A score larger than 10 is recommended for further evaluation when GAD7 is used as a screening instrument for anxiety disorders.

Although evidence suggests some universality in the experience of depression and anxiety in SSA when measured with scales that have primarily been validated in high-income settings, there also appears to be some variation in the expression and salience of symptoms across contexts that may reduce the sensitivity of PHQ9, GAD7 and related instruments to assess ***DA*** in a SSA LIC context (Sweetland et al. 2014). To reduce these concerns about the validity of established cutpoints for classifying ***DA***, for most of our analyses we assume that mental health does not involve a qualitative discontinuity between depressed and non-depressed status (or no/mild/severe anxiety disorder) that occurs at specific PHQ9 or GAD7 levels. Instead of relying on the official symptom classifications for the PHQ9 and GAD7, therefore, we use a linear specification of the PHQ9 depression score and GAD7 anxiety scores. In both cases, higher scores indicate that individual experiences higher number of depressive or anxiety symptoms. By using the full variation in the PHQ9 and GAD7 scores, we are able to better capture the range of depressive and anxiety symptoms without relying on a classification scheme that has predominately been validated for Western and more affluent contest and which may or may not be fully applicable to the LIC context studied here (Jacob and Patel 2014; Sweetland et al. 2014).

To facilitate a longitudinal analyses of ***DA*** based on the MLSFH waves 2006–13, of which only the last two waves include the above detailed mental health data, we also define a combined depression/anxiety index (DAX) that is derived from two questions that are part of the SF12: *"Q1: How much time of the time during the past 4 weeks have you felt calm and peaceful?"* and *"Q2: How much of the time during the past 4 weeks have you felt downhearted and depressed?"*. Both questions are specifically related to ***DA***, and are available in the MLSFH since 2006. The response categories range from 1 ="*All of the time*" to 5 = "*None of the time*". The DAX is then computed as follows: DAX = 0 (*no depression/anxiety*) when Q1 $\leq$ 2 and Q2 $\geq$ 4; DAX = 2 (*moderate/severe depression/anxiety* if Q1 $\geq$ 4 and Q2 $\leq$ 2; and DAX = 1 (*mild depression/anxiety*) otherwise. This DAX index is related to the SF12 mental health score, with a correlation of about -.8 in our data, but it has the advantage for our analyses that it is more explicitly focused on ***DA***.

4. RESULTS

4.1. MLSFH Mature Adults: Summary statistics

Table 1 (Columns 1–3) reports summary statistics of the analysis sample ($N_{2012} = 1,246$).[4] All respondents are 45 years or older. About 40% of the sample is aged 45–54, and the remainder is ap-

[4]The 2012 MLSFH interviewed 1,266 respondents, but 20 were below age 45.

Table 1: Summary statistics for the study population aged 45+ in 2012, Malawi

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Females mean (sd)	**Males** mean (sd)	**Total** mean (sd)	**Regression coefs for MH scores** (females & males combined) Depression	Anxiety	SF12 Ment.	Sub. Wellb.
# of observations	711	535	1,246	1,191	1,211	1,204	1,192
Age (2012)	59.4 (11.3)	60.7 (10.8)	60.0 (11.1)	–	–	–	–
Age Group							
45-54	0.43	0.35	0.39	ref	ref	ref	ref
55-64	0.29	0.33	0.31	0.50*	0.48**	-0.41	-0.042
65-74	0.17	0.20	0.18	1.27**	1.18**	-3.19**	-0.27**
75+	0.12	0.12	0.12	2.69**	2.08**	-5.19**	-0.53**
Schooling attainment							
No formal schooling	0.48	0.20	0.36	ref	ref	ref	ref
Primary schooling	0.50	0.68	0.58	-0.30	-0.23	-0.051	0.079
Secondary or higher	0.02	0.11	0.06	-1.51**	-0.83**	0.98	-0.018
Muslim	0.28	0.26	0.27	-0.42	-0.16	-0.24	0.069
Currently married	0.63	0.95	0.77	-0.79*	-0.38^{+}	2.39**	0.19*
HIV positive	0.04	0.05	0.05	1.05	0.22	-0.91	-0.24^{+}
Female	–	–	0.57	0.72**	0.57**	-1.84**	-0.15*

Note: HIV positive: any HIV test during 2004–12 is HIV positive. Columns 4–7 report the coefficients of a multivariate regression of the depression (PHQ9 score), anxiety (GAD7 score), SF12 mental health score and subjective well-being on respondent characteristics. p-values for these regression coefficients are indicated as: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

proximately evenly split between ages 55-64 and 65+. Schooling attainment is generally low, with 36% having no formal schooling and very few respondents having attended secondary school. About 27% of the study population is Muslim. Almost all of the men included in this analysis are currently married in contrast to only 63% of women (2/3rd of the not currently-married women are widowed, with the remainder being divorced or separated). Only about 5% of the study population is HIV positive,[5] reflecting possibly high levels of mortality among HIV+ individuals for these cohorts in the past (Figure 1). HIV prevalence among mature adults by age group is reported in Appendix Table A2.

4.2. Patterns of depression and anxiety among mature adults

The top panel of Table 2 reports summary statistics for three mental health scores collected in 2012: PHQ9 score for depression, GAD7 score for anxiety and SF12 score for an overall mental health indicators. Subjective well-being is reported for comparison,[6] as is our DAX depression/anxiety index derived from two questions of the SF12. Columns 1–3 report the mean scores and standard deviations in 2012, and columns 4–6 report the correlations among the four scores in 2012 (similar patterns prevail in 2013, see Table A3). In addition, Column 7 reports the correlation of

[5]Based on HIV testing in 2012, plus possibly any prior HIV test from 2008, 2006 or 2004.

[6]Subjective well-being, based on the question *How satisfied are you with your life, all things considered?*, ranges from 1 = very unsatisfied to 5 = very satisfied.

Table 2: Summary statistics for mental health indicators, respondents age 45+ in 2012, Malawi

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	2012 Mean (std dev)			Corr. across measures in 2012			Corr. with
	Females	Males	Total	PHQ-9	GAD-7	SF12	2013
PHQ-9 Depression Score	3.59	2.61	3.17	–	–	–	0.36
	(3.97)	(3.60)	(3.85)				
GAD-7 Anxiety score	2.88	2.20	2.59	0.68	–	–	0.32
	(2.65)	(2.45)	(2.59)				
SF12 Mental Health Score	51.9	54.4	53.0	-0.55	-0.65	–	0.27
	(10.4)	(9.09)	(9.91)				
Subj. Wellbeing	3.44	3.65	3.53	-0.30	-0.29	0.30	0.23
	(0.97)	(1.06)	(1.01)				
DAX depress./anxiety index	0.61	0.42	0.53	0.50	0.59	-0.79	0.26
	(0.81)	(0.74)	(0.78)				
	Proportions (2012)				Change in Score 2012-13		
	Females	Males	Total		worse	const.	better
Depression classification							
No depression	0.24	0.38	0.30		0.30	0.70	0.00
Minimal depression	0.47	0.42	0.45		0.26	0.42	0.32
Mild depression	0.20	0.14	0.17		0.17	0.16	0.68
Moderate depression	0.07	0.04	0.06		0.05	0.13	0.82
Moderately severe depression	0.02	0.01	0.02		0.12	0.00	0.88
Severe depression	0.01	0.01	0.01		0.00	0.00	1.00
Anxiety classification							
No anxiety	0.22	0.34	0.27		0.38	0.63	0.00
Some anxiety symptoms	0.53	0.48	0.51		0.24	0.49	0.27
Mild anxiety	0.23	0.16	0.20		0.16	0.27	0.57
Moderate/severe anxiety	0.02	0.02	0.02		0.00	0.29	0.71
# of observations	724	542	1,266				

Notes: Subjective well-being ranges from 1 = very unsatisfied to 5 = very satisfied. The 2012–13 change in score is classified as *worse* if the PHQ9 or GAD7 score increases by more than 1 during 2012–13 (thus indicating higher levels of depression/anxiety in 2013 as compared to 2012; the change in score is classified as *better* if the PHQ9 or GAD7 score declines by more than 1 during 2012–13 (thus indicating lower levels of depression/anxiety in 2013 as compared to 2012. The change is considered constant if the difference in the 2012–13 scores equals one or less. See Table A3 for corresponding 2013 descriptive statistics.

each measure between the 2012 and 2013 waves. Columns 4–7 in Table 1 report a multivariate regression of each of the three mental health scores and subjective well-being on basic respondent characteristics.

All three measures indicate marked gender difference, with women having worse mental health and subjective well-being than men (Table 2), and a significant decline of mental health occurs with age (Table 1, Columns 4–5): the PHQ9 depression score and the GAD7 anxiety score are elevated among 65–74 year olds by about 33% and 46% of one standard deviation respectively, and by about 70% and 80% of one standard deviation among 75+ year olds. Overall mental health declines accordingly with age, as does well-being (Table 1, Columns 6–7). These age patterns of ***DA*** will be analyzed in more detail in Section 4.3. Higher levels of schooling are associated with better mental health outcomes, as is being currently married (Table 1). Being HIV-positive is *not* significantly associated with mental health in this study population, possibly related to the low HIV prevalence (5%), and neither is being Muslim.

The relatively low levels of the PHQ9 and GAD7 scores in Table 2 are noteworthy given that the scales range from zero to 27 (for the PHQ9) and zero to 21 (for the GAD7), and that casual observation during fieldwork indicated relatively widespread problems with poor mental health. The mean SF12 mental health score of 53 is also not substantially different from the mean levels that this score yields in many higher-income contexts (e.g., the SF12 score is calibrated to have a mean of 50 and SD of 10 in the US population), and only about 15% of mature adults reported being very or somewhat unsatisfied with life. Consistent with these findings, classifying depression and anxiety based on the respective PHQ9 and GAD7 guidelines in the bottom panel of Table 2 (Columns 1–3) indicates fairly low levels of depression or anxiety. Based on these PHQ9 and GAD7 classification guidelines, which have primarily been validated in more affluent populations (Jacob and Patel 2014; Sweetland et al. 2014), about 25% of respondents (29% among women, 19% among men) exhibit mild or higher levels of depression, and 22% (25% among women, 28% among men) express mild or higher levels of anxiety. Moderately-severe and severe depression, and moderate-severe anxiety are fairly rare, affecting only about 2% of mature adult respondents.

These low reported levels of ***DA*** may be related to the fact that individuals in a context such as Malawi are often not very sensitized towards issues related to poor mental health (for a related discussion, see Kessler and Bromet 2013), and individuals thus tend to underreport anxiety, depression and poor mental health; or, they may tend to understate feelings of ***DA*** because they occur relatively common in this context, and individuals use their immediate social environment as their reference group. The influence of such reference group has been well documented with respect to subjective well-being and subjective health (Carrieri 2012; Giora and Baron-Epel 2003), where subjective measures often accurately reflect within-population variation in well-being and health, but often do not substantially vary across populations with very different levels of objective health or well-being.

Nevertheless, even at the fairly modest levels of depression and anxiety identified by the PHQ9 and GAD7 measures, the presence of depression and anxiety is importantly associated with lower subjective well-being, less food consumption, less sexual activity, lower earnings and savings,

and reduced work efforts in this study population (Models 1 and 2 in Table 3). The effects are sizable, with mild depression for instance associated with 11% decline in the number of days in which individuals consume chicken, fish or meat, a 15% reductions in annual earnings, and a 15% reduction in the number of hours devoted to work on the own farm or domestic work. Reductions are larger—often by about 50–100%—for moderate and more severe levels of depression, and for several outcomes in Table 3, depression and anxiety have independent effects in multivariate analyses (Model 3).

Within each wave, the correlation coefficients (absolute values) for the PHQ9, GAD7 and SF12 scores range between .55–.68 (Columns 4–5 in Table 2), indicating that depression, anxiety and overall mental health are affected by common stressors revealed through multiple dimensions of mental health, including depression *and* anxiety. Such stressors, investigated in more detail below, include social or economic shocks (such as poor crop yields and morbidity/mortality among household members), health concerns (including worries about HIV/AIDS), and poor physical health. The correlation of the mental health measures—depression, anxiety and overall mental health (SF12)—with subjective well-being is around .30, indicating that subjective well-being does not adequately capture these dimensions of mental health. Our combined DAX depression/anxiety index is correlated at .50–.59 with the more detailed PHQ9 and GAD7 measures of depression and anxiety, indicating that this simple index already captures significant variation in ***DA***.

