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# The Mature Adults Cohort of the Malawi Longitudinal Study of Families and Health (MLSFH-MAC)

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## Recommended Citation

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## Abstract

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*Design and Measures*: The MLSFH-MAC is a population-based cohort study of mature adults aged 45 years and older living in rural communities in three districts in Malawi (Mchinji, Balaka and Rumphi). Initial enrollment at baseline is 1,266 individuals in 2012. MLSFH-MAC follow-ups were in 2013, 2017, and 2018. Survey instruments cover aging-related topics such as cognitive and mental health, NCDs and related health literacy, subjective survival expectations, measured biomarkers including HIV, grip strength, hypertension, fasting glucose, BMI, a broad range of individual- and household-level social and economic information, a 2018 qualitative survey of mature adults and community officials, 2019 surveys of village heads, health care facilities and health care providers in the MLSFH-MAC study areas.

*Unique features*: MLSFH-MAC is a data resource that covers 20 years of the life course of cohort members and provides a wealth of information unprecedented for aging studies in a low-income SSA context that broadly represents the socioeconomic environment of millions of individuals in south-eastern Africa. Among these are the longitudinal population-based data on depression and anxiety using clinically-validated instruments. MLSFH-MAC is also vanguard in measuring longitudinal changes in cognitive health among older individuals in SSA. Complemented by contextual and qualitative information, the extensive MLSFH-MAC data facilitate a life-course perspective on aging that reflects the dynamic and distinct settings in which people reach older ages in SSA LICs. Across many domains, MLSFH-MAC also allows for comparative research with global aging studies through harmonized measures and instruments.

*Collaboration and data access*: Public-use version of the 2012 (baseline) MLSFH-MAC data can be requested at http://www.malawi.pop.upenn.edu. Sharing of additional MLSFH-MAC data is currently possible as part of collaborative research projects (if not overlapping with ongoing research projects, and subject to a Data Use Agreement).

## Keywords

Malawi, HIV/AIDS, longitudinal data, mental health, MLSFH-MAC

## Disciplines

African Studies | Demography, Population, and Ecology | Diseases | Family, Life Course, and Society | Mental and Social Health | Social and Behavioral Sciences | Sociology

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# Cohort Profile: The Mature Adults Cohort of the Malawi Longitudinal Study of Families and Health (MLSFH-MAC)

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January 28, 2020

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## WHY WAS THE COHORT SET UP?

*Mature adults* (= individuals aged 45+ years old) constitute a demographically, economically and socially important subset of societies in sub-Saharan African (SSA)

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countries. Yet, due to a relative lack of aging studies in SSA or low-income countries (LICs), very little is known about the health and socioeconomic contexts of older individuals in SSA LICs. Long-term cohort studies covering older adults, which are critical for understanding life-course determinants of health and aging, are particularly rare. To fill this niche, the *"Mature Adults Cohort of the Malawi Longitudinal Study of Families and Health (MLSFH-MAC)"* was initiated in 2012 as a collaboration of the University of Pennsylvania with the College of Medicine in Malawi, and Invest in Knowledge Initiative (IKI), a Malawian NGO involved in the implementation of the data collections. The MLSFH-MAC cohort has been followed up in 2013, 2017 and 2018, with forthcoming data collection in 2020. The key innovation of the MLSFH-MAC is that it provides a rare opportunity to better understand the processes of individual- and population-aging, and the public health and social challenges associated with aging and the coincident shifts in disease burdens, in a low-income SSA context where very few comparable aging studies exist. The MLSFH-MAC additionally includes a focus on mental and cognitive health, representing two important but generally understudied health dimensions in SSA LICs. Overall, the MLSFH-MAC provides longitudinal data on aspects such as: prevalence/incidence of depression, anxiety, overall mental well-being, dimensions of cognition and overall cognitive health; association of mental/cognitive health with cardiovascular diseases (CVDs) and communicable diseases such as HIV/AIDS; mental/cognitive health as well as overall NCDs-related knowledge and disease management, understanding of disease symptoms, access and utilization of related health care; relationship of mental/cognitive health with social exclusion and marginalization, poverty, life-cycle decision making, social and economic development; life-course and family/socioeconomic factors associated with poor mental/cognitive and physical health outcomes.

This contribution of the MLSFH-MAC to the portfolio of global aging studies is important as patterns of aging and disease trajectories, as well as the appropriate health-systems and health-policy responses, are distinctly different in SSA LICs from those that have been extensively studied in higher income populations. The broader relevance of studying mature adults in the MLSFH-MAC is supported by the fact that, in the next decades, the population of mature adults in SSA will grow more rapidly than that of any younger 10-year age group, and it will grow 50% faster than mature adults in other high/middle-income regions that are the focus of most research on aging.[1] Although there is increasing recognition of the epidemiological and social challenges of individual and population aging in SSA,[2,3] few low-income countries (LICs) in the region have developed effective and/or viable health policies and responses to address the critical confluence of individual and population aging and shifting disease burdens towards NCDs.[4–6] Analyses of the MLSFH-MAC can help inform health policies and health sector strategies that are required for the growing population of mature adults and elderly individuals in SSA countries.

## WHO IS IN THE COHORT?

The MLSFH-MAC is a population-based cohort study of mature adults aged 45 years and older established in 2012 (baseline survey) and follow-up surveys in 2013, 2017 and 2018, with a forthcoming data collection in 2020. The cohort is set in rural communities in three districts in Malawi: Balaka in the southern region, Mchinji in the central region, and Rumphi in the northern region. A unique aspect of MLSFH-MAC is that it was derived from the Malawi Longitudinal Study of Families and Health (MLSFH), an ongoing longitudinal panel study established in 1998 that examines how families and individuals in rural Malawi cope with the social, economic, demographic and health consequences of high morbidity and mortality caused by the HIV/AIDS epidemic.[7] Specifically, the MLSFH-MAC cohort was established by selecting MLSFH respondents aged 45+ years in 2012, and enrolling them in the MLSFH-MAC as part of an extensive aging and health baseline survey in 2012. The advantage of this approach is that the extensive health and aging data collected in the MLSFH-MAC since 2012 can be linked to the prior life-course and contextual information covering the period since 1998. In combination with the MLSFH, the MLSFH-MAC thus currently covers two decades of mid- to older-age life course information, thereby providing exceptional insights into how individual and population aging has unfolded over the course of twenty years in a relatively poor rural context with high HIV prevalence that broadly represents the living contexts of millions of individuals in south-eastern Africa. Mortality levels among MLSFH-MAC respondents, including their recent reversal, correspond to those of the overall Malawian population.[8,9] The MLSFH-MAC thus provides a unique opportunity to study how the cohort of individuals now reaching mature adult ages has weathered one of the greatest global health crises of the late 20th and early 21st centuries, the HIV/AIDS epidemic, that struck the SSA region that is also dealing with poverty, famines and basic uncertainties in life.

The key inclusion criteria in 2012 for enrollment in the MLSFH-MAC were twofold: (*i*) being a MLSFH respondent aged 45 years or older in 2012; and (*ii*) having been interviewed in both the 2008 and 2010 MLSFH data collection rounds. The second criteria ensured that at least three waves of mental health and subjective well-being data were available for each baseline participant in 2012. These inclusion criteria resulted in a MLSFH-MAC baseline enrollment of 1,266 individuals clustered in 130+ villages, representing more than 90% of the 1,402 eligible MLSFH respondents who met the enrollment criteria for the MLSFH-MAC (= target sample) (Figure 1). Migration out of the MLSFH study areas and mortality were the primary reasons for not enrolling eligible respondents. Comparisons of the MLSFH-MAC study population and nationally representative samples are reported in the Supplemental Materials.

The MLSFH-MAC sample has been augmented at each follow-up with additional MLSFH respondents who reached eligibility (attaining age 45, and having participated in the 2008 and 2010 MLSFH surveys). To ensure an adequate representation of HIV+ individuals, the inclusion criteria were relaxed for the HIV+

**Figure 1: Initial MLSFH-MAC sample selection, additional enrollments, mortality and sample attrition during 2012–2018**
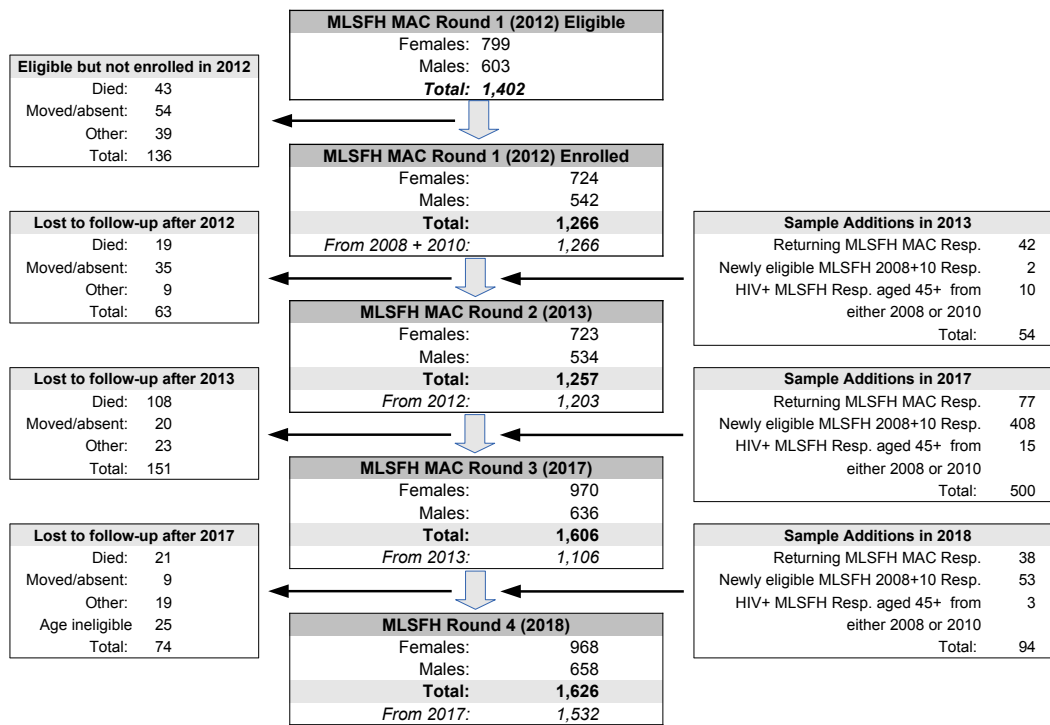


*Notes:* MLSFH-MAC is based in three districts in Malawi—Rumphi in the north, Mchinji in the center, and Balaka in the south. MLSFH-MAC sampling and related relevant data collection procedures are described in Section A1.8. Returning MLSFH MAC Respondents refers to respondents who were interviewed in the current MLSFH-MAC wave, but were eligible but not successfully surveyed d in the prior MLSFH-MAC wave (usually because they were temporarily absent). MLSFH-MAC Study instruments are described in Table 4. The MLSFH-MAC survey data are complemented by extensive qualitative data with a focus on mental health collected in 2018, and in 2019 the MLSFH-MAC team interviewed village heads, health care providers, community health workers and representatives of all health care facilities in the MLSFH-MAC study areas.

**Table 1: Summary statistics for the MLSFH-MAC in 2018**

|  | Women | Men | Total |
|---|---|---|---|
| # of enrolled MLSFH-MAC respondents | 968 | 658 | 1,626 |
| Age | 59.7 | 60.6 | 60.1 |
|  | (11.9) | (11.6) | (11.8) |
| Age group |  |  |  |
| *< 45* | 0.02 | 0.01 | 0.02 |
| *45-54* | 0.39 | 0.36 | 0.38 |
| *55-64* | 0.28 | 0.28 | 0.28 |
| *65-74* | 0.18 | 0.20 | 0.18 |
| *75+* | 0.13 | 0.15 | 0.14 |
| Schooling attainment |  |  |  |
| *No formal schooling* | 0.37 | 0.19 | 0.29 |
| *Primary schooling* | 0.60 | 0.70 | 0.64 |
| *Secondary or higher* | 0.03 | 0.12 | 0.07 |
| Muslim | 0.27 | 0.24 | 0.26 |
| Currently married | 0.60 | 0.94 | 0.74 |
| HIV+ | 0.09 | 0.07 | 0.08 |
| Female | — | — | 0.60 |

Means with std. deviations in parentheses (where applicable). HIV status is indicated as HIV+ if any MLSFH HIV test in 2006, 2008, 2012 or 2017 indicated infection with HIV.

subpopulation, and age-eligible MLSFH respondents were enrolled in the MLSFH-MAC if they participated in either the 2008 or 2010 MLSFH data collection. Due to this ongoing enrollment of age-eligible MLSFH respondents, the MLSFH-MAC sample size increased over time, reaching 1,257 in 2013, 1,606 in 2017 and 1,626 in 2018 (Figure 1).

Summary statistics for the 2018 MLSFH-MAC cohort are reported in Table 1. The mean age of the MLSFH-MAC respondents is 60.1 years, with men being on average about 1 year older than women. The MLSFH-MAC population is characterized by low levels of formal education, with the majority of our respondents having no formal schooling (29%) or completing only primary education (64%). Women have lower levels of schooling compared to men, and only 3% of women age 45+ years has completed secondary or higher education as opposed to 12% among men. Marriage is essentially universal in Malawi, marital transitions are frequent, and substantially higher fraction of men was married at the time of the survey in 2018 (94%) compared to 60% of women. About 1/3 of the cohort is Muslim, which reflects regional differences with the southern district of Balaka having a higher fraction of Muslims than other regions of Malawi. In 2018, 8% of the MLSFH-MAC cohort was HIV-positive, with HIV+ individuals concentrated at the younger end of the mature adults age range.

**Table 2: Attrition in the MLSFH-MAC sample, 2012—2018**

|  | Women | Men | Total |
|---|---|---|---|
| 2012 MLSFH-MAC Respondents | 724 | 542 | 1,266 |
| 2018 MLSFH-MAC survey outcome for 2012 respondents: |  |  |  |
| *Completed interview* | 0.874 | 0.834 | 0.857 |
| *Dead* | 0.101 | 0.140 | 0.118 |
| *Moved and lost to follow-up* | 0.003 | 0.009 | 0.006 |
| *Other* | 0.022 | 0.017 | 0.020 |

*Notes:* Survey outcome "moved" includes respondents who moved and were not found during the migration follow-ups in 2017 and 2018. "Other" includes respondents who were not successfully interviewed because of various reasons such as temporarily absent, hospitalized, etc.

### HOW OFTEN HAVE THEY BEEN FOLLOWED UP?

Figure 1 describes enrollment in, and attrition from the MLSFH-MAC cohort since 2012. At each follow up, all existing MLSFH-MAC-eligible respondents were reinterviewed (or approached for interview), and newly-eligible MLSFH respondents were added to the MLSFH-MAC cohort. The largest number of respondents was added in 2017 ($408 + 12 = 423$ new respondents), while the 2013 and 2018 data collections added only $10 + 2 = 12$ and $53 + 3 = 56$ new respondents as few respondents reached eligibility within the 1-year since the prior survey. In 2017 and 2018, MLSFH-MAC conducted extensive migration follow-up of respondents who left their original villages and moved to other areas within Malawi. Eligible MLSFH-MAC respondents respondents who were not successfully interviewed in a given year, generally because they were temporarily absent during the 3 contact attempts and/or could not be contacted during migration follow-ups, were continued to be approached for interview in any follow-up data collections.

Table 2 reports reasons for attrition between the 2012 baseline survey and the (currently) last follow up in 2018. Of 1,266 respondents interviewed at baseline, 86% were successfully found in 2018. The primary cause for loss to follow-up is mortality (11.8% of the 2012 respondents died by 2018 when last followed-up). Refusal to participate in the MLSFH-MAC, conditional on successfully contacting a respondent, is relatively rare (less than 1% at baseline). Temporary/permanent migration out of the MLSFH-MAC study regions is less common for mature adults aged 45+ years as compared to younger individuals, and after the MLSFH-MAC migration follow-up efforts, less than 1% of the 2012 respondents were lost due to migration. Excluding respondents who died between 2012 and 2018, the MLSFH-MAC successfully surveyed in 2018 a remarkable 97% of the respondents interviewed at the 2012 baseline, providing a very high rate of long-term retention of surviving study participants in a longitudinal cohort study.

Extensive pre-2012 information is available for all MLSFH-MAC respondents

**Table 3: MLSFH survey rounds available for MLSFH-MAC in 2018**

|  | Women | Men | Total |
|---|---|---|---|
| # of MLSFH-MAC study participants in 2018 | 968 | 658 | 1,626 |
| Proportion of 2018 MLSFH-MAC respondents with linkage to: | | | |
|     2017 MLSFH-MAC survey data | 0.95 | 0.93 | 0.94 |
|     2013 MLSFH-MAC survey data | 0.67 | 0.69 | 0.67 |
|     2012 MLSFH-MAC survey data | 0.65 | 0.69 | 0.67 |
|     2010 MLSFH survey data | 0.98 | 0.99 | 0.99 |
|     2008 MLSFH survey data | 0.99 | 0.99 | 0.99 |
|     2006 MLSFH survey data | 0.68 | 0.76 | 0.71 |
|     2004 MLSFH survey data | 0.63 | 0.69 | 0.66 |
|     2001 MLSFH survey data | 0.65 | 0.59 | 0.62 |
|     1998 MLSFH survey data | 0.58 | 0.60 | 0.59 |

through linkages with prior data collected as part of the MLSFH. For example, longitudinal information covering 20 years of their life course (i.e., 1998–2018) is available for 59% of the 2018 MLSFH-MAC respondents (Table 3), and 10-years of follow-up—covering the period 2008–2018—is available for 99% of MLSFH-MAC respondents. The difference in longitudinal data linkages is explained by the fact that the MLSFH expanded its sample to older respondents in 2008, which implied that a subset of current MLSFH-MAC respondents were enrolled in 2008, with the remaining MLSFH-MAC respondents having either been part of the initial 1998 MLSFH sample or having been enrolled as part of MLSFH sample expansions during 2001–2006.[7] Because the 2018 MLSFH-MAC sample includes respondents who became mature adults only after 2012, only about 2/3 of the 2018 sample was surveyed at baseline in 2012.

### WHAT HAS BEEN MEASURED?

MLSFH-MAC surveys are conducted in the local languages (Chichewa, Chiyao and Chitumbuka) by carefully trained interviewers and/or HIV testing counselors. The survey instruments (Table 4) are a combination of previously-existing MLSFH instruments and newly developed survey instruments covering in particular aging-related topics such as cognitive and mental health, NCDs, NCD-related health literacy, etc. This survey design offers the advantage of allowing longitudinal comparability of information collected for the MLSFH-MAC cohort since 1998, thereby facilitating long-term life-course studies, while also allowing for an expansion of the MLSFH-MAC survey into new aging and NCD-related dimensions for which prior data do not exist or are very limited. All new survey modules (i.e., mental/cognitive health instruments) were extensively pretested during focus-group interviews and pilot tests, and reverse translations ensured the accuracy of the final instruments in the local languages. In most cases, newly implemented instru-

### Table 4: Selected aging and health-related MLSFH-MAC measurements (longitudinal data is available for most of these measures)

| Construct Definition | Measurement/Scales/Items Source |
|---|---|
| *Mental health and depression* | SF12 mental health score; Primary Care Evaluation of Mental Disorders (PRIME-MD), including PHQ-9 depression module and GAD-7 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 hand-held 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 use* | Alcohol use based on the Alcohol Use Disorder Identification Test (AUDIT); tobacco consumption (current/ever smoked and amount). |
| *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* | MLSFH modules on social capital & family transfer networks. Egocentric health conversation networks (2018) |
| *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. |

Longitudinal data is available in the MLSFH-MAC for most of the above measures. HIV status is known for *all* MLSFH-MAC respondents (measured in 2017 and 2012 as part of MLSFH-MAC, and 2008, 2006, 2004 as part of MLSFH). All MLSFH-MAC households are geocoded, and can be linked to health infrastructure and other spatial data (roads, schools, trading centers, markets, etc.). Spouses are linked in the MLSFH-MAC, and so are children if they are included in the MLSFH. Children reported by respondents in the household/family rosters are longitudinally linked in the household rosters across waves dating back to 2004. The MLSFH-MAC survey data are complemented by extensive qualitative data with a focus on mental health collected in 2018, and in 2019 the MLSFH-MAC team interviewed village heads, health care providers, community health workers and representatives of all health care facilities in the MLSFH-MAC study areas.

ments were also harmonized as much as possible with other aging studies (such as the *Health and Retirement Survey* (HRS) and its international sister-studies) that provide a wide-ranging multidisciplinary body of data on aging in high- and middle-income countries[10] and in which the MLSFH-MAC data can be integrated for comparative analyses.

  *Mental health* of the MLSFH-MAC cohort is assessed using: (*a*) the contin-

ued implementation of the SF-12 mental health scores that is available for all respondents since 2006/08; and (*b*) since 2012, the depression and anxiety modules of the Patient Health Questionnaire-9 (PHQ-9 and GAD-7) that provide more detailed indicators of both the presence and the severity of depression and anxiety. *Cognitive health* is assessed using: (*a*) spatial/temporal orientation and language based on typical questions used in many different mental status examinations; visual/constructional tests to assess space and object perceptions; (*b*) visual/verbal memory, attention/working memory, immediate and delayed recall and executive functioning that resemble many clinical tests assessing these functions, but with necessary adaptations to the prevailing low literacy levels among mature adults. Instruments to assess respondents' *physical health* status include: (*a*) grip strength as a measure of physical performance; (*b*) measured weight/height, hip and waist circumference; (*c*) gait speed or time walk (2017); (*d*) measured blood pressure and fasting blood glucose (the latter only in 2017); (*e*) self-reports of activities of daily living (ADLs), experience of acute and chronic pain, medical diagnosis of selected cardiovascular diseases (CVDs). NCD- and aging-related *health-literacy* is assessed by knowledge about symptoms of, and treatment options for several NCDs, as well as by questions about the survival-implications of being affected by different NCDs. The MLSFH-MAC continues to collect instruments on *subjective risks assessments* and probabilistic expectations, using an innovative MLSFH expectations module focused on mortality and HIV-related risk perceptions. *Other instruments* measure respondents social capital and resource networks, social, demographic and economic background, work efforts, productivity, consumption and related household income/expenditure measures (for additional details, see MLSFH Cohort Profile[7]). MLSFH-MAC also measures exposure to *behavioral risk factors* such as alcohol consumption, smoking and sexual partnerships and sexual risk taking. In 2018, MLSFH-MAC collected information on *egocentric health conversation networks*, measuring how mature adults interact about NCDs, including mental health, with others within and outside of their households. The MLSFH-MAC has conducted repeated *HIV testing and counseling* (HTC) in 2012 and 2017 at respondents' homes, and it has collected information about access to, and use of antiretroviral treatment (ART).

MLSFH-MAC data are linked between spouses (spouse linkages are updated at each round), and to children if they are included in the MLSFH. The individuals listed on the MLSFH-MAC household rosters are linked to prior MLSFH household rosters dating back to 2004, allowing detailed longitudinal analyses of household dynamics, investments in child human capital and intergenerational relations for mature adults.The MLSFH-MAC has collected in several rounds GPS coordinates of all respondents' residence, allowing linkages to other geospatial data and the computation of proximity to important landmarks such as roads, schools, health care facilities, trading centers, markets, etc.

In addition to the main survey data collections, the study has collected extensive complementary data that expand the potential research questions that can be

addressed using the MLSFH-MAC. For example, in 2017, the MLSFH-MAC implemented a study that focused on the extent to which pessimistic survival expectations present an understudied but potentially important and modifiable determinant of mental health, health behaviors and other life-cycle decisions, and how targeted information about mortality risks can improve mental health, life-course decision-making and a broad range of social/economic outcomes among mature adults.[11] In 2018, a qualitative study component was implemented with the goal to provide critical insights to aid the interpretation and contextualization of the quantitative findings from the MLSFH-MAC. The qualitative study sample was composed of 60 respondents age 45+ years recruited from the same study areas, and who have never participated in MLSFH-MAC or MLSFH, plus additionally 12 village heads (4 per MLSFH-MAC study region), members of village health committees, and health care providers.