The correlation of the mental health scores between 2012 and 2013 is however relatively weak at .27–23 (Table 2, Col 7), indicating that many of these influences on depression, anxiety and overall mental health are relatively short-term, and often dissipate during the course of one year.[7] The change in the PHQ9 and GAD7 score between 2012 and 2013, which is indicated in the bottom panel (Columns 5–7) of Table 2 as a function of the 2012 level of depression (for PHQ9) and anxiety (for GAD7), shows that the relatively modest 2012–13 correlation is due to the fact that depression (anxiety) often improves for individuals exhibiting moderate to severe levels of depression (anxiety), while 31% (38%) of individuals with no depression (anxiety) exhibit some levels of depression (anxiety) by 2013. These low correlations between the DA scores in 2012 and 2013 are consistent with the expectation that mild and moderate DA are more likely to be short term and fluctuate over time, which we also document in our multi-state lifetable analyses in Section 4.7, while severe depression is generally more persistent and treatment recommendations include pharmacotherapy and/or psychotherapy (Kessler and Bromet 2013).

4.3. Age patterns of mental health

Figure 2 depicts the age pattern of the depression (PHQ9), anxiety (GAD7) and overall mental health (SF12 mental) scores (based on pooled 2012–13 regressions, controlling for schooling, region

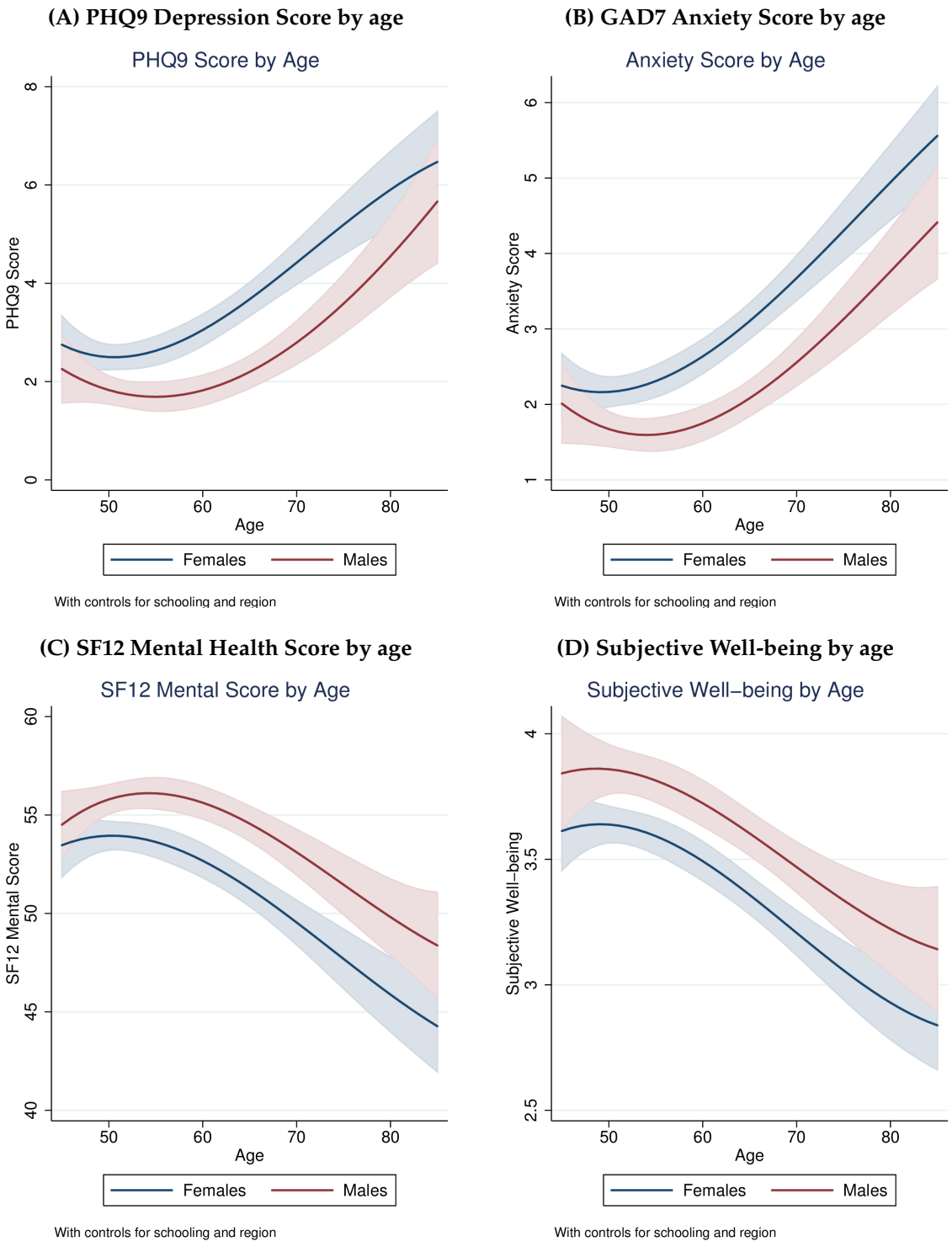
[7] Measurement error in the different mental health scores is a second possibility resulting in a low 2012–13 correlation in these scores; but if measurement error were substantial, one would also expect relatively low correlation across different scores within a survey year; but this is not the case, and the PHQ9, GAD7 and SF12 scores within each wave are relatively strongly correlated with correlation coefficients (absolute values) at 0.55–0.68 (in 2012) and 0.69–0.90 (in 2013).

Table 3: Association of depression and anxiety with subjective well-being, food consumption, sexual activity and work efforts and earnings: pooled regressions for 2012 and 2013

	(1)	(2)	(3)	(4)	(5)	(6)
	Subj. well-being[a]	Food intake[b]	Sexual activity[c]	Earnings (log) past year[d]	Any savings[e]	Work effort
Mean of dep. var.	3.53	2.90	3.66	10.2	0.40	21.3
Std dev	(0.97)	(1.93)	(1.89)	(1.31)	(0.49)	(14.4)
Regressions on:	OLS	OLS	OLS	OLS	Logit	OLS
Model 1: Depression (based on PHQ9; ref: no depression)						
Minimal depress.	-0.21**	-0.13	-0.20**	-0.075	-0.14	-0.24
	(0.043)	(0.087)	(0.074)	(0.058)	(0.11)	(0.67)
Mild depress.	-0.52**	-0.31**	-0.46**	-0.16*	-0.26*	-3.13**
	(0.058)	(0.11)	(0.096)	(0.077)	(0.13)	(0.82)
Moderate+ depress.	-0.97**	-0.63**	-0.83**	-0.41**	-0.91**	-7.42**
	(0.091)	(0.18)	(0.13)	(0.14)	(0.22)	(1.23)
Model 2: Anxiety (based on GAD7; ref: no anxiety)						
Some anxiety	-0.26**	0.024	-0.22**	0.016	-0.022	0.74
	(0.044)	(0.088)	(0.074)	(0.056)	(0.10)	(0.65)
Mild anxiety	-0.65**	-0.36**	-0.49**	-0.19*	-0.26+	-3.33**
	(0.056)	(0.11)	(0.099)	(0.079)	(0.13)	(0.83)
Moderate/severe anx.	-1.11**	-0.45	-0.80**	-0.79**	-0.47	-12.1**
	(0.14)	(0.28)	(0.21)	(0.24)	(0.32)	(1.55)
Model 3: Depression and anxiety						
Depression (based on PHQ9; ref: no depression)						
Minimal depress.	-0.046	-0.21+	-0.12	-0.11	-0.23+	-0.91
	(0.061)	(0.12)	(0.098)	(0.074)	(0.14)	(0.87)
Mild depress.	-0.25**	-0.27+	-0.36**	-0.13	-0.37+	-2.57*
	(0.079)	(0.16)	(0.13)	(0.11)	(0.19)	(1.10)
Moderate+ depress.	-0.61**	-0.57**	-0.70**	-0.20	-1.06**	-3.93*
	(0.12)	(0.22)	(0.18)	(0.16)	(0.28)	(1.59)
Anxiety (based on GAD7; ref: no anxiety)						
Some anxiety	-0.21**	0.16	-0.12	0.089	0.14	1.52+
	(0.060)	(0.12)	(0.098)	(0.072)	(0.14)	(0.84)
Mild anxiety	-0.41**	-0.11	-0.15	-0.081	0.13	-1.25
	(0.079)	(0.16)	(0.14)	(0.11)	(0.19)	(1.16)
Moderate/severe anx.	-0.58**	0.035	-0.22	-0.66*	0.33	-8.94**
	(0.17)	(0.33)	(0.27)	(0.26)	(0.39)	(1.97)

Notes: p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. Analyses are pooled across 2012 and 2013 MLSFH mature adult survey. Standard errors are adjusted for clustering within respondents. All analyses additionally control for age, age squared, female, region and MLSFH wave. (*a*) Based on question: How satisfied are you with your life, all things considered? 1 = very unsatisfied, 6 = very satisfied. (*b*) Based on question: About how many days last week did you eat chicken, fish or meat? (*c*) Based on question: In general, how frequently did you have sex in the past 12 months? 1 = not at all, 6 = 4 or more times per week. (*d*) Based on question: Think about all of the work that you have done in the past 12 months in which you have been paid cash or kind. How much do you estimate that you have earned in the past year? 268 observations (11%) were excluded when taking logs because zero earnings were reported. (*e*) Based on question: Do you currently have any savings for the future, such as a bank account, savings group, or cash? (*f*) Based on sum of responses to questions: Approximately how many hours did you spend during the last completed week doing unpaid work for your own household farm (such as field preparation, ridging, planting, farm labor, weeding, harvest, animal care, gathering vegetables, etc.)? Approximately how many hours did you spend during the last completed week doing unpaid domestic household duties for your household (such as cooking, fetching water, washing clothes, repairing building, cleaning inside/outside home)?

Figure 2: Age patterns of depression, anxiety and overall mental health for men and women age 45+ in 2012–13, Malawi



Notes: Marginal means (with 95% confidence intervals) obtained by regressing the respective mental health score on a cubic function of age, separately by sex, and controlling for schooling, region and MLSFH wave. Analyses are pooled across 2012 and 2013 MLSFH mature adult survey. Confidence intervals are adjusted for clustering within respondents.

and MLSFH wave).[8] Depression and anxiety scores increase markedly for individuals aged 55 and older, with women exhibiting higher levels of ***DA*** across all mature-adult ages. The increases with age are substantial: the average depression score for a 70 year old woman is on average 1.9 points (52% of a standard deviation) above that of a 50 year old women, and the anxiety score is 1.5 points (55% of a standard deviation) higher (for men, the respective differences are 29% and 35% of a SD). Overall mental health, as reflected by the SF12 score, declines accordingly, and the diminishing mental health among older adults in rural Malawi is part of a broader pattern of declining subjective well-being with age among mature adults.

Linear approximation of the age-gradients in Figure 2, estimated via linear regressions of our mental health measures on age and selected controls, are reported in Table 4 (Columns 1–2). The coefficients show that the depression and anxiety scores increase on average by .093 and .077 respectively per year of age for mature adults in the 2012–13 MLSFH data, and that overall mental health (SF12) and subjective well-being decline by .21 and .02 per year of age. Except for the anxiety score, there are no significant differences in these linearized age-gradients between males and females. For anxiety, the age-gradient is about 34% steeper for women then for men.

The analyses in Figure 2 and Table 4 (Columns 1–2) are cross-sectional, and it is thus conceivable that the age-gradient in these analyses results from cohort differences in mental health (Blanchflower and Oswald 2008). However, as the MLSFH includes longitudinal information on the SF12 mental health score and subjective well-being for the period 2006–13 (5 waves, available for these two outcomes only), we are able to estimate the age-gradient in overall mental health (SF12), well-being and our DAX depression/anxiety index using 2006–13 panel data (Table 4): in Columns 3–4, using a random-effect model with 10-year cohort dummies, and in Columns 5–6, using a fixed-effect model with individual-level fixed effects. In both the random-effect and fixed-effect models, the age gradient of ***DA*** is identified because the MLSFH data provide multiple (up to five) observations for SF12, subjective well-being and DAX during 2006–13. Most importantly, the fixed-effect analyses in Columns 5–6 show that the SF12 mental health score and subjective well-being *decline*, and the DAX *increases*, as individuals age during 2006–13, even after controls for individual fixed effects. The magnitude of the age-gradient in the fixed-effect model is generally not substantially different from that observed in the cross-section during either 2012–13 (Columns 1–2) or 2006–13 (Columns 3–4), and there is no evidence for male–female differences in the age-gradient. While we can conduct the fixed-effect analyses for the time period 2006–13 only for the bottom-three indicators in Table 4, the moderately-strong correlation of these measures with both the depression and anxiety scores (Table 2) suggests that findings would be similar also for the PHQ9 depression and GAD7 anxiety scores (which are only available for 2012–13). Hence, because the fixed effect eliminate any time-invariant individual-level factors, including any cohort effects, the results in Table 4 provide evidence that the observed declines of mental health with age are not the result of cohort differences. Both the longitudinal analyses and the cross-sectional anal-

[8]We do not control for religion because it is essentially collinear with region (in the MLSFH study population, Muslims are concentrated in the MLSFH region of Balaka); we do not control for marital status because it is time-variant and endogenous with respect to mental health.