In 2019, the study team additionally augmented the available MLSFH-MAC data with an extensive information on health care facilities and health care providers serving the MLSFH-MAC enumeration areas/villages. These heath-care provider and facility surveys included a focus on NCDs, including mental and cognitive health, and provide key information on the resources of the local health care system in MLSFH-MAC study communities, and their ability to meet the health care needs of the growing population of mature adults. Furthermore, in 2019 the team interviewed the village heads of roughly 30 villages per study region (total of 97 village heads) and collected wide-ranging contextual information on overall demographic trends in the villages since 2010, general village characteristics, village leadership, village social and economic development and governmental assistance, environmental changes over the last 10 years, village conflicts, gender norms and gender-based violence, etc.

## WHAT HAS THE MLSFH-MAC FOUND? KEY FINDINGS AND PUBLICATIONS

Findings based on the MLSFH-MAC have started to make important contributions to emerging literature on population aging and NCDs in SSA LICs, and the distinct health and aging trajectories at older ages that occur when individuals are exposed to frequent and sustained adversity throughout the life-course. Initial key findings of the MLSFH-MAC are summarized below, while other analyses that exploit the full (and only recently available) 1998–2018 cohort data, as well as the potentials of the MLSFH-MAC for comparative analyses with other global aging data, are ongoing.

***Mental health among MLSFH mature adults:*** To our best knowledge, no large-scale population-based data on depression and anxiety using established clinically validated instruments were available for a SSA LIC study population prior to this study, and the MLSFH-MAC cohort provides an important resource for understanding mental health of older individuals outside of frequently-studied high- and middle-income populations. Methodologically, MLSFH-MAC has demonstrated that the collection of commonly-used survey instruments for measuring and es-

**Figure 2: Age patterns of depression (PHQ-9 Score) for mature adults, 2012–13**
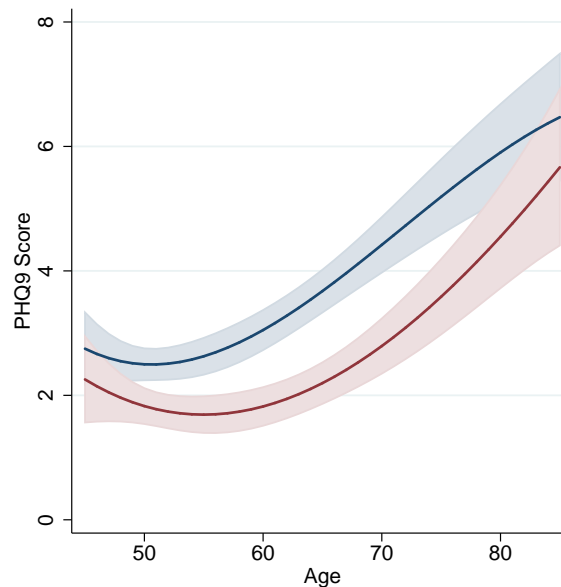


*Notes:* PHQ-9 Depression Score by age for women and men. Figure shows marginal means (with 95% confidence intervals) obtained by regressing the respective mental health score on a cubic function of age, separately by sex. Analyses are pooled across 2012 and 2013 MLSFH-MAC surveys. Confidence intervals are adjusted for clustering within respondents. Analyses control for schooling, region and MLSFH-MAC wave. Religion is not controlled for because it is essentially collinear with region in the MLSFH-MAC; marital status is not controlled for because it is time-variant and endogenous with respect to mental health.

tablishing the incidence and prevalence of depression and anxiety is possible in a subsistence-agriculture population that is characterized by high levels of poverty, low levels of schooling, high levels of illiteracy, often poor health and generally low awareness about mental disorders. Substantively, our MLSFH-MAC studies found that depression and anxiety are more frequent among women than men in Malawi, and individuals are often affected by *both*. Depression and anxiety also increase substantially with age (Figure 2), and mature adults can expect to spend a substantial fraction of their remaining lifetime—for instance, 52% for a 55 year old woman—affected by poor mental health.[12] This pattern is consistent with an overall decline in mental health and subjective well-being with age measured by the SF-12 and other indicators. The positive age-gradients of depression/anxiety are not due to cohort effects, and they are in sharp contrast to the age pattern of mental health that has been shown in high-income contexts, where older individuals often experience lower levels of depression/anxiety. While socioeconomic and risk/uncertainty-related stressors are strongly associated with depression and anxiety, they do not explain the positive age gradients and gender gap in depression/anxiety.[12] Stressors related to physical health, however, do. Moreover, marital dissolutions are associated with changes mental health, but with important differ-

**Figure 3: 2012–18 cohort change in PHQ-9 depression score, by age in 2018**
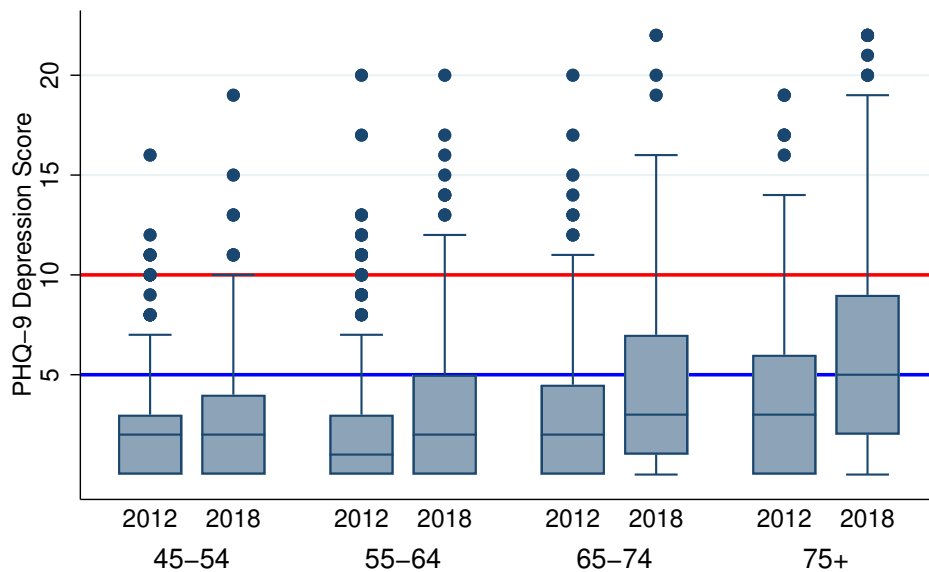


*Notes:* Boxplots of PHQ-9 Depression Score in MLSFH-MAC cohort, by age in 2018. PHQ-9 scores are top-coded at a score of 22 (affecting very few observations). Analysis includes only respondents who participated in the 2012 and 2018 MLSFH-MAC surveys, and show the change in the distribution of PHQ-9 as the MLSFH-MAC cohort members aged during 2012–18. Red line: PHQ-9 threshold for moderate depressive symptoms; blue line: PHQ-9 threshold for mild depressive symptoms.

ences by gender: for men, a longer time spent outside marriage is associated with worse mental health, whereas more marital dissolutions are surprisingly linked to better mental health for women, possibly related to the fact that dissolution are initiated by women as a result of marital dissatisfaction or perceptions of increased HIV risk due to their partners.[13]

While these initial findings were primarily based on 2012/13 cross-sectional data, the follow-up of the MLSFH-MAC cohort until 2018 allows now for longitudinal life-course analyses as well as analyses of the the trajectories of mental/physical health as individuals get older over time. For example, the boxplots in Figure 3 show that the prevalence of depression increases as MLSFH-MAC members get older, consistent with the cross-sectional patterns found in the initial MLSFH-MAC studies on mental health (Figure 2). Importantly, because the complete distribution of PHQ-9 scores shifts to higher values between 2012 and 2018, these MLSFH-MAC cohort analyses confirm that depression indeed increases in rural Malawi as individuals become older. In all but the youngest age group, the median PHQ-9 depression score increased as cohort members aged, and in the oldest subset of MLSFH-MAC respondents (aged 75+ in 2017), more than 50% of the respondents experienced mild or worse depressive symptoms in 2018, an increase from only 33% in 2012, and 87% of respondents in this age group reported at least some depressive symptoms.

***Cognitive health among MLSFH mature adults:*** The MLSFH-MAC is among the first population-based studies that have provided insights into the cognitive health trajectories among older individuals in a SSA LIC context. Cross-sectional analyses of the 2012–13 data found that women have substantially worse cognitive health than men, and experience a steeper age-gradient in cognitive abilities.[14] Strong social ties and exposure to socially complex environments were associated with higher cognitive health, as was higher life-course socioeconomic status. Poor cognitive health, similar to poor mental health, is associated with adverse social and economic well-being outcomes such as less nutrition intake, lower income, and reduced work efforts even in this subsistence-agriculture context. Lower levels of cognitive health are also strongly associated with increased levels of depression and anxiety, and were associated with worse physical health measured through both self-reports and measured physical performance. Additional analyses that build on the longitudinal follow-up data collected after 2012/13 furthermore show that cognitive health and overall cognitive scores predict mortality in the MLSFH-MAC cohort until 2018, but do not predict other types of attrition. Cohort analyses also confirm the patterns of cognitive decline as individuals become older over time, which had previously been suggested—but not confirmed—based on cross-sectional 2012/13 analyses.[14] In combination, these MLSFH-MAC findings indicate that cognition plays a key—but potentially understudied—role in shaping late-life well-being in low-income populations, and that despite the overall subsistence-agriculture context dominated by manual labor, variation in cognitive health is important for well-being in this mature adult population.

***HIV prevalence among mature adults:*** MLSFH-MAC tested all study participants for HIV at baseline in 2012, updating earlier HIV tests from 2004–08 available through linkage to MLSFH. Only 60 HIV+ mature adults (HIV prevalence 4.8%) were identified in 2012 (32 women and 28 men) (Table 5). As antiretroviral treatment (ART) became available in the MLSFH study regions only after 2008, the low HIV prevalence of 4.8% among MLSFH-MAC respondents is the result of high mortality for HIV+ individuals in this cohort prior to the availability of ART, as documented by analyses of mortality among MLSFH respondents before 2010.[9] HIV prevalence is higher among MLSFH-MAC respondents who died subsequent to the 2012 baseline (until 2017) than among those that survived (7.2% vs. 4.5%), indicating that despite better availability of ART since 2012, HIV infection continues to substantially elevate mortality risks among mature adults in rural Malawi.

At follow-up in 2017, when the most recent HIV tests were conducted as part of the MLSFH-MAC, 8% of respondents tested HIV-positive, corresponding to an increase of 40% in HIV prevalence since the 2012 baseline. This increase is *not* the result of high HIV incidence in the MLSFH-MAC cohort, as only 5 new infections were identified among MLSFH-MAC respondents who were tested in both 2012 (baseline) and 2017. During 2012–17, HIV incidence in the MLSFH-MAC cohort is therefore very low with only .87 new infections per 1,000 person years lived. Given this low HIV incidence, the increase in HIV prevalence in the MLSFH-MAC cohort

**Table 5: HIV prevalence among 2017 MLSFH Mature Adults, and HIV incidence among 2012–17 MLSFH Mature Adults**

|  | Women | Men | Total |
|---|---|---|---|
| **2012 MLSFH Mature Adults (N=1,217)** | | | |
| HIV prevalence, all 2012 respondents | 4.5% | 5.3% | 4.8% |
| HIV positive, 2012 respondents aged 45–49 | 5.9% | 8.5% | 6.9% |
| HIV prevalence among those who | | | |
|     died by 2017 (N = 125) | 6.8% | 7.6% | 7.2% |
|     survived to 2017 (N = 1,122) | 4.3% | 4.9% | 4.5% |
| **2017 MLSFH Mature Adults (N=1,555)** | | | |
| HIV prevalence, all 2017 respondents | 8.8% | 7.6% | 8.3% |
| HIV prevalence, 2017 respondents aged 45–49 | 14.6% | 9.2% | 12.6% |
| HIV incidence (%, among respondents tested both 2012 and 2017) | .15% | .83% | .43% |
| HIV incidence rate (per 1,000 person years, among respondents tested in both 2012 and 2017) | .30 | 1.66 | .87 |

*Notes:* 1,200 MLSFH-MAC respondents were tested for HIV in 2012, and 1,551 in 2017. Combined with earlier MLSFH HIV tests, HIV status information is available for 1,247 MLSFH-MAC respondents in 2012, for 1,598 in 2017, and for 1,080 who were surveyed in both 2012 and 2017.

is driven by a substantial rise of the high HIV prevalence among MLSFH-MAC respondents aged 45-49 years, 11.8% of whom tested HIV+ in 2017 as compared to 6.9% in that age group in 2012. All MLSFH-MAC respondents aged 45–49 in 2017 were newly enrolled in the study in 2017, and it is the increased prevalence among these relatively young mature adults—who likely benefited more from the roll-out of ART and the resulting mortality reductions for HIV+ individuals—that is elevating the HIV prevalence in the MLSFH-MAC cohort.

***Physical health among MLSFH mature adults:*** The MLSFH-MAC includes a broad array longitudinal data for both self-reported and measured indicators of physical health. We focus here on two critical indicators for understanding aging trajectories and NCD risks: grip strength and blood pressure. Hand-grip strength as a measured marker of physical health has been shown to be related to physical performance in a wide range of day-to-day activities, and has been consistently shown to predict future mobility decline, disability and mortality.[15–17] Panel A in Figure 4 documents the cohort change in grip strength during 2012–17, by baseline (2012) age groups, for respondents who participated in both the 2012 and 2017 MLSFH-MAC data collections. Grip strength for the US population age 55-64 yrs is indicated for comparison (25th and 50 percentile, based on HRS). In the MLSFH-MAC cohort, grip strength is weaker for older individuals, as is the case in other populations, but it is the overall pattern that is noticeable: the boxplots show that even at the youngest ages 45-54, more than 75% of the MLSFH-MAC population measures grip strength that is below the median estimated for the 10yrs older US population

**Figure 4: Cohort change in hand-grip strength and blood pressure, by age in 2018**

**(A) Hand-grip strength 2012 & 2017, same respondents, by baseline (2012) age group**
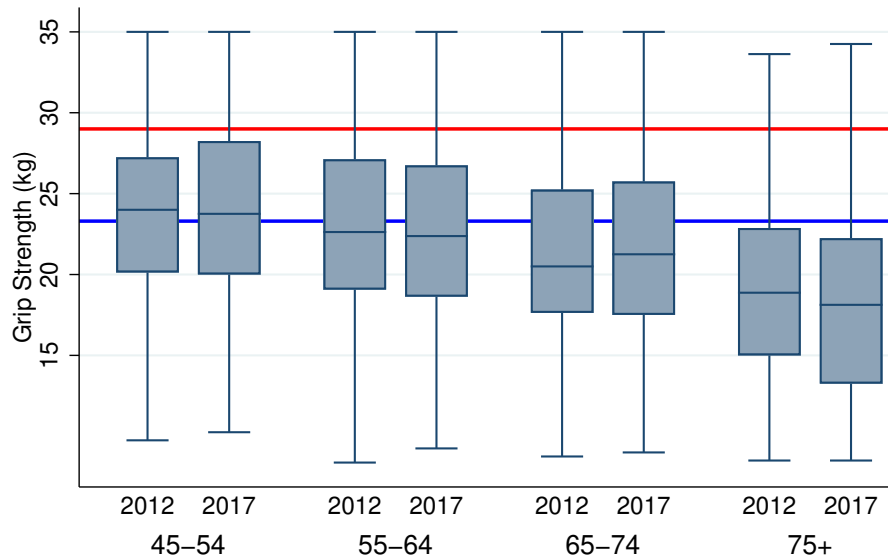


**(B) Systolic blood pressure 2013 & 2017, same respondents, by baseline (2012) age group**
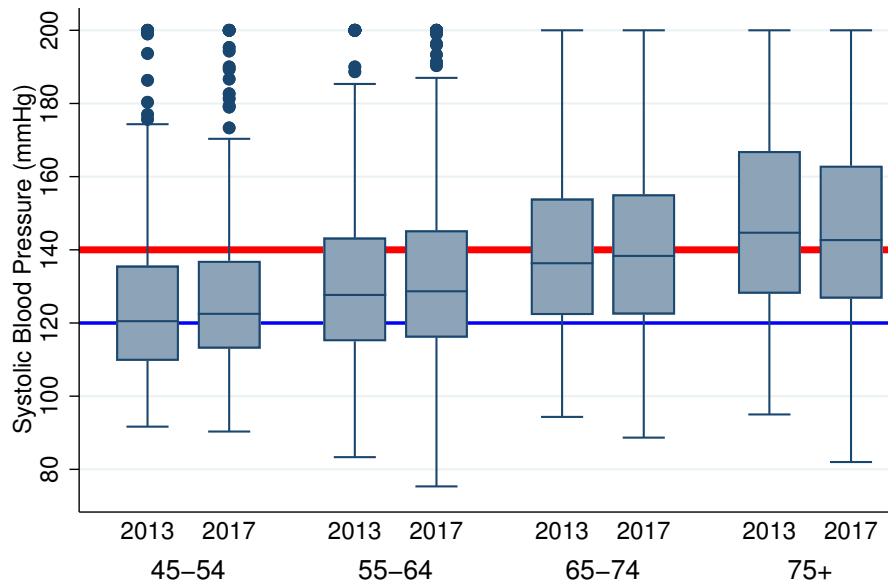


*Notes:* Boxplots of grip strength and systolic blood pressure in MLSFH-MAC cohort, by age in 2018. Both genders combined. Analyses include only respondents who participated in the 2012 (2013) and 2017 MLSFH MAC surveys (=surveys with the initial and most recent measures).

*Additional notes for top panel:* Grip strength is measured in kg, combining average left and right hand, each based on 3 measurements. Red line indicates median grip strength for the US population age 55-64 years old estimated from the Health and Retirement Study (HRS); blue line indicates 25th percentile of grip strength for the HRS population age 55-64 years.

*Additional notes for bottom panel:* Systolic blood pressure is measured in mmHG, average value based on 3 measurements. Red line indicates 140 mmHG, a common cut-off for suggesting hypertension, and blue line indicates 120 mmHG, a common cut-off suggesting pre-hypertension.

aged 55-64 yrs (red line) and about 50% of MLSFH-MAC has grip strength below the 25th percentile of the US population (blue lines). Additional analyses also reveal that the rate of disabled individuals in Malawi is more than twice higher than in the US at age 50 and the increase of the disabled population with age is substantially steeper compared to the US, and it closely traces levels observed in other SSA populations such as South Africa and Ghana.[18] Analysis combining the comprehensive health and socioeconomic information available in MLSFH-MAC show that the relationship between physical health and working status at older ages is different in the low-income context of rural Malawi as compared to higher income countries.[18] Specifically, in Malawi physical health and mobility limitations predict working status much better than chronological age, and individuals withdraw from active labor force participation because of physical health limitations rather than because of getting old per se. Weak grip strength also predicts poor mental health and cognitive decline. These patterns are consistent with prior analysis of physical health among mature adults for 2006–10 that showed that at older ages, chronic and disabling conditions are common, leading to significant functional limitations in day-to-day activities, and a substantial gap between potential and actual productivity.[19]

In contrast to the cross-sectional pattern of older persons having weaker grip strength, the longitudinal grip strength pattern in the MLSFH-MAC cohort indicates a relative stability in grip strength during the period 2012–17: for ages below 75 years, the median grip strength did not decline for individuals who participated in both the 2012 and 2017 data collections, and a decline is only present for the oldest members of the MLSFH-MAC cohort. This relative stability of grip strength in the MLSFH-MAC during a 5-year period can in part be attributed to mortality selection, as weak grip strength is associated with higher mortality and stronger individuals are thus more likely to survive. In addition, the cross-sectional decline of grip strength with age could reflect cohort differences, with older cohorts having weaker grip strength throughout life, for instance, due to worse early life determinants of physical development.

As is the case in other African populations,[20] hypertension is relatively prevalent in the MLSFH-MAC cohort (Panel B in Figure 4): in 2018, 67% of MLSFH mature adults aged 45+ had pre-hypertension (systolic blood pressure $\geq$ 120 mmHg) or hypertension, increasing to 78% above age 60, indicating significant cardiovascular risk among mature adults across all ages. The MLSFH-MAC cohort stands out when compared to other populations in which hypertension is prevalent in that conventional risk factors of hypertension, such as obesity, lack of physical activity or exposure to western diets, are not very common. For example, only about 17% had a BMI above 25 in 2017, only 5.9% have an indication of diabetes (fasting blood glucose $>$ 5.6 mmol/L), and most respondents report regular and high levels of physical activity.

Older members of the MLSFH-MAC cohort are significantly more likely to have elevated blood pressure, and in the cross-section, systolic blood pressure increases

by about .6 base points per year of age for both men and women. Longitudinal analyses of blood pressure reveal important heterogeneity. For women aged 45–74 years (but not for men) or men and women aged 75+, there is an increase in systolic blood pressure of 2.5 base points during 2013–17, corresponding to a .6 point increase of blood pressure per year (similar to the age gradient in Western, but more than that in some other low-income populations[21]). The gender-difference potentially reflects the well documented sexual dimorphism of blood pressure changes with age.[22]

MLSFH-MAC analyses of the *cascade of care* for hypertension reveal large discrepancies between the needs of the rural Malawian population to be screened and treated for hypertension, and the limitations of the resource-constrained health care system to address these needs.[20] Among MLSFH-MAC respondents who measured with high blood pressure in 2012 and 2017, only a small fraction had ever been diagnosed with high blood pressure by a health care professional and even a much smaller fraction was on treatment and having their blood pressure effectively under control. These findings suggests that simple and cost-effective measures such as free population-level screening for hypertension, with referrals to a medical provider when indicated, can reduce blood pressure within four years by about half a standard deviation.[23] This effect is explained by a 20 percentage points increase in the probability of being diagnosed as hypertensive, as well as suggestive evidence for an increasing uptake of medication, but it does not seem to be due to increases in hypertension-related knowledge or change in health-related behavior.

***Subjective survival expectations and mortality:*** Detailed subjective expectations data has been a hallmark of the MLSFH since 2006,[24] including expectations about mortality (own and population), HIV infection and transmission, and the experience of socioeconomic shocks. This subjective expectations module has been continued in the MLSFH-MAC to provide an opportunity to study how perceived mortality and HIV risks affect decision-making and well-being as individual age and face higher objective mortality risks. The MLSFH-MAC expectations module asks respondents to allocate up to ten peanuts (previously beans) on a plate to express the likelihood that an event will occur. For example, respondents reported in 2017 on average a 67% chance of surviving for the next 5 years, and a 44% chance of surviving in the next 10 years. They expect a hypothetical healthy individual to have a 70% chance to survive in the next 5 years, compared to 62% for someone who is HIV+, 49% for someone who is sick with AIDS and 57% for someone who is treated with ART. The chance of surviving not conditional on health status is 69% which is just below the average reported survival for healthy individuals.