Table 4: Linear age-gradients for mental health outcomes: cross-sectional and longitudinal analyses

Method	Random Effect Model (RE)		RE with Cohort Dummies		Fixed Effect Model	
MLSFH waves	2012–13		2006–13		2006–13	
	(1)	(2)	(3)	(4)	(5)	(6)
PHQ9 depression score:						
Age	0.093**	0.085**	–	–	–	–
	(0.0076)	(0.012)				
Age × female		0.014	–	–	–	–
		(0.015)				
Observations	2,407	2,407	–	–	–	–
GAD7 anxiety score:						
Age	0.077**	0.064**	–	–	–	–
	(0.0055)	(0.0085)				
Age × female		0.022*	–	–	–	–
		(0.011)				
Observations	2,429	2,429	–	–	–	–
SF12 mental health score:						
Age	-0.21**	-0.18**	-0.17**	-0.15**	-0.20**	-0.27**
	(0.020)	(0.031)	(0.049)	(0.052)	(0.059)	(0.081)
Age × female		-0.060		-0.035		0.14
		(0.040)		(0.028)		(0.10)
Observations	2,419	2,419	5,397	5,397	5,557	5,557
Subjective wellbeing:						
Age	-0.020**	-0.020**	-0.014**	-0.013*	-0.025**	-0.027**
	(0.0019)	(0.0030)	(0.0048)	(0.0051)	(0.0059)	(0.0082)
Age × female		-0.0008		-0.0021		0.0042
		(0.0038)		(0.0027)		(0.010)
Observations	2,428	2,428	5,457	5,457	5,618	5,618
DAX depression/anxiety index:						
Age	0.019**	0.018**	0.011**	0.010**	0.013**	0.019**
	(0.0015)	(0.0023)	(0.0036)	(0.0039)	(0.0046)	(0.0063)
Age × female		0.0010		0.0016		-0.0099
		(0.0030)		(0.0021)		(0.0078)
Observations	2,426	2,426	5,448	5,448	5,609	5,609

Notes: p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. Depending on the outcome, analyses are based on 1,240–1,297 individuals; the reported number of observations is the total number of data points (with multiple observations per individual). Analyses are pooled across the MLSFH rounds indicated, and random effect models are used to adjust for clustering within respondents in the pooled analyses. Random-effect models additionally control for female, region, schooling, and include dummies for each MLSFH wave to control for potential time trends. The RE model for 2006–13 includes 10-year cohort dummies. Fixed-effect models include dummies for each MLSFH wave to control for potential time trends.

yses therefore consistently suggest that older individuals have worse mental health—including higher levels of ***DA*** and lower levels of well-being—than middle aged individuals.

This marked decline of mental health is in sharp contrast to the age pattern of psychological well-being that has been documented in the U.S. and other high-income countries (Blanchflower and Oswald 2008; Easterlin 2006; Stone et al. 2010). In these contexts, psychological well-being is generally U-shaped, showing increasing well-being after an age of 50 years. A large scale study in the U.S. for example showed that stress and anger steeply declined from the early 20s, worry was elevated through middle age and then declined, and sadness was essentially flat (Stone et al. 2010). Depression has been shown to have a similar inverted U-shape, declining markedly after mid-ages (López-Ulloa et al. 2013). We find the opposite in our data: ***DA*** increase with age among mature adults in Malawi, along with an decline in overall mental health and subjective well-being.

In summary, two important aspects emerge from the analyses of mental health among mature adults in Malawi: First, across all measures—depression, anxiety, overall mental health and subjective well-being—a consistent *gender gap* prevails, with women having worse mental health (but not necessarily a stronger age-gradient) than men (this pattern is often observed also in other populations Kessler and Bromet 2013). Second, mature adults in Malawi have an age-pattern of mental health that is opposite to the one documented in high-income contexts: mental health among mature adults in Malawi *declines* with age, with a particularly marked decline after age 55. This pattern does not conform with the inverted U-shape of well-being and U-shape of mental health that has been documented across the life-course in the U.S. and other developed countries (Stone et al. 2010).

4.4. Mental health, age and socioeconomic stressors

Mature adults in rural Malawi are regularly exposed to social and economic shocks (stressors) that are likely to affect mental health, including mortality of household members, disease and health shocks, volatile crop yields and incomes, etc. Beyond the direct mental health affects of these shocks, stress due the perception of uncertainty and exposure to substantial risks can result in depression and/or anxiety (Carleton et al. 2012; Lund et al. 2010). Our analyses in this section will try to answer whether the gender-gap and age-gradients are due to differential exposure to such stressors, either by sex or age, or if other factors provide the underlying cause of mental health differentials by age and sex. Here, as well as in the subsequent sections, our main analyses will focus on depression and anxiety, as measured in the 2012–13 MLSFH Mature Adult Surveys through the PHQ9 and GAD7 scores. Corresponding analyses of overall mental health and subjective well-being are included in the Appendix.

Measures of socioeconomic shocks in the MLSFH are based on a set of questions about whether a respondent's household was affected in the last year by (1) death or serious illness of an adult member, (2) poor crop yields, loss of crops due to disease or pests, or loss of livestock, (3) loss of income source, (4) breakup of household and (5) damage of house due to fire, flood or other expected event. Panel A in Table 5 shows the mean number of shocks experienced by mature adults of different ages, conveying clearly that the experience of shocks is common: more than

Table 5: Age-patterns in anxiety/depression and socioeconomic stressors: 2012–13 MLSFH mature adults

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Death or illness[a]	Poor crop yields[b]	Loss income source[c]	Breakup of househ.[d]	Damage of house[e]	Total (=sum)[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	0.36	0.55	0.23	0.05	0.08	1.27
55-64	0.32	0.57	0.23	0.03	0.08	1.23
65-74	0.30	0.57	0.23	0.01	0.09	1.20
75+	0.31	0.53	0.22	0.03	0.07	1.15
Female–male diff.	0.076**	0.038+	0.020	0.0084	0.014	0.16**
B. Association of stressor with depression (PHQ9 score)[2]						
Stressor	0.78**	0.68**	1.00**	-0.054	0.47	0.62**
	(0.17)	(0.15)	(0.19)	(0.42)	(0.31)	(0.087)
C. Depression: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age-gradient	1.0%	0.6%	0.4%	-0.1%	0.1%	2.4%
Female–male diff.	-5.6%	-1.9%	-2.7%	0.0%	-0.7%	-9.2%
D. Association of stressor with anxiety (GAD7 score)[2]						
Stressor	0.54**	0.51**	0.58**	0.34	0.70**	0.46**
	(0.12)	(0.11)	(0.13)	(0.31)	(0.23)	(0.063)
E. Anxiety: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age-gradient	0.8%	0.5%	0.2%	0.5%	0.2%	2.1%
Female–male diff.	-5.5%	-2.0%	-2.4%	-0.4%	-1.4%	-9.9%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

(1) The social and economic stressors were measured in the MLSFH through the question: *Over the past two years, was your household affected positively or negatively by any of the following unexpected events or crises?* (1 = yes, 0 = no) (*a*) Death or serious illness of an adult member or someone who provides support for yourself or your family? (*b*) Poor crop yields, loss of crops due to disease or pests, or loss of livestock due to theft or disease, or loss of coupon? (*c*) Loss of source of income—such as loss of employment, business failure, someone who had been assisting the household stopped their support? (*d*) Breakup of household, such as a divorce? (*e*) Damage to house due to fire, flood, or other unexpected event? (*f*) Total is the sum across *a*–*e*.

(2) Regression coefficient for each of these socioeconomic stressors obtained in linear regressions of the PHQ9 depression score (or the GAD7 anxiety score) on the respective stressor, age, female and selected controls (region, schooling, MLSFH wave).

(3) Change in the age-gradient and female–male difference in depression (or anxiety) if the socioeconomic stressor is included in a regression of the PHQ9 depression score (or the GAD7 anxiety score) on age, female and selected controls (region, schooling, MLSFH wave).

30% of mature adults experienced a death or serious illness of an important household member, more than 50% were affected by poor crop yields or crop failures, and more than 20% lost an income source within the 1–2 years prior to the survey. On average, respondents experienced around 1.2 of the shocks listed in Columns 1–6 of Table 5. However, while experience of such socioeconomic shocks is common, none of the shocks in Table 5 exhibit a strong age pattern. This is due to the fact these socioeconomic shocks are essentially household-level or community-level events, hence affecting individuals mostly irrespective of their age.

To analyze if these experience of socioeconomic shocks is associated with depression, Panel B in Table 5 reports the regression coefficient for each of these socioeconomic stressors obtained from linear regressions of the PHQ9 depression score on the respective stressor, age, female, and selected controls (region, schooling, MLSFH wave). Panel C reports the change in the age-gradient of depression and the female–male difference in depression when each socioeconomic stressor is included in the estimation.

The key finding obtained from these analyses in Table 5 is that, while several of the socioeconomic shock variables are strongly and significantly associated with depression, controlling for socioeconomic shocks in the estimation neither changes the age-gradient of depression nor reduces the estimated female–male difference. Similar findings prevail for anxiety (Panel D–E in Table 5), and as well as overall mental health (SF12) and subjective well-being (Appendix). It is therefore likely that the experience of socioeconomic shocks—events such as mortality or morbidity of household members, poor crop yields or income loss—importantly contribute to ***DA*** among mature adults in Malawi, as one would expect based on the existing literature (Baird et al. 2011; Lund et al. 2010). However, a differential exposure to such socioeconomic stressors neither explains the gender gap in mental health, nor rise of depression or anxiety with age among mature adults.

4.5. Mental health, age and risk/uncertainty-related stressors

Table 6 continues the approach of the previous section, investigating if stressors related to perceived risks and uncertainty provide an explanation for the increase of ***DA*** with age, and the gender gap in mental health among mature adults in Malawi. Perceived risks and uncertainties are well-known factors contributing to depression and anxieties (Carleton et al. 2012; Lund et al. 2010), and the MLSFH contains several measures of perceived risk that are particularly pertinent to the Malawian context: worries about HIV/AIDS, perceived local level of AIDS mortality (how many people the respondent knows who have died from AIDS), and several measures of perceived risk based on subjective probabilities,[9] including the subjective probability of own HIV infection, HIV infection of spouse or partner, risk of dying within one year of the survey, and risk that a local person of the respondent's age and sex dies within one year (general mortality).

Panel A in Table 6 shows that mature adults in Malawi perceive substantial risks and uncertainty, perhaps not unexpected given the high-HIV-prevalence environment with widespread

[9]These probabilities were elicited using the interactive technique ("beans method") developed by Delavande and Kohler (2009) for measuring probabilistic expectations in contexts with low literacy and numeracy

Table 6: Age-patterns in anxiety/depression and stressors due to perceived risk and uncertainty: 2012–13 MLSFH mature adults

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Worried about HIV/AIDS[a]	Perceived local AIDS mortality[b]	Perceived Risk (Subjective Probability) of own HIV infection[c]	spouse HIV positive[d]	dying within year (self)[e]	general mortality[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	1.68	3.35	0.21	0.24	0.28	0.33
55-64	1.52	3.53	0.18	0.20	0.27	0.32
65-74	1.32	3.66	0.12	0.17	0.35	0.32
75+	1.25	4.10	0.13	0.14	0.38	0.33
Female–male diff.	0.050	-0.40**	0.021*	0.057**	0.066**	0.0062
B. Association of stressor with depression (PHQ9 score)[2]						
Stressor	0.45**	0.065*	1.58**	1.79**	2.16**	0.40
	(0.10)	(0.028)	(0.38)	(0.39)	(0.37)	(0.33)
C. Depression: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age-gradient	7.9%	-1.7%	6.5%	7.9%	-4.9%	-0.3%
Female–male diff.	-2.1%	1.9%	-3.2%	-11.6%	-11.1%	-0.1%
D. Association of stressor with anxiety (GAD7 score)[2]						
Stressor	0.49**	0.043*	1.16**	1.17**	1.50**	0.097
	(0.077)	(0.020)	(0.29)	(0.30)	(0.27)	(0.25)
E. Anxiety: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age gradient	10.1%	-1.4%	5.7%	6.3%	-4.1%	-0.1%
Female–male diff.	-3.0%	1.8%	-3.1%	-10.4%	-10.2%	0.0%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

(1) The stressors related to perceived risk and uncertainty were measured in the MLSFH through the following questions: (*a*) *How worried are you that you might catch HIV/AIDS?*, with answers ranging from 1 = not worried at all to 3 = worried a lot. (*b*) *Overall, how many people known to you do you suspect have died from AIDS in the past 12 months?* (*c*) Subjective probability, ranging from 0 to 1, that respondent thinks he/she is infected with HIV now; elicited using the interactive technique ("beans") developed by Delavande and Kohler (2009) for measuring probabilistic expectations in contexts with low literacy and numeracy. (*d*) Subjective probability of partner being HIV positive. (*e*) Subjective probability of dying within 1 year of the survey (i.e., perceived *own* mortality risk). (*f*) Subjective probability of a person of the respondent's sex and age living in his/her community will die within one year (i.e., perceived level of mortality in the community, or general mortality risk).