Compared to their objective risk of surviving, however, MLSFH-MAC respondents report median subjective probabilities of surviving for the next 5 years of about 43–66%, compared to 81–86% suggested by current life-tables (Figure 5). This implies that rural Malawians *underestimate* their chances to survive five years on average by 33% (Figure 5), which is consistent with a considerable *overestimation* of

**Figure 5: Subjective probabilities of surviving 5 years**
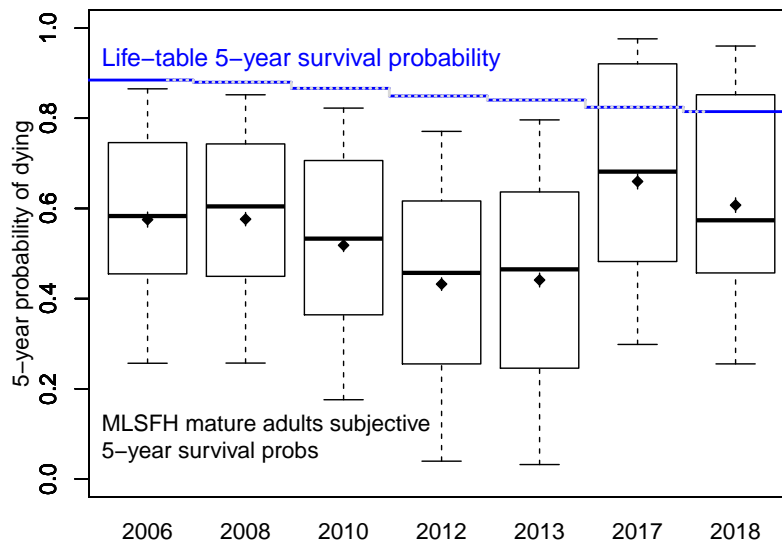


*Notes:* For MLSFH mature adults (aged 45+) who participated in the 2012–13 and 2017–18 MLSFH mature adults data collection. The boxplot-like graph displays the mean (dot) and median (center line) of the corresponding 5-year survival expectations, as well as the 10th (lower whisker), 25th (bottom of box), 75th (top of box), and 90th (upper whisker) percentiles of the distribution. Life-table survival probabilities are merged by age and gender from the UN Malawi 2005–15 lifetables,[25] and combined into an average to match the age- and gender-distribution of the MLSFH-MAC cohort.

local HIV prevalence and morbidity. These misperceptions about survival risks potentially have important implications for well-being and life-cycle decisions such as savings and household investments. While the general pessimism regarding survival has been fairly persistent since 2006, the extent of pessimism has somewhat fluctuated over time, being most pronounced in 2012 and 2013 possibly as a result of a very poor economic context, and has recovered somewhat in the 2017 and 2018 MLSFH waves.

A 2017 MLSFH-MAC study that provided targeted information about mortality risks to respondents documented that perceived population-level mortality risks—but not perceptions of own morality risks—are modifiable by providing objective life-table information along with general information about recent mortality trends.[11] The updates of survival risks among those who received this information resulted in changes in several important life-course behaviors. For example, by 2018, MLSFH-MAC respondents who received the 2017 life-table information about mortality risks had a 19% reduction in the propensity to have multiple sexual partners without using a condom, and 8% increase in sexual abstinence; they also engaged in more forward-looking behaviors, for instance by increasing savings and investing more in agriculture.

## WHAT ARE THE MAIN STRENGTHS AND WEAKNESSES?

The MLSFH-MAC is a cohort study that in its core demonstrates how existing data collection efforts can be leveraged to enhance innovative research on aging and health at older ages. This study approach is particularly advantageous for low-income regions and contexts where aging research is nascent and resources for setting up large aging cohort studies are limited. The MLSFH-MAC fills an important research need in this context by providing two decades of information on health, NCDs, physical and mental health, cognition, social networks, sexual behavior, social and economic conditions, household structure, risk perceptions, and other aspects, and by facilitating comparative research with global aging studies through harmonized and comparable measures of key aspects of aging.

The study is conducted in one of the world's poorest countries where a per-capita GDP is equal to about 4% of the global average. While research on aging was not a high priority in Malawi and similar contexts until recently, researchers and policy makers now recognize that importance to address the emerging challenges and opportunities associated with individual and population aging in low-income contexts. This changing assessment is due to several factors: (*i*) although recent cohorts of those age 45 and older benefit from gains in survival, their health and as a result biological aging trajectories are marked by the early life experiences and exposure to infectious diseases and adverse conditions throughout childhood, adolescence and young adulthood; (*ii*) most of the LICs in SSA are experiencing an increase of NCDs while continuing to have high prevalence of infectious diseases, including HIV/AIDS; (*iii*) mature and older individuals live in conditions characterized by high poverty levels and inequality, familial and social structures that foster but also constrain their roles and opportunities; (*iv*) health care services are inadequately equipped to address the newly proliferating NCDs; and (*v*) mature and older adults in LICs are active contributors to the social safety networks, but these contributions are confined within limits because of poor health status and health outcomes.

An important strength of the MLSFH-MAC is that the collected individual-level and contextual cohort information facilitate research on aging from a life-course perspective that reflects the dynamic and distinct settings in which people reach mature and older ages in SSA LICs. The study includes detailed longitudinal measurements of cognition and mental health (including depression and anxiety), thereby measuring two important dimensions of health that remain understudied in LICs due to the lack of appropriate data. In addition, the MLSFH-MAC provides longitudinal information across a period in which cohort members faced the peak and decline of the HIV/AIDS epidemic, which heightened the adversities faced by a population already exposed to poverty and a high burden of other diseases. Other strengths of the MLSFH-MAC include the relatively large sample size, a high data quality resulting from the ability to build on the MLSFH experience and methodologies, the ability to link MLSFH-MAC cohort data between spouses and to MLSFH data back to 1998 (including also data on children and village contexts).

Furthermore, the MLSFH-MAC data can be linked via geocoded information to nationally representative sources of information on health care facilities, and additional detailed 2019 MLSFH data on health care providers and health care facilities serving the MLSFH-MAC population.

Some weaknesses of the MLSFH-MAC are noteworthy. The cohort is not a nationally representative sample, but instead represents mature adults in rural Malawi (specifically, rural areas in the three study districts Mchinji, Rumphi and Balaka). A limitation of the MLSFH-MAC is also the relative lack of biomarker-based health data, which currently includes only HIV-testing and diabetes testing complemented by several measured health indicators (blood pressure, anthropometrics and BMI, grip strength). Another concern is related to attrition that is primarily due to mortality (see Table 2), while attrition from other reasons is relatively small given the extensive MLSFH-MAC efforts to locate respondents (including through migration follow-ups) and the strong ties to the MLSFH study communities that ensures high rates of study participation.

Despite the limitation that the urban population is not included in this study, MLSFH-MAC reflects the diversity and heterogeneity of the rural Malawian population as it is conducted in three regions with distinctly different ethnic/religious composition and socioeconomic contexts. The MLSFH-MAC attempts to compensate for attrition by enrolling new cohort members from the MLSFH upon reaching age 45.

### CAN I GET HOLD OF THE DATA? WHERE CAN I FIND OUT MORE?

Public-use version of the 2012 (baseline) MLSFH-MAC data without identifying individual or village information can be requested on the project website at http://www.malawi.pop.upenn.edu, and inclusion in the ICPSR is pending. MLSFH-MAC data covering subsequent data collections will be made publicly available in the future. In the meantime, interested researchers can approach the MLSFH-MAC principal investigators (mailto:iliana@upenn.edu and/or mailto:hpkohler@pop.upenn.edu) for sharing MLSFH-MAC data as part of collaborative research projects (if not overlapping with ongoing research projects, and subject to a Data Use Agreement).

## THE MLSFH-MAC COHORT PROFILE IN A NUTSHELL

- MLSFH-MAC is a population-based collaborative cohort study of mature adults age 45 years and older in three rural communities in Malawi, a low-income SSA country with moderately high HIV prevalence. It was established in 2012, with follow-up in 2013, 2017, 2018, and forthcoming data collection in 2020.

- The dataset comprises a wide range of socioeconomic, self-reported and measured health information/biomarkers, linkages to prior data since 1998, contextual information on health care facilities and health care providers serving the sampling areas, village-level contextual data, supplementary qualitative data.

- At last follow-up in 2018, the MLSFH-MAC included 1,626 respondents. Average age of the cohort was 60.1 years in 2018, about 60% are women. HIV prevalence is 8%. Longitudinal information covering 20 years of cohort members' life course is available for 59% of the 2018 MLSFH-MAC respondents, and since 2008 extensive information is available for 99% of the cohort members interviewed in 2018.

- MLSFH-MAC fills an important niche in global aging studies as it provides a rare opportunity for life-course studies of health trajectories at older ages and socioeconomic aspects of aging in low-income SSA contexts in which such data are very rarely collected.

- De-identified MLSFH-MAC data will be made publicly available, and in part are already available on the MLSFH website (http://www.malawi.pop.upenn.edu), and are also shared as part of collaborative projects with the MLSFH-MAC principal investigators.

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## SUPPLEMENTAL MATERIALS

These Supplemental Materials provide additional information about the MLSFH-MAC study areas and study contexts, the sample selection for the MLSFH-MAC, procedures for HIV testing and counseling, collection of biomarkers such as blood pressure and fasting glucose, data collection protocols and other details relevant to better understand the study procedures and framework. The Supplemental Materials also provide comparisons of the MLSFH-MAC study population with nationally representative datasets, additional analyses of attrition in the sample, and discussions of some specific features of the MLSFH-MAC data that are relevant to researchers using the MLSFH-MAC public use and/or restricted use datasets.

### Content:

## MLSFH-MAC: ADDITIONAL STUDY DETAILS

### A1. MLSFH-MAC: Context, Baseline Enrollment, and Study Procedures

#### A1.1. Study Context

Malawi's Human Development Index for 2018 is 0.485, placing Malawi at rank 172 out of 189 countries and territories.[51] About 20% of its population is considered "ultra-poor" (24% in rural areas) in 2016/17, representing a decline from 24.5% (28.1% rural) since 2010/11 and from 28.7 in 1997/98.[52] About 51% is considered poor (59.5% in rural areas), thus having a total consumption that does *not* provide 2,400 calories per day per person plus some basic nonfood items.[52] Life expectancy at birth was 59.6 for men and 66.9 for women in 2017, and healthy life expectancy at birth is estimated to be 52.4 years for males and 57.8 years for females.[53]

Based on the 2018 Census, Malawi's total population is estimated at 17,563,749, up from 13,029,498 in 2008 (+35%, corresponding to an annual growth rate of 3%),[54] with population growth driven by relatively high fertility (6.0 in 2004 and 4.4 in 2015/16),[55] combined with recent recovery and gains in life expectancy (during 2000–17 life expectancy increased for women from 45.6 to 66.9 years, and for men from 43.5 to 59.6 years.[53] 84% of the population resides in rural areas, a fraction that has essentially remained unchanged during 2008–18.[54,56]

Currently, mature adults (=individuals aged 45+) represent 12.6% of the rural Malawi population (12% for men, and 13.3% for women), and mature adults represent 23% of the rural adult population aged 15+ (22.3% for men, and 23.8% for women).[54] While the population of mature adults is expected to grow rapidly during the next decades, at an annual rate of 4.1% during 2020–50 that exceeds that of the overall population (2.3%), there is only modest population aging: even by 2050, mature adults are expected to represent only 20.2% of the total population, as compared to 11.8% in 2020.[1]

While per capita income is below the SSA average, Malawi is similar to other SSA countries and countries in the World Bank low-income country (LIC) group in terms of life expectancy, infant mortality, children's malnutrition, access to clean water, literacy and schooling enrollment.[57,58] In rural areas, where the MLSFH-MAC study population is based, the majority of individuals engage in home production of crops, primarily maize, which is the dietary staple and is highly influenced by the vagaries of the weather and the availability of fertilizer: during the period of the MLSFH-MAC, there were several years with "hunger months", when maize production was insufficient. Subsistence agriculture is complemented by some smallholder cash crops (primarily tobacco and cotton), casual agricultural labor and small-scale market activities, such as selling second-hand clothing and vegetables.

Given the subsistence agricultural context of the MLSFH-MAC study areas, work efforts are highly seasonal (Figure A1).[59] The peak labor demand season occurs during the rainy season, which coincides with the hunger season, a time when the nutritional consumption of the poorest households may be reduced to one meal

**Figure A1: Seasonality of harvest and labor demand in Malawi**
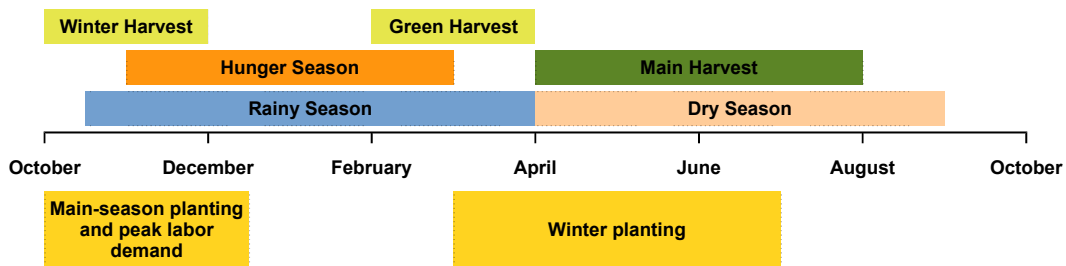


*Source:* Adapted from USAID & FEWS NET (2012).[59]

of watery porridge a day. An ethnographer working in village in southern Malawi wrote that towards the end of the hunger season, "*farmers' eyes grow increasingly hollow, their faces shrunken, and their bodies frail. [...] Activities are reduced to a minimum; villagers lie listlessly in the shade of their huts, waiting for the hours to pass and the maize to mature.*"[60] Because the hunger season is also the rainy season, it is the height of the malaria season, when people are more likely to be ill.

Malawi has the globally 9th highest prevalence of HIV in the adult population with an estimated 2018 HIV prevalence among 14–49 year olds of 10.4% (women: 12.2%; men: 8.3%).[55] HIV prevalence is lower in rural areas 7.4%, where the MLSFH-MAC study population is based, as compared to urban areas (14.6%) (for women, rural urban difference is 17.8% vs. 9.2%, and for men it is 5.4% vs. 11.0%). HIV incidence is estimated to have peaked in the mid-1990s, and the HIV incidence-to-prevalence ratio has declined from 9.64 in 2000 to 3.65 in 2018.[61] HIV incidence among adults aged 15–49 is estimated at 4.4 per 1,000 in 2018.[61] Despite the successes in reducing HIV incidence, the HIV epidemic had, and continues to have, major effects on virtually all aspects of life, many of which were documented by the MLSFH.[7] Importantly, with aid from international donors, access to antiretroviral treatment (ART) in Malawi expanded during the past decade, attaining a 79% ART coverage among adults in 2018, resulting in significant reductions in adult mortality.[62,63]

HIV prevalence among mature adults aged 45+ was still relatively low when the MLSFH-MAC was initiated in 2012 (Table 5). However, the HIV prevalence among mature adults is expected in increase significantly as younger cohorts with higher prevalence age and benefit from higher life expectancy as a result of antiretroviral treatment.[64] This change is already evident among the youngest cohorts included in the MLSFH-MAC (Table 5), and is likely to continue in the future and expand to older ages.

In addition to HIV, tuberculosis, malaria, and endemic parasites (e.g., soil-transmitted helminths (STH) and schistosomia mansoni) also have a relatively high prevalence,[65,66] as do some chronic diseases such as hypertension (Figure 4A).[67]

The consequences of exposure to communicable and non-communicable dis-

**Figure A2: SF12 physical health score among 2010 MLSFH respondents by age**
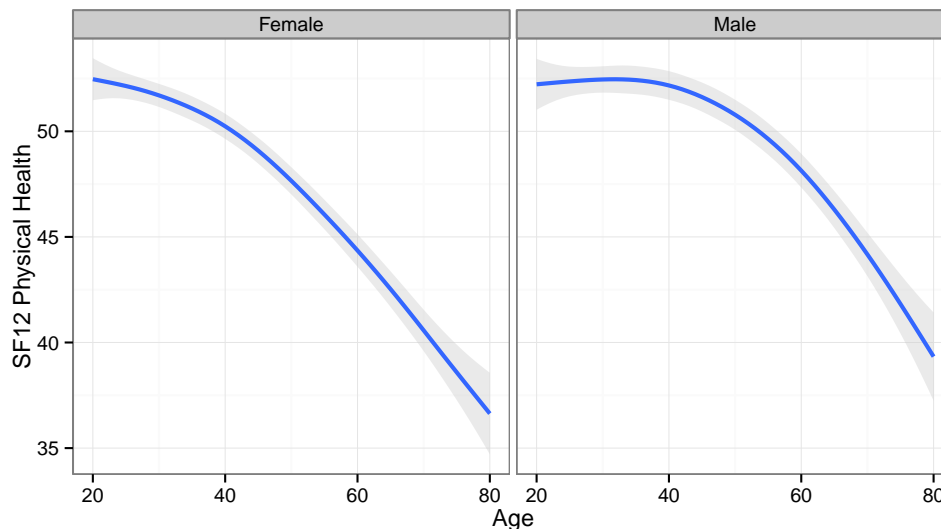


*Notes:* To cover the complete adult age range, analysis are based on the 2010 MLSFH that includes mature adult respondents as well as respondents below age 45. At age 20–40, the SF12 physical health score in the MLSFH has a mean of 51.6 (females) and 52.4 (males), with a standard deviation of 7.2 and 6.1 respectively. The average SF12 physical health score for a 60 year old women is therefore more than 1 SD below the mean of 20–40 year old women, with health rapidly declining further with age; the average SF12 physical health score of a 60 year old male is .6 SDs below below the mean of 20–40 year old men, again, with further substantial declines at older ages.

eases in rural Malawi are often exacerbated by high levels of poverty, episodic malnutrition, poor sanitation, and limited access to health care facilities. The cumulative load of these pressures may have substantial consequences for health, well-being and functional limitations that persist throughout the remaining life-course[68]. As a result, physical health tends to decline fairly rapidly as individuals age (Figure A2), and so does mental health.[7,12]

### A1.2. Study Areas and Context

The MLSFH-MAC is based in three districts in rural Malawi that have been study sites of the Malawi Longitudinal Study of Families and Health (MLSFH) since 1998 (Figure A3): 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 being ever married by age 25–29, and more than 95% of men being ever married by age 30–34.[69] 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 include: Rumphi District, located in the northern region of the country, is primarily inhabited by

**Figure A3: MLSFH study locations in Malawi**



Tumbukas, is predominantly Christian (Protestant), and follows the patrilineal system of kinship and lineage where residence is generally patrilocal, inheritance is traced through sons, and the parents of the groom pay bridewealth. Mchinji District, located in the central region, follows a less rigid matrilineal system whereby residence may be matrilocal or patrilocal. The district 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 in the study areas. The region follows a matrilineal system of kinship and lineage system where residence is generally matrilocal, although it is not uncommon for wives to live at least some period of time in their husband's village. The Balaka district also exhibits a lower age of sexual debut and larger numbers of lifetime sexual partners than the other MLSFH study areas, and residents tend to have lower levels of formal schooling and are 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 districts.

### A1.3. 2012 Baseline Sample

MLSFH-MAC was drawn from respondents age 45 and older who were enrolled in the Malawi Longitudinal Study of Families and Health (MLSFH). Inclusion criteria were: (*i*) being a MLSFH respondent aged 45 years or older in 2012; and (*ii*) having been interviewed in both the 2008 and 2010 MLSFH data collection rounds. The second criteria ensured that at least three waves of mental health and subjective well-being data were available for each baseline participant in 2012. Baseline enrollment in the MLSFH-MAC included 1,266 individuals clustered in 130+ villages, representing more than 90% of the 1,402 eligible MLSFH respondents who met the enrollment criteria (= target sample) (Figure 1). Age-eligibility for enrollment was determined based on the age recorded in the 2008 or 2010 MLSFH surveys, and as age among older persons is not always accurately known or remembered in

**Table A1: Summary statistics for the MLSFH-MAC baseline sample in 2012**

|  | Women | Men | Total |
| --- | --- | --- | --- |
| # of enrolled MLSFH-MAC respondents | 724 | 542 | 1,266 |
| Age | 58.6 | 60.3 | 59.3 |
|  | (11.3) | (11.0) | (11.2) |
| Age group |  |  |  |
| *< 45* | 0.03 | 0.02 | 0.02 |
| *45-54* | 0.42 | 0.33 | 0.38 |
| *55-64* | 0.28 | 0.33 | 0.30 |
| *65-74* | 0.16 | 0.19 | 0.17 |
| *75+* | 0.11 | 0.12 | 0.11 |
| Schooling attainment |  |  |  |
| *No formal schooling* | 0.48 | 0.20 | 0.36 |
| *Primary schooling* | 0.50 | 0.68 | 0.58 |
| *Secondary or higher* | 0.02 | 0.12 | 0.06 |
| Muslim | 0.29 | 0.26 | 0.27 |
| Currently married | 0.63 | 0.95 | 0.77 |
| HIV+ | 0.045 | 0.053 | 0.048 |
| Female |  |  | 0.57 |

Means with std. deviations in parentheses (where applicable). HIV status is indicated as HIV+ if any HIV test in 2006, 2008, 2012 indicated infection with HIV.

this study population, some respondents (N = 31 or 2.45%) reported an age below age 45 upon enrollment in 2012 (Table A1). Refusal to participate in the MLSFH-MAC, conditional on successfully contacting a respondent, is relatively rare (less than 1% at baseline). Migration out of the study areas and mortality were the primary reasons for not enrolling eligible respondents. At each follow-up, the study population was augmented with additional MLSFH respondents who reached eligibility. To ensure an adequate representation of HIV+ individuals in the cohort, age-eligible HIV+ respondents were enrolled if they participated in either the 2008 *or* 2010 MLSFH data collection. Summary statistics for the 2018 MLSFH-MAC cohort are reported in Table 1, and summary statistics for the 2012 baseline sample of the MLSFH are reported in Table A1.

### *A1.4. Respondent characteristics 2012–18*

At enrollment in 2012, the mean age of MLSFH-MAC respondents was 59.3 years, with men being on average about 1.7 years older than women (Table A1). The MLSFH-MAC population is characterized by low levels of formal education, with the majority of our respondents having no formal schooling (36%) or completing only primary education (58%). Women have lower levels of schooling compared to men, and only 2% of women age 45+ years has completed secondary or higher education as opposed to 12% among men. Marriage is essentially universal in Malawi, marital transitions are frequent, and substantially higher fraction of men was mar-

ried at the time of the survey in 2012 (95%) compared to 63% of women. About 1/3 of the cohort is Muslim, which reflects regional differences with the southern district of Balaka having a higher fraction of Muslims than other regions of Malawi. In 2012, 4.8% of the MLSFH-MAC cohort was HIV-positive, with HIV+ individuals concentrated at the younger end of the mature adults age range. Because of age-misreporting (or lack of knowledge of accurate age), the MLSFH-MAC continues to include in 2018 a small number of respondents that are younger than 45 years (N = 30, or 1.85%)

Due to the ongoing enrollment in the MLSFH-MAC of new respondents reaching age 45 in the MLSFH, the mean age of the MLSFH-MAC cohort increased only minimally to 60.3 years by 2018 (Table 1). Through the addition of more recent cohorts by 2018, the schooling level of the MLSFH-MAC cohort somewhat increased during 2012–18, and there has been a significant rise in HIV prevalence from 4.8% in 2012 to 8.0% in 2018, driven by a high HIV prevalence among 2018 respondents aged 45–49 who were added to the MLSFH-MAC during 2017–18.