(2) Regression coefficient for each of these risk/uncertainty stressors obtained in linear regressions of the PHQ9 depression score (or the GAD7 anxiety score) on the respective stressor, age, female and selected controls (region, schooling, MLSFH wave).

(3) Change in the age-gradient of depression (or anxiety) if the risk/uncertainty stressor is included in a regression of the PHQ9 depression score (or the GAD7 anxiety score) on age, female and selected controls (region, schooling, MLSFH wave).

poverty. For example, mature adults are substantially worried about AIDS, know between 3.3–4.1 persons who (they suspect) have died of AIDS in the last year, estimate their own risk of HIV infection between 12–21% and that of their spouses/partners of 14–24%, and perceive a 1-year mortality risk of 28–38%—the latter being a substantial overestimation of the actual mortality risk (for a discussion, see Delavande and Kohler 2009, 2011). Moreover, these stressors exhibit modest age patterns (Panel A): worries about HIV/AIDS, and the subjective probability the respondent or his/her spouse being infected with HIV decline with age, while the perceived local AIDS mortality and the subjective probability of dying (self) increase with age. There is no age pattern in the perception of general mortality.

All of these stressors pertaining to the respondent him/herself or his/her spouse (i.e., Columns 1–5) are strongly and significantly associated with ***DA*** in the expected direction: the higher the perceived risk or uncertainty, the more depressed or anxious is the respondent (Table 6, Panels B and D).

However, a differential exposure to these risk/uncertainty-related stressors by age does not explain the increase in ***DA*** by age. Controlling for these stressors in analyses of the age-gradient of depression or anxiety does not substantially reduce the age-gradient in any of the models (Table 6, Panels C and E), and in several cases the age-gradient becomes even steeper after controlling for risk/uncertainty-related stressors. Similarly, sex-differences in risk/uncertainty-related stressors do not explain the gender gap in depression or anxiety. Hence, the analyses in Table 6 suggest that risk/uncertainty-related stressors are possibly important factors contributing to ***DA*** (and more generally, poor mental health and subjective well-being) in Malawi, but they do not provide an explanation of why older individuals tend to have worse mental health (including higher levels of ***DA***) than middle-aged individuals, and neither do they explain why women have worse mental health than men.

4.6. Mental health, age and physical-health-related stressors

Table 7 investigates whether stressors related to a respondents physical health contribute to poor mental health among mature adults in Malawi, and if these stressors possibly explain the female–male difference in anxiety/depression and the increases in ***DA*** with age.

Physical-health-related stressors available in the MLSFH include: the respondent accomplished less in the past 4 weeks due to his/her physical health, he/she experienced work limitations due to physical health, or pain interfered with his/her work. In addition, the MLSFH mature adult data include measures of grip strength, body mass index and blood pressure.[10] All of these stres-

[10]Grip strength is important as an estimate of the isometric strength in the upper extremity, and it correlates highly with other muscle groups and is often seen as a measurement of overall strength and physical performance (Rantanen et al. 1994). It is a strong predictor of functional limitations, limitations in ADL, morbidity and mortality (Nybo et al. 2001; Rantanen et al. 2000). It is preferable to other measures of physical performance such as climbing stairs, walking on a flat surface, etc., that are difficult to collect and/or are inappropriate (e.g., there are no stairs) in rural Malawi (Robertson et al. 2009). Grip strength was measured in both hands using a mechanic handheld dynamometer (Frederiksen et al. 2006) and was measured on both hands, with 2 alternating measurements on each hand following identical field procedures as those used by the Health and Retirement Study (HRS) and SHARE studies. In the present analysis, we parameterize grip strength by taking the mean grip strength of both hands calculated on the basis of all 4 measurements. Body mass index (BMI), an important indicator of nutritional status (Molini et al. 2010), was obtained

Table 7: Age-patterns in anxiety/depression and physical-health-related stressors: 2012–13 MLSFH mature adults

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Accomplished less, due to phys. health[a]	Work limitation, due to phys. health[b]	Pain interfered with work[c]	Grip strength (mean) [d]	Body Mass Index (BMI)[e]	Blood pressure (systolic)[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	1.66	1.61	1.72	23.9	22.2	126
55-64	1.73	1.69	1.77	22.7	21.8	137
65-74	2.11	2.08	2.15	20.3	21.1	145
75+	2.80	2.82	2.93	16.6	20.7	144
Female–male diff.	0.36**	0.38**	-0.42**	-6.27**	0.99**	0.79
B. Association of stressor with depression (PHQ9 score)[2]						
Stressor	1.83**	2.06**	1.74**	-0.13**	0.013	-0.0058
	(0.090)	(0.092)	(0.085)	(0.017)	(0.023)	(0.0040)
C. Depression: change in age-gradient and female–male difference, after controlling for stressor[3]						
Age-gradient	-66.1%	-78.0%	-64.2%	-34.7%	0.6%	4.1%
Female–male diff.	-54.2%	-65.3%	-60.8%	-69.7%	-1.6%	0.3%
D. Association of stressor with anxiety (GAD7 score)[2]						
Stressor	1.50**	1.68**	1.43**	-0.10**	0.0066	-0.0067*
	(0.060)	(0.059)	(0.054)	(0.012)	(0.016)	(0.0027)
E. Anxiety: change in age-gradient and female–male difference, after controlling for stressor[3]						
Age-gradient	-65.4%	-77.1%	-64.5%	-32.3%	0.4%	5.7%
Female–male diff.	-60.7%	-72.8%	-68.6%	-76.8%	-1.1%	0.6%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

(1) The stressors related to perceived risk and uncertainty were measured in the MLSFH through the following questions: (*a*) *During the past 4 weeks, how much of the time have you accomplished less than you would like with your work or other regular daily activities, as a result of your physical health?*, with answers ranging from 1 = none of the time to 5 = all of the time. (*b*) *During the past 4 weeks, how much of the time have you been limited in the kind of work or other regular daily activities, as a result of your physical health?*, with answers ranging from 1 = none of the time to 5 = all of the time. (*c*) *During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?*, with answers ranging from 1 = not at all to 5 = extremely. (*d*) Grip strength is the average left and right hand, each obtained by averaging three measurements using a hand-held dynamometer; (*e*) BMI is obtained from measured height and weight; available for 2013 only, and in the pooled analyses, the 2013 BMI values is used for both 2012 and 2013. (*f*) Systolic blood pressure is the average of three measurements, obtained using upper-arm blood pressure monitors.

(2) Regression coefficient for each of these physical-health-related stressors obtained in linear regressions of the PHQ9 depression score (or the GAD7 anxiety score) on the respective stressor, age, female, and selected controls (region, schooling, MLSFH wave).

(3) Change in the age-gradient and female–male difference in depression (or anxiety) if the physical-health-related stressors stressor is included in a regression of the PHQ9 depression score (or the GAD7 anxiety score) on age, female and selected controls (region, schooling, MLSFH wave).

sors in Table 7 indicate that the physical health of mature adults in Malawi tends to get worse with age: older individuals experience pain or are limited in their work due to poor health more often than younger mature adults. Grip strength and BMI decline substantially with age, while blood pressure increases. Only 4% of MLSFH mature adults have a BMI $\geq$ 30 in 2012 (6.5% of women and .8% of men), most (67%) have normal BMI (62% of women and 74% of men), and 17.7% are underweight with a BMI $<$ 18.5 (18% of women and 17% of men).

The physical-health-related stressors in Columns 1–4 of Table 7 are strongly and significantly associated with both depression and anxiety, as is expected (Kessler and Bromet 2013), indicating physical and mental health are closely related in this rural Malawi context. Particularly noteworthy is the association with grip strength, which is measured rather than self-reported, and has been suggested as a good indicator of strong predictor of functional limitations, limitations in ADL, morbidity and mortality (Nybo et al. 2001; Rantanen et al. 2000).

Moreover, contrary to our earlier analyses of socioeconomic and risk/uncertainty-related stressors, including the physical-health-related stressors in Columns 1–4 in estimates of the age-gradient of ***DA*** substantially reduces the estimated coefficient for age. The results in Panels C and E of Table 7 thus indicate that declines in physical health, as indicated by grip strength, and the implications of declining physical health for daily activities and work, as indicated by the self-reported limitations in Columns 1–3, are possibly very important contributors to the rise in ***DA*** with age among mature adults. For example, the age-gradient in both depression and anxiety is reduced by about one third if the analyses control for grip strength. This reduction is remarkable as grip strength is measured rather than self-reported and is generally seen as an indicator of functional limitations.

The age-gradient is reduced even more, by about two-thirds, if the self-reported work limitations in Columns 1–3 are included. In addition to "explaining" a substantial fraction of the decline of mental health with age among mature adults, controlling for the physical-health-related stressors in Columns 1–4 also substantially reduces the female–male difference in ***DA***. In contrast, BMI does not seem to be associated with either depression or anxiety among mature adults in Malawi, and higher blood pressure—somewhat surprisingly—seems to be associated with lower levels of anxiety (for depression, the point estimate is also negative, but not statistically significant). Neither help explain the age-gradient or female-male difference in ***DA***.

Physical-health related stressors, and in particular hand grip strength as an overall measure of physical strength and indicators that physical health interferes with daily activities, therefore differ from the socioeconomic and risk/uncertainty-related stressors analyzed in the previous sections. The latter were strongly associated with ***DA***, but did *not* help explain the age-gradient and female–male difference in ***DA***. Physical-health related stressors, in contrast, are strongly associated with ***DA***, and *help explain* the age-gradient and female–male difference in ***DA***. The age-gradient is reduced by up to two thirds, as is the female-male difference, after analyses control for these

in 2012 and 2013 from *measured* height and weight. Blood pressure as an indicator of cardiovascular risk was measured in 2013 using upper-arm blood pressure monitors; three measurements on left arm were taken about 1 min apart in sitting position; the average of the three measurements is used in the analyses below.

stressors. Moreover, the differential physical health of female and males, highlighted in Panel A of Table 7 and Payne et al. (2013), also seems to contribute importantly to the fact that women experience higher levels of ***DA*** than men across all mature adult ages.

Our analyses of course cannot identify the causal direction, but it seems likely that in a context such as Malawi, the relatively poor physical health of mature adults and the decline of physical health with age is importantly related to the long-term exposure to disease and poor nutrition that mature adults in this context have experienced. If this is the case, our analyses suggest that the general decline of physical strength and health with age, as is indicated by grip strength, and the interference of poor physical health with day-to-day activities, as indicated by the self-reported limitations in Columns 1–3, importantly contribute to the rise of ***DA*** with age among mature adults. This pattern is similar to that observed in the Tsimane forager-farmers that share with our Malawian mature adult population a decline of mental health with age (Stieglitz et al. 2014). ***DA*** arising from poor physical health in contexts such as Malawi may be importantly related individuals perception of being an adult and functioning member of their families and communities. For example, in a qualitative study aging in Malawi, Freeman (2012) observes how declining health with age results social disengagement and a loss of identity, both of which are likely to contribute to ***DA*** among older adults: "*Through declining bodily strength, ageing undermined an individual's ability to be productive and contribute reciprocally. At its culmination, this inability produced dependent behaviour that was incompatible with the adult identity. It signalled disengagement from the social world and the practices of the social order—at its basest, the ability to secure survival. In withdrawal from participation, the very old became less than fully human—fully 'adult'.*" (p. 138). "*[R]espondents recognised that if they lived long enough, the inevitability of physical decline would eventually prevent them from carrying out any work. At this point, the individual would become [...] totally 'useless'.*" (p. 141).

4.7. Mental health transition probabilities

In this final section of this paper, we shift from the analyses of respondents' mental health status in 2012–13 and its determinants to a dynamic analyses of *transitions* between different mental health statuses during 2006–12, specifically with respect to ***DA***. The specific aim is to derive *health expectancies* (HEs), that is, estimates of the remaining person years a mature adult spends with depression or anxiety, as well as age-and-gender-specific *transition probabilities* between different mental health states. Because these analyses rely on the four MLSFH waves from 2006–12 (each two years apart), we define individuals mental health state using the DAX with the following three states: DAX = 0 (*no depression/anxiety*); DAX = 1 (*mild depression/anxiety*); DAX = 2 (*moderate/severe depression/anxiety*). While only based on two questions, and not on a clinically validated scale such as the PHQ9 or GAD7 measures, this DAX index nevertheless captures the presence of ***DA*** among MLSFH mature adults fairly accurately (Table 8). For example, both the PHQ9 depression and GAD7 anxiety score strongly increase with DAX, the proportion of respondent who are depressed (anxious) increases from 7–12% if DAX = 0 to 58–59% if DAX = 2, and the proportion of respondents who are neither depressed nor anxious decreases from 84% if DAX = 0 to 31% if DAX = 2. The correlation of the DAX with the SF12 mental health score is about -.8 (Table 2).

Table 8: Means of 2012 PHQ9 depression score, GAD7 anxiety score and derived measures by 2012 DAX level

		(1)	(2)	(3)	(4)	(5)
	N	PHQ9 depression score	GAD7 anxiety score	PHQ9 Depressed (yes/no)[a]	GAD7 Anxious (yes/no)[b]	Neither depressed nor anxious
Means of mental health measures (column heading), if DAX equal to:						
0 (*no depression/anxiety*)	803	1.86	1.48	0.12	0.07	0.84
1 (*mild depression/anxiety*)	200	4.53	4.11	0.42	0.40	0.44
2 (*moderate/severe depr./anx.*)	219	6.72	5.18	0.59	0.58	0.31
Overall	1,222	3.16	2.59	0.25	0.22	0.68

Notes: (*a*) Depressed: PHQ9 depression score ≥ 5 (at least mild depression based on PHQ9 guidelines). (*b*) Anxious: GAD7 anxiety score ≥ 5 (at least mild anxiety).

Using the DAX for the four MLSFH waves 2006–12, we can therefore estimate the conditional annual probabilities of experiencing a transition between the three DAX states (0 = no depression/anxiety, 1 = mild depression/anxiety, and 2 = moderate/severe depression/anxiety) as function of age, age-squared and gender. These age-specific transition probabilities between the three DAX states are then used as input for a multi-state life table (MSLT) model to estimate the health expectancies for each of the DAX states (Cai et al. 2010), that is, the expected number of years a person can expect to live with no depression/anxiety, mild depression/anxiety, and moderate/severe depression/anxiety if the transitions probabilities observed in the MLSFH during 2006–2012 were to prevail for the rest of a person's life (Appendix A4 provides a detailed description of the estimation of this MSLT model).

The key insight of the multi-state life table analyses is that that mature adults in rural Malawi can expect 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 is expected to live about 28.6 additional years, making her expected age at death above 73 (the corresponding estimates for men are 26 and 71 respectively) (Figure 3 and Table 9).[11] A significant proportion of this remaining LE is subject to living with mild to severe depression and/or anxieties, with again a significant gender difference. 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 half of the time lived with depression 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.

Figure 3 also highlights the clear and progressive increase in the amount of remaining life spent with depression/anxieties. By 75, women are expected to live about 73% of their remaining

[11] These remaining life expectancies correspond to those estimated in Payne et al. (2013) based on the MLSFH, as well as life expectancies reported for Malawi in WHO (2011) and Malawi NSO (2012).

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

Age	45		55	
	LE	95% CI	**LE**	95% CI
Females				
Life Expectancy	**30.2**	(28.2–31.8)	**23.2**	(21.7–24.4)
No anxiety/depression (no AD)	**16.3**	(15.2–17.3)	**11.2**	(10.1–12.0)
Mild anxiety/depression (mild AD)	**7.2**	(6.3–8.1)	**6.1**	(5.3–6.9)
Moderate/severe AD	**6.7**	(5.7–7.6)	**6.0**	(5.1–6.7)
Males				
Life Expectancy	**28.1**	(26.5–29.8)	**21.6**	(20.4–22.9)
No anxiety/depression (no AD)	**18.3**	(17.1–19.5)	**13.1**	(12.1–14.1)
Mild anxiety/depression (mild AD)	**5.0**	(4.3–5.8)	**4.3**	(3.7–4.9)
Moderate/severe AD	**4.8**	(4.1–5.6)	**4.2**	(3.6–4.9)
Age	**65**		**75**	
	LE	95% CI	**LE**	95% CI
Females				
Life Expectancy	**16.3**	(15.3–17.3)	**9.2**	(8.8–9.7)
No anxiety/depression (no AD)	**6.8**	(6.0–7.8)	**3.5**	(2.8–4.3)
Mild anxiety/depression (mild AD)	**4.9**	(4.2–5.8)	**2.6**	(2.2–3.2)
Moderate/severe AD	**4.6**	(3.8–5.5)	**3.1**	(2.5–3.7)
Males				
Life Expectancy	**15.2**	(14.5–16.9)	**8.9**	(8.3–9.4)
No anxiety/depression (no AD)	**8.1**	(7.3–9.7)	**4.2**	(3.5–5.0)
Mild anxiety/depression (mild AD)	**3.5**	(2.9–4.4)	**2.2**	(1.6–2.7)
Moderate/severe AD	**3.6**	(3.0–4.3)	**2.4**	(1.9–3.2)

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 2006–2012 MLSFH data.

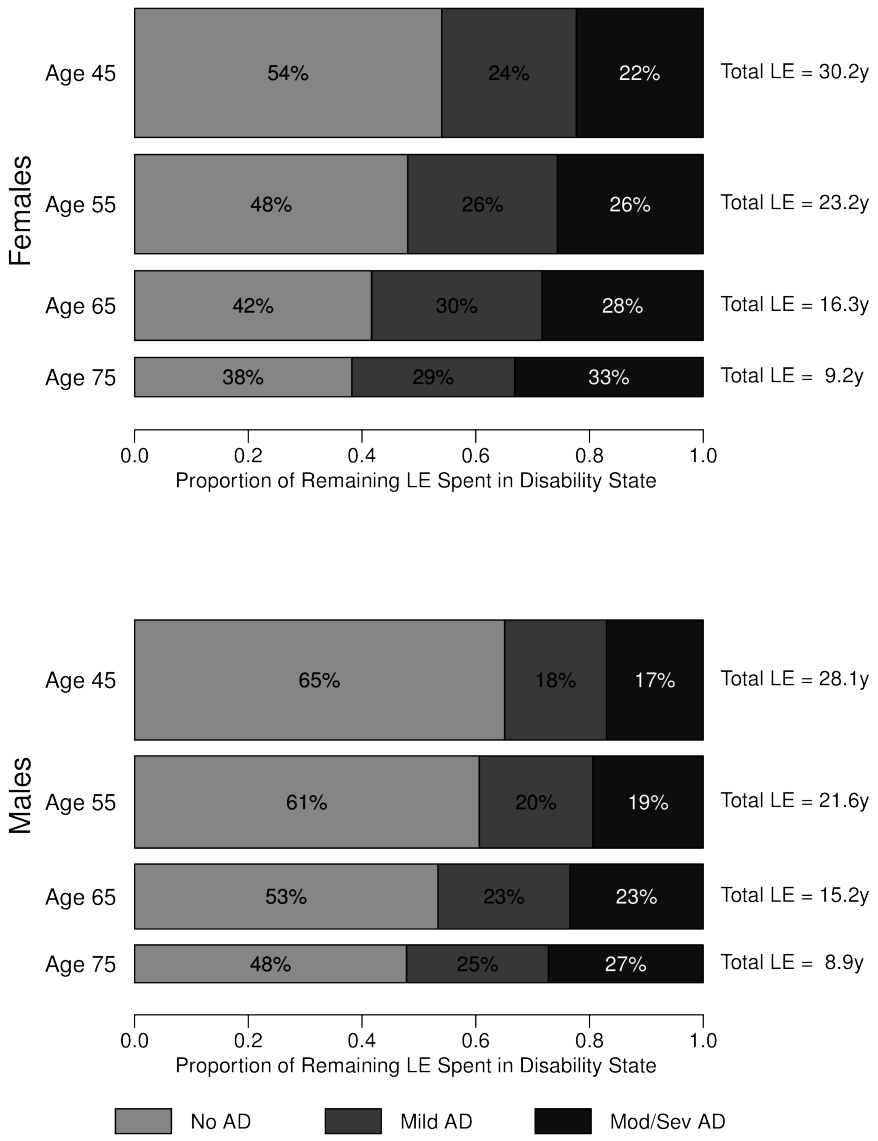


Figure 3: Distribution of remaining life expectancy (LE) by mental health: no anxiety/depression (No AD), mild anxiety/depression (Mild AD), moderately or severe anxiety/depression (Mod/Sev AD)

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.

life with some depression/anxieties (this figure is 62% for men). Again, about half of this time with anxieties/depression is subject to moderate to severe levels of depression and/or anxiety. The analyses of the underlying transition rates between DAX states (Appendix Figures A1–A3) furthermore reveals that transitions between DAX states are fairly common, and are strongly age patterned: especially the probabilities of recovering from mild or moderate/severe depression/anxiety (DAX = 1 or 2) decline strongly with age, while the probabilities of transitioning to a worse mental health state increase with age. Moreover, the fairly high rates of transition between DAX states during the mature-adult life-course mean that time spent with depression or anxieties (see Figure 3) does not occur solely at the end of life; instead, these DAX states are dynamic, and especially at younger mature adult ages, individuals will often recover from depression and/or anxieties.

5. Summary and Discussion

Most of the research investigating the prevalence and determinants of mental disorders is conducted in the high-income countries. Yet, mental health represents a neglected health dimension in middle and low-income settings, and possible interactions of mental disorders with HIV risks, HIV prevention and AIDS treatments, and the rising burden of NCDs in SSA give a particular urgency to research on mental health in sub-Saharan Africa.

Our analyses in this paper focus on the *demography on mental health* among mature adults (= persons aged 45+) in rural Malawi, documenting age and gender differences in depression and anxieties (***DA***), their relation to social, economic HIV-related and physical-health-related stressors, and the expected person years (health expectancies) that mature adults can expect to spend subject to ***DA*** in this poor high HIV-prevalence context. Mature adults are an important subpopulation for these analyses because of their growing demographic relevance, their almost universal labor force participation with virtually no "*retirement*", their important contributions to intergenerational transfers to both children and elderly parents, and their pivotal caretaking roles in families affected by HIV/AIDS. Though they are a critical subpopulation in SSA LICs, mature adults are often affected by poor mental and physical health that can exacerbate the effects of poverty and social deprivation in this population. An understanding of demography of mental health in this population is essential for informing ***MH***-related health policies and international aid efforts in SSA, as mental health disorders, and especially depression and anxiety (***DA***), frequently co-occur with physical disabilities and have significant consequences for the productivity and overall well-being of individuals.

Using the 2012–13 mature adult survey conducted as part of the MLSFH, our analyses show that, despite substantial socioeconomic hardship, few mature adults experience moderately-severe or severe levels of ***DA*** as defined by scales that have predominantly been developed for and used in Western contexts. But mild to moderate levels of ***DA*** are common among mature adults, and even at these moderate levels, ***DA*** are systematically associated with adverse outcomes, such as less nutrition intake, less sexual intercourse and substantially reduced work efforts and earnings.

Moreover, multiple indicators of ***DA*** obtained from different instruments all provide a very consistent pattern, and our ***DA*** scales are associated in the expected direction with stressors such as recent income loss, household-level morbidity/mortality, worries about HIV, or elevated risk-perceptions of mortality, poor physical health, etc. Hence, even at the modest severity levels identified in our data, the ***DA*** scales collected as part of the MLSFH identify important mental health disorders that seem to significantly affect well-being and day-to-day activities of mature adults in rural Malawi.

We show that depression and anxiety are more frequent among women than men, and that individuals are often affected by *both*. This gender-gap in ***DA*** is not explained by a differential exposure to socioeconomic shocks or risk/uncertainty-related stressors. Among mature adults, ***DA*** also increase substantially with age for both females and males. Neither the positive age-gradients of ***DA***, nor the male-female gender-gap in ***DA*** in our cross-sectional 2012–13 MLSFH data are due to cohort effects as both prevail in fixed-effect analyses of longitudinal MLFSH data 2006–13. Our multi-state life table analyses of mental-health changes in the MLSFH during 2006–12 additionally show that mature adults can expect to spend a substantial fraction of their remaining life time affected by ***DA*** (52% for a 55 year old woman, 39% for a 55 year old male, and even higher proportions for older individuals). Hence, even if the prevalence of ***DA*** at any given point in time is only moderately-high, spells of ***DA*** across the mature adult life-course "*add up*", especially as individuals get older, and ***DA*** spells accumulate so that a substantial fraction of remaining life-expectancy for mature adults is lived with ***DA***. Together, our analyses therefore characterize a processes of declining mental health among mature adults, with significant gender differences and possibly important productivity and well-being implications, in a rapidly-growing but understudied portion of the SSA population.

Our analyses also describe an aging trajectory that is distinctly different from those observed in higher-income countries: The positive age-gradients in ***DA*** observed in Malawi are in sharp contrast to the age pattern of mental health that have been shown in high-income contexts where older individuals often report lower levels of ***DA*** and better subjective well-being than middle-aged individuals. While socioeconomic and risk/uncertainty-related stressors are strongly associated with ***DA***, they do not explain the positive age gradients and gender gap in ***DA***. Stressors related to physical health, however, do. For example, the age-gradient in both depression and anxiety is reduced by about one third if the analyses control for the decline in grip strength with age. The magnitude of this reduction is striking as grip strength is measured rather than self-reported, and is generally seen as an indicator of physical strength, functional limitations and morbidity/mortality risk. While our analyses cannot identify the causal direction, it seems likely that in a rural SSA context the relatively poor physical health of mature adults is importantly related to the long-term exposure to disease and poor nutrition that mature adults have experienced. If this is the case, our analyses suggest that the general decline of physical strength and health with age, and the interference of poor physical health with daily activities, are key drivers of the rise of ***DA*** with age among mature adults. Addressing the challenge of poor mental health among mature adults in SSA LIC contexts may therefore require approaches that address both

physical and mental health concerns, including treatment for ***DA*** combined with palliative care for pain and physical health problems for which the overburdened health system in rural SSA LICs is currently unlikely to provide effective treatments.