The most extensive measures of health for the cohort were collected in 2012 and 2017, and Table A2 reports selected indicators of MLSFH-MAC respondents' physical and mental health in 2012 and 2017. Average SF12 mental health scores vary between 48.5 and 51.9, and average SF12 mental health scores range from 44.8 to 49.8. Most respondents range their subjective health as good to very good, with some noticeable declines in the subjective health rating between 2012 and 2017. Mild depression, as classified based on established PHQ-9 cutpoints, affects between 13 to 32% of respondents, and a large fraction of respondents reports having been ill in the last 12 months. For more than 10% of respondents, the illness lasted for 1 month or longer. The majority of respondents has a BMI in the normal range (18.5≤BMI<25), and 16–18% are underweight based on their BMI. Only a small fraction of the MLSFH-MAC cohort is overweight and very few (7% or less) are obese. Grip strength is less than 20kg for women and around 25–27 for men, both relatively weak for a population that is extensively engaged in manual labor. Blood pressure is relatively high in light of the low prevalence of conventional risk factors for hypertension, with a mean systolic blood pressure in the MLSFH-MAC cohort above 130 mmHg and a mean diastolic blood pressure above 82. Average blood glucose (fasting) is relatively low at 4.49 mmol/L (only available for 2017)

### A1.5. MLSFH Sample Selection and Sample Additions, 1998–2010

To better understand the composition of the MLSFH-MAC at its creation in 2012 (baseline survey), we provide a more detailed description of the MLSFH study sample, including the initial MLSFH sample selection and additions to the MLSFH sample over time. MLSFH was established in 1998 and the original target sample was 1,500 ever-married women age 15–49 (500 in each of the 3 districts), plus their husbands (for additional information, see the MLSFH Project Website (http://malawi.pop.upenn.edu) and the MLSFH Cohort Profile[7]). In total, across all three regions, the MLSFH Round 1 in 1998 enrolled a sample of 1,541 ever-married women aged 15–49 and close to 1,100 of their spouses residing in about 120 study

**Table A2: Selected physical and mental health indicators for the MLSFH-MAC respondents in 2012 and 2017**

| | 2012 | | | 2017 | | |
|---|---|---|---|---|---|---|
| | **Women** | **Men** | **Total** | **Women** | **Men** | **Total** |
| # of observations | 724 | 542 | 1,266 | 970 | 636 | 1,606 |
| SF12 Mental Health Score | 51.9 | 54.4 | 53.0 | 48.5 | 51.0 | 49.5 |
| | (10.3) | (9.08) | (9.88) | (10.7) | (9.71) | (10.4) |
| SF12 Physical Health Score | 46.1 | 49.8 | 47.7 | 44.8 | 47.4 | 45.8 |
| | (10.1) | (9.32) | (9.93) | (10.1) | (9.69) | (10.0) |
| Subjective health | | | | | | |
| *very poor* | 0.05 | 0.04 | 0.05 | 0.08 | 0.06 | 0.07 |
| *poor* | 0.13 | 0.09 | 0.11 | 0.25 | 0.18 | 0.22 |
| *good* | 0.43 | 0.33 | 0.39 | 0.44 | 0.44 | 0.44 |
| *very good* | 0.29 | 0.40 | 0.34 | 0.17 | 0.26 | 0.21 |
| *excellent* | 0.09 | 0.15 | 0.11 | 0.06 | 0.07 | 0.06 |
| Subjective well-being (satisfaction with life) | | | | | | |
| *Very unsatisfied* | 0.02 | 0.03 | 0.02 | 0.01 | 0.02 | 0.02 |
| *Somewhat unsatisfied* | 0.13 | 0.11 | 0.12 | 0.13 | 0.12 | 0.13 |
| *Satisfied* | 0.39 | 0.28 | 0.34 | 0.34 | 0.25 | 0.30 |
| *Somewhat satisfied* | 0.31 | 0.33 | 0.32 | 0.31 | 0.32 | 0.32 |
| *Very satisfied* | 0.15 | 0.25 | 0.19 | 0.20 | 0.29 | 0.24 |
| Depression (based on PHQ-9 cutpoints) | | | | | | |
| *None to minimal depression* | 0.71 | 0.81 | 0.75 | 0.56 | 0.67 | 0.61 |
| *Mild depression* | 0.20 | 0.13 | 0.17 | 0.32 | 0.25 | 0.29 |
| *Moderate depression* | 0.07 | 0.04 | 0.06 | 0.08 | 0.06 | 0.08 |
| *Moderately severe depression* | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 |
| *Severe depression* | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Ill in past 12 months | | | | | | |
| *None* | 0.20 | 0.29 | 0.24 | 0.31 | 0.42 | 0.35 |
| *< 1 month* | 0.62 | 0.57 | 0.60 | 0.52 | 0.46 | 0.50 |
| *1-3 months* | 0.13 | 0.11 | 0.12 | 0.12 | 0.07 | 0.10 |
| *>3 months* | 0.05 | 0.03 | 0.04 | 0.05 | 0.05 | 0.05 |
| Body Mass Index, categorical | | | | | | |
| *Underweight (BMI<18.5)* | 0.18 | 0.17 | 0.18 | 0.16 | 0.18 | 0.17 |
| *Normal ($18.5 \leq BMI < 25$)* | 0.62 | 0.74 | 0.67 | 0.62 | 0.73 | 0.66 |
| *Overweight ($25 \leq BMI < 30$)* | 0.14 | 0.08 | 0.11 | 0.15 | 0.08 | 0.12 |
| *Obese ($BMI \geq 30$)* | 0.06 | 0.01 | 0.04 | 0.07 | 0.01 | 0.05 |
| Grip strength (kg, average | 19.7 | 25.5 | 22.2 | 19.9 | 27.2 | 22.8 |
| both hands) | (5.04) | (6.42) | (6.36) | (5.27) | (6.34) | (6.73) |
| Systolic blood pressure (mmHg, | 134.9 | 135.3 | 135.1 | 132.3 | 133.4 | 132.7 |
| mean of 3 measurements) | (26.3) | (24.4) | (25.5) | (25.3) | (22.7) | (24.3) |
| Diastolic blood pressure (mmHg, | 86.3 | 85.8 | 86.1 | 83.9 | 82.9 | 83.5 |
| mean of 3 measurements) | (13.0) | (12.4) | (12.7) | (13.0) | (11.7) | (12.5) |
| Blood glucose (mmol/L) | – | – | – | 4.55 | 4.39 | 4.49 |
| (fasting) | | | | (0.74) | (1.04) | (0.87) |

*Notes:* Blood pressure was measured in 2013 and 2017; blood glucose was only measured in 2017.

villages.

Additions to the MLSFH after 1998 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 collections, 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 to the sample the current spouse (all current spouses) 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 in 2006, 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 ($N = 998$). Because of their young age, members of the adolescent sample are not included in the MLSFH-MAC study population. ***2008 MLSFH Parent Sample:*** To increase the suitability of the MLSFH to study intergenerational aspects and relationships in Malawi, a sample of respondents' parents was added to the MLSFH in 2008. This new sample of parents of existing MLSFH respondents was drawn from family listings of 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, 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.

The MLSFH returned to the study areas in 2001, 2004, 2006, 2008 and 2010 to reinterview the study participants. For this purpose, the MLSFH maintained a respondent database that contained previously collected identifying information for each respondent (respondent's name and nickname, compound name, village name and GPS coordinates, respondent's photo, 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, 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 re-visited and 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 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, and analyses of attrition during the MLSFH-MAC 2012–18, are reported below (Sections A2– A3.

Migration follow-ups for the MLSFH were conducted in 2007 and 2012/13. The MLSFH 2007 migration follow-up aimed to collect data on respondents who were interviewed by the MLSFH prior to the 2006 waves, but could to be located at the 2006 round of the MLSFH, and the 2012/12 migration follow-up focused on respondents where were not surveyed as part of the 2010 MLSFH survey.[70] These migration follow-ups interviewed 398 of 715 migrants in 2007 (55.7%), and 722 of 1013 in 2013 (71.3%). Work and family transitions are the primary reasons for migration. For example, in 2007, approximately 31% of migrants moved for marriage-related reasons (divorce, widowhood, or new marriage), compared with 39% who moved for work.

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 (MDHS).[71] After three rounds of longitudinal data collection during 1998–2004, despite attrition and the enrollment of new subjects, the 2004 MLSFH sample remained in close agreement in observable characteristics with the nationally-representative 2004 MDHS (rural sub-population).[72] 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, despite the fact that the initial MLSFH sample was not selected to be nationally representative and the MLSFH has been subject to attrition over time (see below).[7] 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. The MLSFH is different from nationally-representative rural samples in terms of its age distribution, 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. Where appropriate, analyses can adjust for this over-representation of married individuals in the MLSFH.

### A1.6. Migration follow-ups in 2017 and 2018

In the MLSFH-MAC, migration of study participants is somewhat less important than in the overall MLSFH study population as the MLSFH-MAC cohort aged 45 years and older is less mobile compared to younger adults. Nevertheless, to achieve the high rates of retention documented in Figure 1, the MLSFH-MAC conducted migration follow-ups in both 2017 and 2018. Specifically, the following types of migrants can be distinguished: (*iii*) those who migrated in nearby villages, which are not sample villages, but are geographically very close; (*iv*) migration within the same district (partially concentrated in the trading centers within the same district); (*v*) migration outside of the district, which is primarily directed to towns, big cities (such as Lilongwe, Mzuzu, Blantyre, Zomba). In addition, there is also some residential mobility within the sample area, that is respondents who moved from one to another sample village. In 2017 and 2018, MLSFH-MAC did interview respondents who migrated within the sample villages, but did not consider them as "migrants". Migrants were followed-up after completion of the main fieldwork in all districts by specially assembled fieldwork teams consisting of interviewers and HIV-testing counselors.

### A1.7. HIV testing and counseling (HTC):

HIV testing and counseling (HTC) was conducted as part of the MLSFH-MAC in 2012 and 2017 using HTC counselors certified by the Malawi Ministry of Health. HIV testing was conducted using finger-prick rapid tests and the HTC procedures followed guidelines given by the Malawi Ministry of Health and the WHO,[73,74] and written consent was obtained from all HTC participants prior to HTC. To ensure the confidentiality of HTC and the HIV test results, the MLSFH-MAC implemented several privacy and data protection measures, including the use of separate IDs and data file for survey data and HTC-related data, non-local HTC counselors who had never lived nor had close relatives or friends in the MLSFH-MAC study villages, a secure storage of consent forms, the separation of identifying information from all study materials containing HIV test results and related information, and adequate protections to ensure the privacy of the in-home HTC sessions. All HIV tests were preceded and followed by a counseling session. The pre-test counseling emphasized privacy and informed consent. The study participant chose the venue for the counseling that he/she considered most private; in order to provide a foundation for informed consent, counselors explained the procedures to be followed during testing, as well as the implications of learning one's own HIV status. Post-test counseling emphasized the results of the test, the window period and importance of retesting, and appropriate behavior for the future. HIV-positive respondents received referrals to district hospitals for confirmatory testing and determining of eligibility for ART.

A total of 1,200 respondents were tested for HIV in 2012 (95% of enrolled respondents), and 1551 in 2017 (97% of 2017 respondents). Overall HIV prevalence was 4.7% in 2012 and 8.0% in 2018, with marked variation by age: prevalence was highest among the "young" mature adults aged 45–64, while relatively few HIV

**Table A3: HIV prevalence by age in 2012 and 2017, with number of persons tested in parenthesis**

| | HIV Prevalence (Number of respondents tested) | | | | | |
| | 2012 | | | 2017 | | |
| Age | Women | Men | Total | Women | Men | Total |
|---|---|---|---|---|---|---|
| <45 | 0.0% | 0.0% | 0.0% | 15.6% | 0.0% | 11.1% |
| | (17) | (10) | (27) | (32) | (13) | (45) |
| 45-54 | 5.1% | 8.9% | 6.5% | 13.8% | 9.0% | 12.0% |
| | (295) | (169) | (464) | (370) | (223) | (593) |
| 55-64 | 5.6% | 6.7% | 6.1% | 6.1% | 9.8% | 7.6% |
| | (198) | (163) | (361) | (261) | (173) | (434) |
| 65-74 | 1.8% | 0.0% | 0.9% | 2.6% | 8.0% | 4.9% |
| | (112) | (103) | (215) | (155) | (113) | (268) |
| 75+ | 0.0% | 3.3% | 1.5% | 1.7% | 0.0% | 0.9% |
| | (72) | (61) | (133) | (121) | (90) | (211) |
| Total | 4.0% | 5.5% | 4.7% | 8.3% | 7.5% | 8.0% |
| | (694) | (506) | (1,200) | (939) | (612) | (1,551) |

*Notes:* Includes only respondents who were tested in 2012 or 2017, and not respondents for whom HIV status is known based on prior tests.

positive respondents aged 65+ were identified. In 2012, 60% of HIV positive respondents reported to be on antiretroviral treatment. By 2018, 83% of HIV positive respondents reported to be on treatment, and among those receiving ART, 70% have been on treatment for more than 3 years (57% for more than five years).