Our results are also important as they help inform the health policies and health sector strategies required for preparing for the growing population of mature adults and elderly individuals in SSA LICs. The average annual growth rate of the population age 60 and above in SSA is projected to increase from over 2% (already higher than the 60+ growth rate in developing countries) to over 4% during the next 45 years—4-times the growth rate expected in developed countries. In countries like Malawi, this rapid growth of the mature adult and older population occurs while the overall age structure of the population will remain relatively young. Hence, while rapid population growth continues to be a major social and policy issue in SSA, current demographic and epidemiological trends foreshadow the coming challenge of a growing elderly population in SSA. Due to high levels of morbidity, low levels of economic development, and widespread poverty, individual aging and population aging in SSA will likely be associated with a unique set of demographic and economic concerns. Yet, there is a dearth of understanding among national and international decision-makers about the magnitude of the aging problem in SSA. Evidence from more developed contexts is often not sufficient for understanding the health issues and healthcare-needs associated with a growing aging population in SSA. In Malawi and other SSA countries, health sector strategies are beginning to recognize the importance of mental health disorders that will gain further prominence in coming decades. Our findings provide important insights into the potential gains in well-being and economic productivity that can arise from investments in the mental health of mature adults in SSA LICs, and they highlight importance of expanding the identification and treatment of mental health disorders in these contexts.

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APPENDIX/SUPPLEMENTAL MATERIALS

A1. MLSFH sampling methods and related relevant data collection procedures

The ***Malawi Longitudinal Study of Families and Health*** (MLSFH) is a collaboration of the University of Pennsylvania with the College of Medicine and Chancellor College at the University of Malawi. A detailed description is available in a MLSFH Cohort Profile (Kohler et al. 2014).

MLSFH Study Areas: The MLSFH is based in three districts in rural Malawi that have been the study sites since 1998: Rumphi in the north, Mchinji in the center, and Balaka in the south. In all of these three regions, the primary source of livelihood for MLSFH respondents is subsistence agriculture, augmented with small-scale trade of agricultural products and other goods. Transportation networks are relatively rudimentary with paved primary roads and generally unpaved secondary roads. Marriage is relatively universal in these rural Malawian regions, with more than 96% of women having ever married by age 25–29, and more than 95% of men having ever married by age 30–34 (Malawi DHS 2011). While the broad demographic, socioeconomic and epidemiological conditions are fairly similar across the three MLSFH study regions, and also across other parts of rural Malawi, some noteworthy differences across the MLSFH regions include the following. Rumphi District, located in the northern region of the country, follows the patrilineal system of kinship and lineage where residence is ideally patrilocal, inheritance is traced through sons, and parents of a groom pay bridewealth. The northern district, inhabited primarily by Tumbukas, is predominantly Protestant. Mchinji District, located in the central region, follows a less rigid matrilineal system whereby residence may be matrilocal or patrilocal. The Center is primarily inhabited by Chewas, with almost equal proportions of Catholics and Protestants. Balaka District, which is located in the southern region, is primarily inhabited by Lomwes and Yaos and has the highest proportion of Muslims. The region follows a matrilineal system of kinship and lineage system where residence is ideally matrilocal, although it is not uncommon for wives to live at least some period of time in their husband's village. The Balaka region also exhibits a lower age of sexual debut and larger numbers of lifetime sexual partners than the other MLSFH study regions, and residents tend to be less educated and poorer than those living in the north, leading to higher levels of migration. HIV/AIDS prevalence in the southern region is significantly higher than in the northern and central region.

Initial MLSFH Sample: The original 1998 MLSFH target sample was 500 ever-married women age 15–49 in each district, plus their husbands (for additional information, see http://malawi.pop.upenn.edu/malawi-documentation-sampling). In total, across all three regions, the MLSFH Round 1 in 1998 enrolled a sample of slightly more than 1,500 ever-married women aged 15–49 and close to 1,100 of their spouses residing in about 120 study villages.

MLSFH Respondent follow-up, migration and vital status: The MLSFH returned to the study areas in 2001, 2004, 2006, 2008 and 2010 to reinterview the MLSFH study population. For this purpose, the MLSFH maintained a respondent database that contained previously collected identifying information for each respondent (respondents name, compound name, village name and GPS coordinates, etc.). Using this existing identifying information, MLSFH interviewers attempted to

contact and reinterview MLSFH participants in each of the follow-up years. If MLSFH participants were absent at the first interviewer visit, up to two additional follow-up visits were made. Except for a migration follow-up study in 2007, which is not part of the present analyses, MLSFH respondents were not followed if they had migrated outside of the MLSFH study villages. However, they remained in the MLSFH sampling frame, and were interviewed at subsequent MLSFH waves if they returned to the MLSFH study villages (as is common since a significant amount of migration is labor-related and thus temporary). On average, the MLSFH succeeded in re-interviewing between about 75–85% of the respondents interviewed at the previous MLSFH waves. Conditional on successfully contacting a MLSFH respondents, refusals to participation in the MLSFH have been very low across all MLSFH waves ($< 3\%$ up to 2008, and $< 5\%$ in 2010). Comparisons of the MLSFH study population with nationally representative datasets are reported below (Section A3).

MLSFH Sample Additions: Additions to the MLSFH have occurred primarily through three mechanisms: new spouses, the 2004 adolescent sample, and the 2008 parent sample. We discuss these three mechanisms in turn. ***New spouses:*** The initial MLSFH sample in 1998 included 1,541 ever-married women aged 15–49 and their spouses. Up to the 2004 round of data collection, the MLSFH attempted to re-interview all of these initial MLSFH respondents and their current spouses; that is, if a MLSFH respondent divorced and remarried, or in the case of polygamous men, added an additional wife, the MLSFH added the current wife (all current wives) of the initial MLSFH participants. However, spouses who were not part of the initial MLSFH sample were not followed and retained in the MLSFH if they divorced or their spouses died. Starting with the 2006 MLSFH, the study retained all MLSFH study participants; that is, from 2006 onward, once an individual was interviewed for the MLSFH once, for instance after being enrolled as a new spouse, the MLSFH made an attempt to re-interview the respondent at all subsequent waves. ***2004 Adolescent Sample:*** In 2004, to compensate for the aging of the initial MLSFH sample and the underrepresentation of unmarried individuals at adolescent and young adult ages, the MLSFH added an adolescent sample in 2004 ($N = 998$). Because of their young age, members of the adolescent sample are not included in the analyses of this paper. ***2008 MLSFH Parent Sample:*** To increase the suitability of the MLSFH to study intergenerational aspects and the health of older individuals in Malawi, a parent sample was added to the MLSFH in 2008. This new sample of parents of MLSFH respondents was drawn from family listings from MLSFH respondents in 2006 (because of the respondents' young age, parents of MLSFH respondents in the 2004 adolescent sample were not included). All living biological parents who resided in the same village as the respondent were included in the 2008 MLSFH new sample of parents. Based on this approach, parents of MLSFH respondents living in the MLSFH study villages were added to the 2008 MLSFH sample ($N = 549$). As a result of this enrolling older individuals who were not necessarily captured by the earlier MLSFH sampling frame, the age range covered by the MLSFH was substantially extended. Among approximately 3,800 respondents interviewed in the 2010 MLSFH, 44.1% were from the original MLSFH sample drawn in 1998, 19.5% were from the 2004 adolescent sample, 12.5% from the 2008 parent sample, and the remainder (23.9%) were new spouses that have been added during 2001–2010.

A2. 2012 and 2013 MLSFH mature adults survey on mental health and well-being

The 2012 MLSFH 7 survey on mature adults (= adults aged 45 and older) focused on mental health and well-being, including MLSFH respondents aged 45 and older, who had previously been interviewed in the 2008 and 2010 MLSFH. The 2012 MLSFH Mature Adult Survey completed 1,266 surveys (clustered in 130+ villages) out of 1402 MLSFH respondents in the MLSFH database who met the enrollment criteria for this survey: being age 45+ and having been interviewed in 2010 and 2008 (a restriction that ensured that at least three waves of MLSFH data were available for each participant in the 2012 MLSFH). That is, the 2012 Mature Adult Survey managed to find and enroll more than 90% of previously interviewed MLSFH mature adults. The 2013 MLSFH mature adult survey reinterviewed 1,203 (95%) of the 2012 respondents and the survey also enrolled some mature adult respondents who were absent in 2012 resulting in 1,257 respondents. The 2012–13 MLSFH mature adult surveys therefore provide a total baseline sample of about 1,300 observations (for 1,320 MLSFH mature adults, either 2012 or 2013 data is available). Comparisons of our 2010 MLSFH mature adult analysis sample characteristics to the age 45+ rural sample of the nationally-representative 2010–11 Third Malawi Integrated Household Survey (IHS3) Malawi IHS (2012) also show that basic demographic and socioeconomic characteristics between our MLSFH study population and the IHS3 are overall quite similar (Payne et al. 2013). Individuals aged 65 and over in the MLSFH were somewhat more likely to have ever attended school that those in the IHS3, and differences arise in the distribution of religion, where Muslims are overrepresented in the MLSFH due to the fact that about 1/3rd of the MLSFH study population is from the primarily Muslim region of Balaka.

In both 2012 and 2013, MLSFH mature adults were interviewed using a questionnaire that continued key elements of the 2008 and 2010 data collections and newly added detailed measures of mental health (including in particular depression and anxiety, ***DA***), cognitive function, and physical health/performance. All new survey modules on mental health and cognitive functions were extensively pretested during focus-group interviews and pilot tests, and reverse translations ensured the accuracy of the final instruments in the local languages (Chichewa, Yao, Tumbuka). Interviewers were carefully trained in the collection the mental health scales and cognitive function scales, and the final surveys included an extensive introduction to the measurement of mental health and cognitive function that familiarized respondents with the survey's aim to measure ***DA***, related aspects of mental health and cognitive function.

Specifically, the measures of mental health and well-being collected as part of the 2012-13 MLSFH mature adult survey included (Table A1): (1) To assess *mental health*, we collected the following data: (*a*) continued measurement of the SF12 mental health score that is available since 2006; (*b*) the depression and 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; (*c*) detailed information of alcohol consumption since alcohol is the most commonly used psychoactive substance in rural Malawi (and comparable SSA contexts), including among HIV+ individuals. (2) To assess *cognitive function and performance*, we collected measurements for: (*a*) spatial/temporal orientation and language based on typical questions used in many different mental status examina-

Table A1: Selected measurements in the 2012–13 MLSFH mature adult surveys on mental health and well-being

Construct Definition	*Measurement/Scales/Items Source*
Mental health and depression	SF12 mental health score; Primary Care Evaluation of Mental Disorders (PRIME-MD), including PHQ9 depression module and GAD7 anxiety module; subjective well-being.
Cognitive function	Spatial/temporal orientation and language; visual/constructional test; visual/verbal memory, attention/working memory, memory/delayed recall and executive functioning developed by the project team.
Physical health and performance	Subjective health assessments; hand grip strength (measured using handheld dynamometer); measured height, weight and body mass index (BMI); blood pressure (2013 only; measured using upper-arm blood pressure monitors); activities of daily living (ADLs); biomarker-based HIV status (2012 only).
Alcohol and tobacco Consumption	Alcohol use based on the Alcohol Use Disorder Identification Test (AUDIT); tobacco use.
Subjective risk assessments and probabilistic expectations	Interactive probabilistic expectation elicitation method developed for Malawi and low literacy populations, including about mortality/survival, own HIV infection, local HIV prevalence and prevalence of local AIDS-related morbidity.
Social capital and resources networks	MLSFH modules on social capital & family transfer networks.
Social, demographic and economic background	Modules repeated from MLSFH questionnaire 2008 & 2010, including income, assets, economic shocks, financial and non-financial transfers, illness/mortality of family members, household composition, socioeconomic context, social and human capital.
Work efforts and productivity	Time devoted to different work activities and intensity of work; work efforts and work-related health limitations.

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.

tions; visual/constructional test to assess space and object perception; (*b*) 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. (3) *Grip strength as a measurement of physical performance:* Grip strength was measured in both hands using a mechanic handheld dynamometer. Grip strength is important as an estimate of the isometric strength in the upper extremity, and it correlates highly with other muscle groups and is often seen as a measurement of overall strength and physical performance. The 2012–23 MLSFH grip strength measurements followed identical field procedures as those used by the Health and Retirement Study (HRS) and SHARE studies. (4) *Additional selected measures of well-being*: the 2012–13 MLSFH mature adult surveys continued to collect the MLSFH instruments on subjective risks assessments and probabilistic expectations, social capital and resource networks, social, demographic and economic background, and work efforts, productivity and related income/expenditure measures (for additional detail, see Kohler et al. 2014). (5) *BMI, blood pressure and HIV testing:* Body mass index (BMI)—an important indicator of nutritional status—was obtained in 2012 from *measured* height and weight, complementing earlier MLSFH BMI data

Table A2: Number of HIV+ respondents and HIV prevalence by age among the MLSFH mature adults in 2012

	Females		Males		Total	
Age	# of Cases	Prevalence (%)	# of Cases	Prevalence (%)	# of Cases	Prevalence (%)
45–54	18	6.0%	12	6.6%	30	6.2%
55–64	11	5.3%	14	8.2%	25	6.6%
65–74 0	0	0.0%	2	1.8%	2	0.9%
75+	2	2.6%	0	0.0%	2	1.4%
Total	31	4.4%	28	5.3%	59	4.8%

Note: HIV positive: any HIV test during 2004–12 is HIV positive

for 2008. Blood pressure (three measurements) obtained in 2013 using upper-arm blood pressure monitors. In addition, all mature adults who participated in the 2012 data collection were tested for HIV, updating earlier MLSFH HIV tests from 2004–08. Based on all available HIV tests 2004–20012, only 59 HIV+ mature adults (HIV prevalence = 4.8%) were interviewed in 2012 (31 woman and 28 males), reflecting possibly high mortality for HIV+ individuals in these cohorts prior to the availability of ART in the study region (ART started to be available in the MLSFH study regions only in 2008). HIV prevalence by age among the MLSFH mature adults in 2012 is reported in Table A2.

A3. Comparisons of the MLSFH with national representative samples

While the initial sampling strategy of the MLSFH was not designed to be representative of the national population of rural Malawi, the initial sample characteristics closely matched the characteristics of the rural population of the 1996 Malawi Demographic and Health Survey (DHS) (Watkins et al. 2003). After three rounds of longitudinal data collection, despite attrition and the enrollment of new subjects, the 2004 MLSFH sample continues to be in close agreement in observable characteristics with the nationally-representative 2004 Malawi DHS (rural sub-population) (Anglewicz et al. 2009; Kohler et al. 2014). Similarly, comparisons of the 2010 MLSFH study population with the rural samples of the MDHS and IHS3 surveys reveal that the MLSFH study population continues to closely match the characteristics of nationally-representative cross-sectional surveys (Kohler et al. 2014). Focusing on MLSFH respondents aged 45 and older, the 2010 MLSFH mature adult population—i.e., the study population that is used for the analyses here—also closely matches the rural subsample in the 2010 national-representative IHS3 survey in key observable characteristics (Payne et al. 2013) (differences arise in the distribution of religion, where Muslims are overrepresented in the MLSFH due to the fact that about 1/3rd of the MLSFH study population is from the primarily Muslim region of Balaka, and individuals aged 65 and over in the MLSFH were somewhat more likely to have ever attended school that those in the IHS3). In summary, however, neither the initial sample selection that restricted the MLSFH to three rural region, nor the MLSFH attrition and enrollment of new MLSFH respondents over time, seem to have importantly affected the MLSFH in terms of its ability to represent the rural population of Malawi. By design,

the MLSFH is different from nationally-representative rural samples in terms of its age distribution and religious composition, and where appropriate, the MLSFH can be weighted to match the age distribution of rural Malawi. The MLSFH also contains a larger fraction of respondents who are currently married, which is likely due to the initial 1998 MLSFH sample that focused on ever-married women and their spouses and the fact that peri-urban regions are missing in the MLSFH.

A4. Mutli-state life table (MSLT) model to estimate the health expectancies for each of the DAX states

In this section we provide additional detail for the mutli-state life table (MSLT) model to estimate the health expectancies for each of the DAX states in Section 4.7. For these MSLT analyses, using the DAX for the four MLSFH waves 2006–12, we first estimate the conditional annual probabilities of experiencing a transition between the three DAX states (0 = no depression/anxiety, 1 = mild depression/anxiety, and 2 = moderate/severe depression/anxiety) as function of age, age-squared and gender. Specifically, the estimation uses a logistic discrete-time hazard model of the form

$$\log\left(\frac{p_{ij}(age,t)}{p_{ii}(age,t)}\right) = \beta_{0ij} + \beta_{1ij} \times age_t + \beta_{2ij} \times age_t^2 + \beta_{3ij} \times male, \tag{A1}$$

where $p_{ij}(age,t)$ is the transition probability from current state i (with $i = 0, 1$ or 2) to health state j (with $j = 0, 1$ or 2) 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 DAX states are then used as input for a mutli-state life table (MSLT) model to estimate the health expectancies for each of the DAX states, that is, the expected number of years a person can expect to live with no depression/anxiety, mild depression/anxiety, and moderate/severe depression/anxiety 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 (Cai et al. 2010). Specifically, to calculate MSLT functions such as health expectancies (HE), we rely on microsimulation, a well-established tool in demographic research (Brown et al. 2012; Cai and Lubitz 2007; Wachter et al. 2002; Wolf 1986; Wolf et al. 2002; Zagheni 2011). 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.(Schoen 1988) 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 the DAX 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.(Rao and Wu 1988) To obtain our final 95% CIs, we took the central 95% of the distribution of these bootstrapped parameters. Appendix Table A7 reports summary statistics of the analysis sample for estimating the transitions probabilities and the distribution of DAX states during 2006–12, and the distribution of observed transition between DAX states during 2006–12 is shown in Appendix Table A8.

A5. Additional Tables and Figures

Table A3: Summary statistics for mental health indicators, respondents age 45+ in 2013, Malawi

	(1)	(2)	(3)	(4)	(5)	(6)
	2012 Mean (std dev)			Corr. across measures in 2012		
	Females	Males	Total	PHQ-9	GAD-7	SF12
PHQ-9 Depression Score	3.27	2.18	2.81	–	–	–
	(3.93)	(3.35)	(3.73)			
GAD-7 Anxiety score	3.00	2.10	2.62	0.90	–	–
	(3.18)	(2.81)	(3.06)			
SF12 Mental Health Score	51.5	54.2	52.7	-0.69	-0.69	–
	(10.7)	(9.79)	(10.4)			
Subj. Wellbeing	3.42	3.66	3.52	-0.37	-0.38	0.33
	(0.93)	(0.91)	(0.93)			
DAX depress./anxiety index	0.60	0.41	0.52	0.64	0.62	-0.80
	(0.78)	(0.71)	(0.75)			
	Proportions (2012)					
	Females	Males	Total			
Depression classification						
None depression	0.32	0.45	0.37			
Minimal depression	0.40	0.38	0.39			
Mild depression	0.21	0.13	0.18			
Moderate depression	0.05	0.03	0.04			
Moderately severe depression	0.02	0.01	0.02			
Severe depression	0.01	0.00	0.00			
Anxiety classification						
None anxiety	0.30	0.42	0.35			
Some anxiety symptoms	0.40	0.41	0.41			
Mild anxiety	0.26	0.14	0.21			
Moderate/severe anxiety	0.04	0.03	0.03			
# of observations	711	535	1,246			

Notes: see Table 2 for corresponding 2012 summary statistics.

Table A4: Age-patterns in SF12 mental health score and subjective well-being and socioeconomic stressors: 2012–13 MLSFH mature adults (Supplement to Table 5)

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Death or illness[a]	Poor crop yields[b]	Loss income source[c]	Breakup of househ.[d]	Damage of house[e]	Total (=sum)[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	0.36	0.55	0.23	0.05	0.08	1.27
55-64	0.32	0.57	0.23	0.03	0.08	1.23
65-74	0.30	0.57	0.23	0.01	0.09	1.20
75+	0.31	0.53	0.22	0.03	0.07	1.15
Female–male diff.	0.076**	0.038+	0.020	0.0084	0.014	0.16**
B. Association of stressor with overall mental health (SF12 mental health score)[2]						
Stressor	-1.96**	-1.03*	-1.72**	-1.59	-1.52+	-1.33**
	(0.45)	(0.41)	(0.49)	(1.13)	(0.79)	(0.22)
C. SF12 score: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age gradient	1.1%	0.4%	0.1%	0.8%	0.2%	2.1%
Female–male diff.	-6.0%	-1.2%	-2.0%	-0.5%	-0.9%	-8.4%
D. Association of stressor with subjective well-being[2]						
Stressor	-0.046	-0.058	-0.033	-0.11	-0.11	-0.048*
	(0.041)	(0.040)	(0.049)	(0.095)	(0.075)	(0.022)
E. Subj. well-being: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age gradient	0.3%	0.2%	0.0%	0.6%	0.1%	0.8%
Female–male diff.	-1.8%	-0.8%	-0.5%	-0.5%	-0.8%	-3.8%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.
(1) See Note (1) in Table 5.
(2) Regression coefficient for each of these socioeconomic stressors obtained in linear regressions of the SF12 mental health score (or subjective well-being) on the respective stressor, age, female and selected controls (region, schooling, MLSFH wave).
(3) Change in the age-gradient and female–male difference in SF12 mental health score (or subjective well-being) if the socioeconomic stressor is included in a regression of the SF12 mental health score (or subjective well-being) on age, female and selected controls (region, schooling, MLSFH wave).

Table A5: Age-patterns in SF12 mental health score and subjective well-being and stressors due to perceived risk and uncertainty: 2012–13 MLSFH mature adults (Supplement to Table 6)

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Worried	Perceived	Perceived Risk (Subjective Probability) of			
	about HIV/AIDS[a]	local AIDS mortality[b]	own HIV infection[c]	spouse HIV positive[d]	dying within year (self)[e]	general mortality[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	1.68	3.35	0.21	0.24	0.28	0.33
55-64	1.52	3.53	0.18	0.20	0.27	0.32
65-74	1.32	3.66	0.12	0.17	0.35	0.32
75+	1.25	4.10	0.13	0.14	0.38	0.33
Female–male diff.	0.050	-0.40**	0.021*	0.057**	0.066**	0.0062
B. Association of stressor with overall mental health (SF12 mental health score)[2]						
Stressor	-1.41**	-0.027	-4.38**	-5.02**	-4.04**	-0.81
	(0.28)	(0.073)	(1.01)	(1.03)	(0.89)	(0.86)
C. SF12 score: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age gradient	10.6%	-0.3%	7.9%	9.2%	-4.2%	-0.2%
Female–male diff.	-2.6%	0.3%	-3.6%	-12.7%	-8.2%	-0.1%
D. Association of stressor with subjective well-being[2]						
Stressor	-0.13**	-0.0060	-0.43**	-0.28**	-0.52**	-0.36**
	(0.028)	(0.0068)	(0.094)	(0.096)	(0.088)	(0.081)
E. Subj. well-being: change in age-gradient and female–male diff., after controlling for stressor[3]						
Age gradient	10.0%	-0.7%	8.1%	5.6%	-5.5%	-1.2%
Female–male diff.	-2.9%	0.9%	-4.3%	-9.8%	-13.1%	-0.6%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.
(1) See Note (1) in Table 6.
(2) Regression coefficient for each of these risk/uncertainty stressors obtained in linear regressions of the SF12 mental health score (or subjective well-being) on the respective stressor, age, female and selected controls (region, schooling, MLSFH wave).
(3) Change in the age-gradient and female–male difference in SF12 mental health score (or subjective well-being) if the risk/uncertainty stressor is included in a regression of the SF12 mental health score (or subjective well-being) on age, female and selected controls (region, schooling, MLSFH wave).

Table A6: Age-patterns in SF12 mental health score and subjective well-being and physical-health-related stressors: 2012–13 MLSFH mature adults (Supplement to Table 7)

	(1)	(2)	(3)	(4)	(5)	(6)
Stressor:[1]	Accomplished less, due to phys. health[a]	Work limitation, due to phys. health[b]	Pain interfered with work[c]	Grip strength (mean) [d]	Body Mass Index (BMI)[e]	Blood pressure (systolic)[f]
A. Stressor: mean, by age group, and female–male difference (adjusted for age)						
45-54	1.66	1.61	1.72	23.9	22.2	126
55-64	1.73	1.69	1.77	22.7	21.8	137
65-74	2.11	2.08	2.15	20.3	21.1	145
75+	2.80	2.82	2.93	16.6	20.7	144
Female–male diff.	0.36**	0.38**	-0.42**	-6.27**	0.99**	0.79
B. Association of stressor with overall mental health (SF12 mental health score)[2]						
Stressor	-5.18**	-5.78**	-4.60**	0.34**	0.055	0.015
	(0.22)	(0.22)	(0.21)	(0.042)	(0.060)	(0.0095)
C. SF12 score: change in age-gradient and female–male difference, after controlling for stressor[3]						
Age gradient	-80.7%	-94.9%	-74.1%	-40.4%	-1.0%	4.4%
Female–male diff.	-62.3%	-74.5%	-65.4%	-79.3%	2.8%	0.5%
D. Association of stressor with subjective well-being[2]						
Stressor	-0.23**	-0.27**	-0.26**	0.024**	0.0046	0.000064
	(0.020)	(0.020)	(0.017)	(0.0043)	(0.0051)	(0.00087)
E. Subj. well-being: change in age-gradient and female–male difference, after controlling for stressor[3]						
Age gradient	-38.7%	-47.5%	-43.8%	-29.6%	-0.9%	0.2%
Female–male diff.	-34.9%	-43.7%	-45.2%	-68.4%	2.9%	0.0%

Notes: Analyses are pooled across the 2012–13 MLSFH mature adult data, and standard errors (adjusted for clustering within individuals) are reported in parentheses. p-values: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.
(1) See Note (1) in Table 7.
(2) Regression coefficient for each of these physical-health-related stressors obtained in linear regressions of the SF12 mental health score (or subjective well-being) on the respective stressor, age, female, and selected controls (region, schooling, MLSFH wave).
(3) Change in the age-gradient and female–male difference in the SF12 mental health score (or subjective well-being) if the physical-health-related stressors stressor is included in a regression of the SF12 mental health score (or subjective well-being) on age, female and selected controls (region, schooling, MLSFH wave).

Table A7: Distribution of Depression/Anxiety Index (DAX) states for MLSFH respondents aged 45+ 2006-2012

	2006		2008		2010		2012	
	N	%	N	%	N	%	N	%
Age 45–64								
Status								
No DA (DAX = 0)	478	76.1%	581	69.4%	549	56.5%	609	69.6%
Mild DA (DAX = 1)	98	20.0%	141	22.0%	201	23.6%	130	20.5%
Mod-sev DA (DAX = 2)	52	10.6%	91	14.2%	191	22.4%	119	18.8%
Dead			24	3.7%	30	3.5%	17	2.7%
Male	341	54.3%	386	46.1%	430	44.3%	368	42.1%
Age 65+								
Status								
No DA (DAX = 0)	44	69.8%	170	54.7%	141	34.7%	179	47.7%
Mild DA (DAX = 1)	10	15.9%	79	25.4%	123	30.3%	70	18.7%
Mod-sev DA (DAX = 2)	9	14.3%	59	19.0%	110	27.1%	98	26.1%
Dead			3	1.0%	32	7.9%	28	7.5%
Male	43	68.3%	148	47.6%	186	45.8%	182	48.5%
Average age	54.1		59.0		59.6		59.9	

Table A8: Distribution of observed transitions between Depression/Anxiety Index (DAX) states (No DA, mild DA, Moderate/Severe DA) for respondents aged 45+ 2006-2012, Malawi

Observed distribution among DAX states (no DA/mild DA/mod-sev DA) and death	Number of transitions	% among all transitions
No DA (DAX = 0) at both interviews	1198	41.7%
No DA to mild DA	280	9.7%
No DA to mod-sev DA	274	9.5%
No DA to dead	59	2.1%
Mild DA (DAX = 1) to no DA	276	9.6%
Mild DA at both interviews	159	5.5%
Mild DA to mod-sev DA	122	4.2%
Mild DA to dead	31	1.1%
Mod-sev DA (DAX = 2) to no DA	228	7.9%
Mod-sev DA to mild DA	100	3.5%
Mod-sev DA at both interviews	115	4.0%
Mod-sev DA to dead	30	1.0%
Total	2,872	

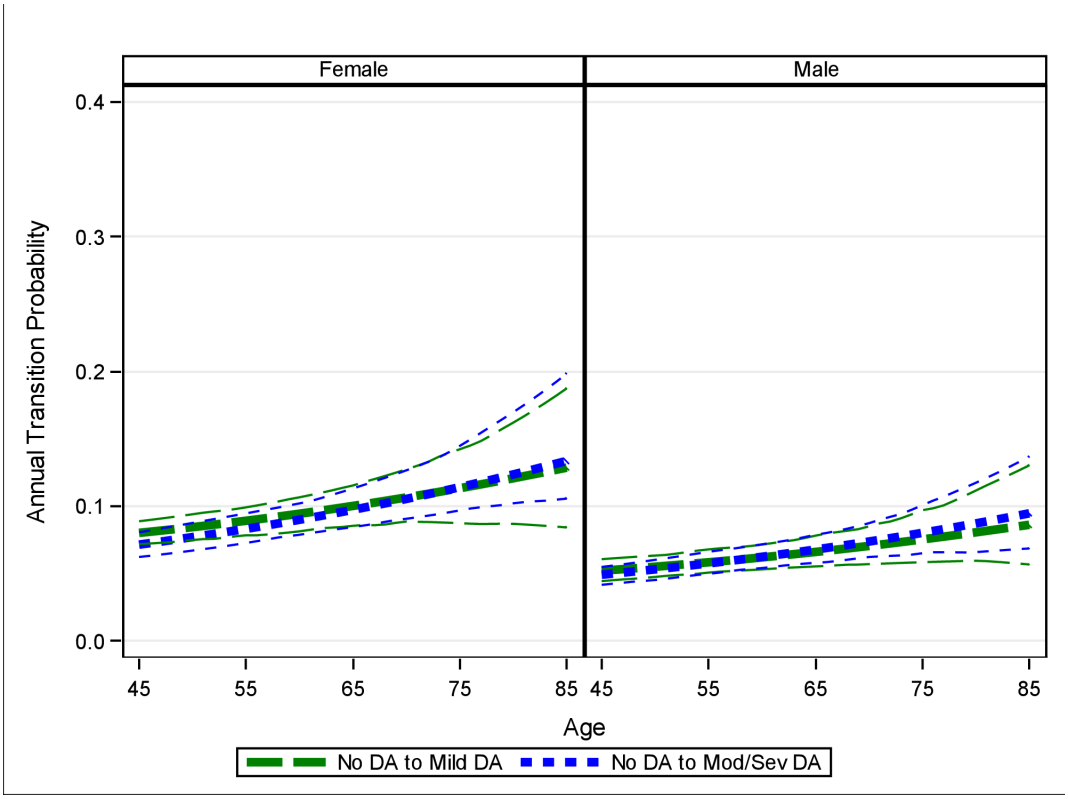

Figure A1: Estimated annual transition probabilities I: From *no depression/anxiety* (no DA or DAX = 0) to *mild depression/anxiety* (mild DA or DAX = 1) or *moderate/severe depression/anxiety* (Mod-sev DA or DAX = 2)

Notes: Thick lines represent the mean transition probabilities by age and gender, estimated via equation (A1), and thin lines depict the corresponding 95% confidence intervals.

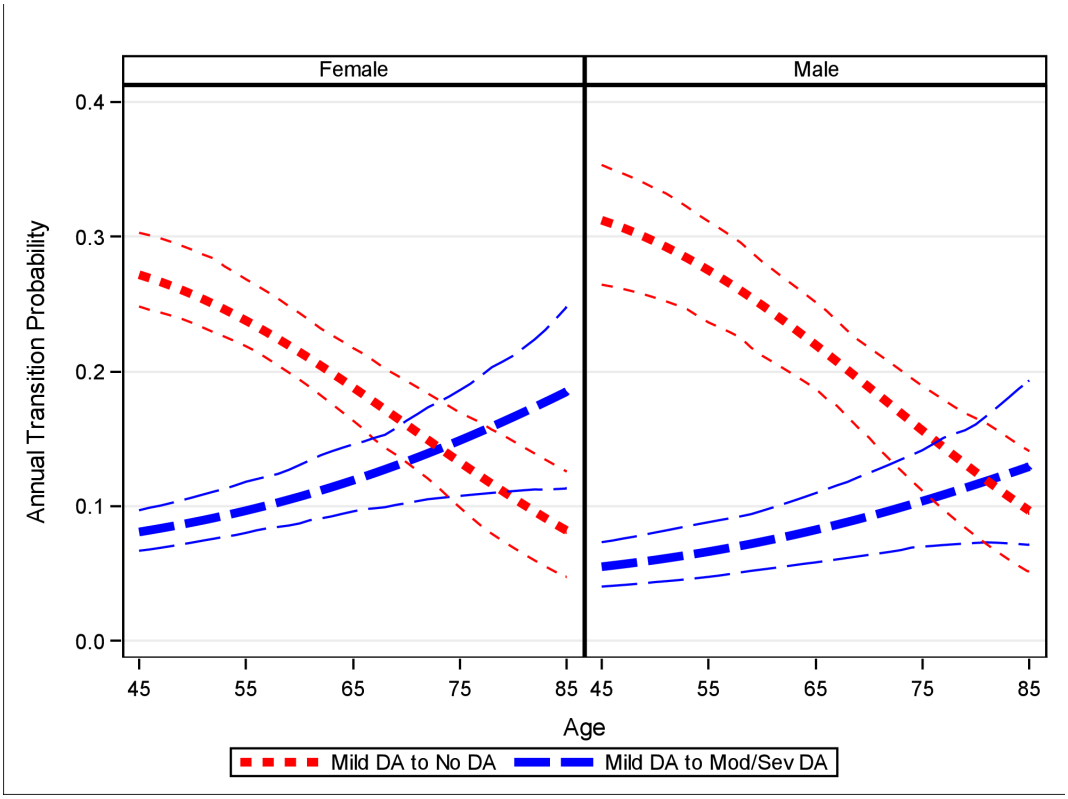

Figure A2: Estimated annual transition probabilities II: From *mild depression/anxiety* (mild DA or DAX = 1) to *no depression/anxiety* (no DA or DAX = 0) or *moderate/severe depression/anxiety* (Mod-sev DA or DAX = 2)

Notes: Thick lines represent the mean transition probabilities by age and gender, estimated via equation (A1), and thin lines depict the corresponding 95% confidence intervals.

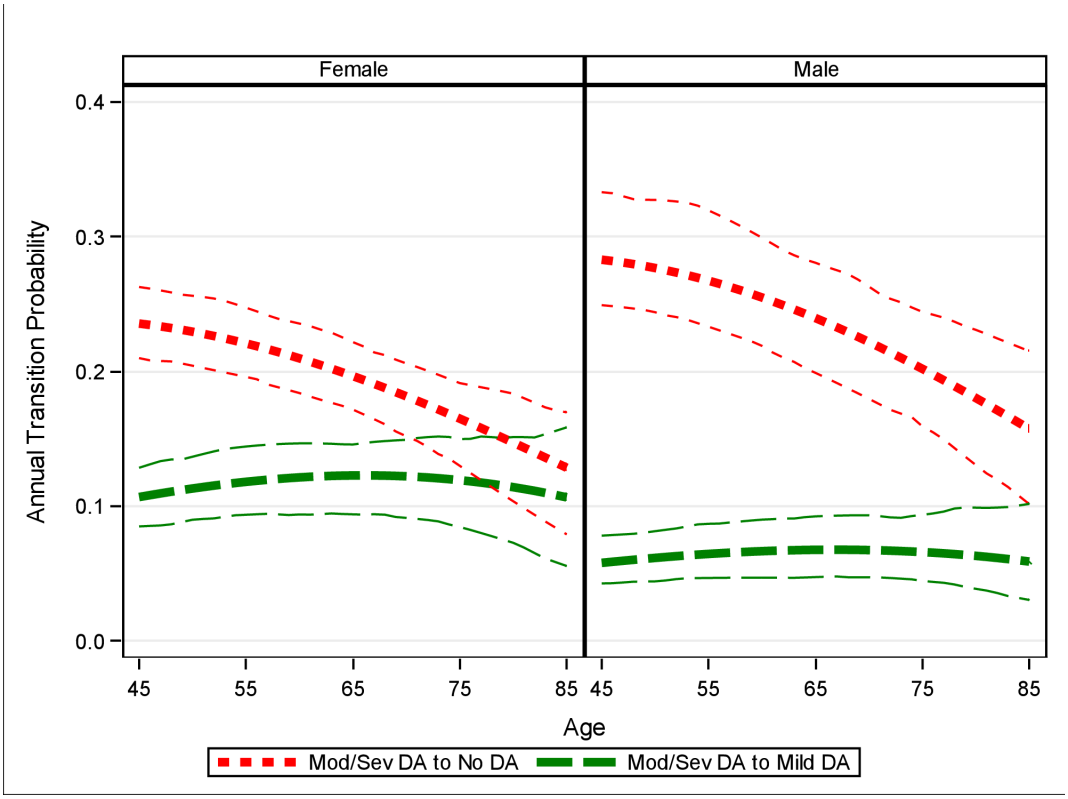

Figure A3: Estimated annual transition probabilities III: From *moderate/severe depression/anxiety* (Mod-sev DA or DAX = 2) to *mild depression/anxiety* (mild DA or DAX = 1) or *no depression/anxiety* (no DA or DAX = 0)

Notes: Thick lines represent the mean transition probabilities by age and gender, estimated via equation (A1), and thin lines depict the corresponding 95% confidence intervals.