**A1.8. Fieldwork procedures**

**A1.8.a. MLSFH-MAC electronic data collections:** The 2012 and 2013 data collections were implemented on paper following the fieldwork logistics developed by the MLSFH, and this approach was to a large extent determined by the fact that the local internet infrastructure was not developed enough to enable the use of tablets in the field and to transfer the collected data to a secure data server. In 2017, the MLSH-MAC study team made partial transition to collecting data for the main questionnaire on tablets, while still using paper questionnaire for the HIV testing and accompanying health questionnaire. Since 2018, all MLSFH-MAC data collections were implemented on tablets using RedCap software in the field (https://www.project-redcap.org/). Collected data were uploaded at the end of each fieldwork day to a secure server at the University of Pennsylvania, and data quality checks using scripts programmed in Stata were performed during fieldwork. This procedure allowed the team to monitory and address data quality issues during fieldwork, ensuring an overall high data quality in the MLSFH-MAC.

**A1.8.b. Longitudinal identification and linkage of MLSFH-MAC respondents:** One of the most methodologically and technically challenging aspects in a longitudinal cohort study is to assure that at each follow-up the same respondents are cor-

rectly identified and re-interviewed. Ensuring a correct longitudinal identification of MLSFH-MAC respondents is particularly challenging in rural Malawi due to the absence of well-defined addresses, frequent mobility of individuals, and relatively common marriage/divorce/widowhood rates that often results in migration. The MLSFH-MAC also encountered community members who claimed to be MLSFH-MAC study participants ("imposters"), even though they were not (often a related family member was).

To maintain a high quality of the longitudinal linkages and overcome these challenges, the MLSFH-MAC employed several steps in its fieldwork and data collections, including: (1) relying on highly trained and experienced fieldwork personnel who have been working with MLSFH-MAC consistently for several years to identify and address problems in the field during data collections, (2) employing our knowledge of the local settings, including identifying villages where challenges are greatest, and becoming aware of and solving these challenges in advance, and (3) using our longitudinal data structure and information during fieldwork, in which respondent's background characteristics (such as names and nick names, age, spouse's name, level of education, birthplace, father's name, children's names and ages, etc.) from current MLSFH-MAC data collection is compared with the same information available from previous waves to ensure that the correct respondent has been interviewed.

MLSFH-MAC maintains a Respondent Database that contains previously collected identifying information for each respondent (respondent's name and fieldwork ID, previously taken pictures of respondents (if available), GPS coordinates of previous residence of respondents (since 2004), most recently respondent's or close relative's cell phone number if available, name of respondent's parents and current husband, names and age of respondent's children, selected respondent characteristics (age, sex, education), and name of village and compound head).

During MLSFH-MAC fieldwork and data collection, interviewer lists were created for the interviewers containing the above identifying and contact information of respondents to be interviewed on a particular day. A shorter version of this contact information is also give to specially trained scouts who locate the respondents in advance and schedule an appointment for an interview. The scouts are usually local people who live in the respective villages and are well familiar with the local settings. Once the interview is scheduled, the trained interviewers locate the respondents and verify the respondent's identity using the comprehensive identifying information provided from the respondent database (including the most recent printed photo of the respondent).

Fieldwork supervisors recorded the interview outcomes (interview completed, refused, temporarily absent, moved, hospitalized, dead, other) on MLSFH-MAC Survey Log Sheets that are provided from the respondent database for each respondent. At the end of each day, the respondent database was updated with a log of the interview outcomes, and if applicable, the respondent database was updated in case that there have been any changes in a respondent's identifying or contact infor-

mation (e.g., respondent has moved). The photo of each respondent that was taken as part of each data collection round was uploaded to the respondent database to replace any previously taken picture. The respondent's identifying information was removed from the remaining questionnaire that contains merely the respondent ID number (and no other identifying information). Using the above process, the MLSFH-MAC has been able to maintain a relatively high retention rate of respondents across waves (Figure 1), and incorrect identification of MLSFH-MAC study participants over time was extremely rare. The same procedures to identify respondents are followed by the team of HIV counselors who conduct HIV testing and counseling, in addition to collecting comprehensive health-related information, including biomarkers.

***A1.8.c. Protocol for collection of measured health indicators*** The MLSFH-MAC collected several measured health indicators, including blood pressure (2013, 2017), blood glucose (2017), height (2012, 2013, 2017), weight (2012, 2013, 2017, 2018), hip and waist circumference (2017), and gait speed (2017). The procedures for obtaining these health measures are outlined below.

Blood pressure was conducted using an automated blood pressure monitor with ComFit cuff, following the protocol established by the Health and Retirement Study (HRS) in the U.S. and using Omron HEM-780 Intellisense Automated blood pressure monitor (or comparable device). Three measurements were taken, 45 seconds apart, on the respondent's left arm. Data recorded for each measurement included systolic and diastolic blood pressure, pulse, and the time of day the reading was taken.

Blood glucose is measured using a standard blood-sugar test kit for home-based use (test kits included a testing strip and a hand-held blood sugar meter). The measurement required a finger prick with a lancing device to collect a drop of blood, which is placed on the testing strip and then analyzed using an automated blood-sugar meter. The measurement was scheduled with the respondent to obtain fasting blood sugar (FBS), that is, a measure blood glucose after a person has not eaten for at least 8 hours.

At the end of the 2017 HTC and blood pressure measurement, the HTC counselors asked respondents to schedule a follow-up appointment (between 7-9 am in the morning) early on the following day when HTC returned to conduct the fasting blood glucose measurement. Respondents were provided with instructions explaining that they were not supposed to eat or drink anything at least 8 hours before the blood glucose measurement. If a respondent did not follow the instructions for collecting fasting blood glucose measurement, the HTC counselors made a second attempt to obtain fasting blood glucose the following day. If this second attempt also failed because the respondent did not follow the instructions, the HTC counselors obtained *random blood glucose* that does not require prior fasting (this deviation was recorded accordingly in the data).

Unless respondents opted-out, all subjects for whom blood pressure and blood glucose measurements have been obtained were informed about their blood pres-

sure and blood glucose level. Following the procedures that have been implemented as part of the Health and Retirement Study (HRS) and other large-scale surveys, respondents were alerted to potentially high levels of blood pressure. Specifically, in 2012 and 2017, if one blood pressure reading obtained was higher than 160 systolic or higher than 110 diastolic (160/110), interviewers were instructed to record the measurements on a pre-designed card instructing the respondent to consult a medically trained health care provider as soon as possible.

Respondents also received a pre-designed card recommending that they consult a medically trained health care provider if their fasting blood glucose exceeds 100 mg/dL or the casual blood glucose exceeds 5.6 mmol/L (150 mg/dL).[75]

Grip strength was measured using mechanical hand dynamometers, twice with each hand (total of 4 measurements). Height, waist and hip circumference were measured using a simple measuring tape (with a horizontal clipboard when measuring height), following standard procedures for measuring height and waist and hip circumference in population surveys.[76] Weight was measured using a simple floor scale.

Walking speed (gait speed) was measured by asking respondents to twice walk a distance of 2.5 meters (total of 5 meters) across a relatively flat surface, and timing how long it takes respondents to do so. If respondents preferred, the interviewer walked alongside the respondent to provide support in case he/she has problems holding his/her balance, and if the respondent was usually using a cane or walking aid, respondents were welcome to use it for the walking test.

**A1.8.d. Human subject considerations for MLSFH-MAC mature adult studies** The MLSFH-MAC implemented extensive precautions to protect the study participants, many of whom were in poor health and/or socially or economically vulnerable, from risks associated with participating in this study. Informed consent was obtained in each MLSFH-MAC wave for each survey round, and also separately for HIV testing and counseling (including health survey) or any other separate study component (such as the BenKnow study described in Section A4.6). The consent form for the MLSFH-MAC survey participation emphasizes confidentiality, privacy, and autonomy. The consent form also clearly indicates the longitudinal nature of this study, and describes that respondents are selected for this study because they have previously been interviewed as part of the MLSFH.

Specific precautions were implemented as part of the HTC to minimize the respondent's risks during HIV testing and counseling, and to ensure the confidentiality of the HIV test results. HTC was conducted by trained HTC counselors in accordance with current Malawi Ministry of Health guidelines,[77] using Determine®, and Unigold®) test kits. The counseling in connection with the HIV tests included: (1) *Pre-test counseling:* Before the collection of samples, the counselors explained to the respondent the procedures to be followed during testing, as well as the implications of finding out about one's own HIV status. (2) *Post-test counseling:* Immediately after the tests have developed (10-30 minutes after sample collection), the respondents were offered the opportunity to find out about their test results. In

case of *HIV-negative results*, the counselor explained the meaning of the result, and discussed the possibility that testing has taken place during the window period following recent infections or during late-stage AIDS, provided information on the prevention of HIV, and refered to other services if appropriate (i.e. STI clinics, TB etc.). In case of *HIV-positive results*, the counselor acknowledged the difficulty of finding about one's status, discussed the benefits associated with knowing one's status, discussed possible disclosure of the results, reviewed the prevention strategies discussed during pre-test counseling, gave specific information about treatments and their availability, and referred the HIV-positive respondent to the nearest district hospital or HTC clinic for a confirmatory test and an assessment of the possibilities of treatment with antiretroviral treatment (ART). In case of *inconclusive results*, the counselor explained the meaning of the result, and discussed the possibility that testing has taken place during the window period following recent infections or during late-stage AIDS, recommend avoiding future risk behavior, referred the respondent to a nearby district hospital or HTC clinic for further testing after 6 weeks, refer for support based in the community or at a clinic during the waiting period.

Because many MLSFH-MAC respondents were not aware of their blood pressure and possibly elevated hypertension risks, study participants with blood pressure measurements were informed about their blood pressure, and respondents were alerted to potentially high levels of blood pressure using a written referral card (see Section A1.8.c). Analogous procedures were followed for blood glucose measurements (see Section A1.8.c).

In addition, given the focus of the MLSFH-MAC on mental and cognitive health, the study provided support for MLSFH-MAC respondents who might have become aware during the study participation about their poor mental health, having depressive symptoms and/or cognitive impairment. First, upon request or where deemed appropriate by the interviewer, respondents were provided with information about district and local hospitals offering support for mental health problems and depression (including also those related to HIV infection).

Second, interviewers were trained and instructed to monitor and evaluate a participant's well-being and emotional stability during the study participation. In rare cases when a respondent became distressed or depressed during the survey, interviewers were trained in using calming techniques such as speaking in a calm, quiet, and confident tone of voice, reassuring the participant that it is okay to admit concerns about mental health and/or cognitive impairment, acknowledging that this is a difficult topic/situation. Interviewers were also instructed to refer again to the various resources for support that are described in the additional information sheet. In the unlikely event that a participant expressed any suicidal or homicidal feelings or thoughts, interviewers are instructed to inform the fieldwork supervisor. If it was determined necessary, fieldwork supervisors visited the study village (generally with a certified nurse) to provide support for the respondent and/or mediate any conflict with spouses or family/community members.

Third, during each MLSFH-MAC data collection, the study team established a "hot line" that respondents could call to obtain additional information about resources and support for depression and cognitive impairment and/or high blood pressure.

Fourth, the study team worked closely with the headmen of the villages in which the MLSFH-MAC was conducted. In a briefing with each headman prior to the data collections, the study team discussed with him the details of the study design, the consent forms (a copy of which remained with the headman), and the potential risks associated with the study. Village headmen were also informed about the resources available to support individuals with mental health problems and/or cognitive impairment, and they were instructed how to mediate conflicts between spouses, family and/or community members that could potentially result from the fact that study participants have been identified with depression and/or cognitive impairment. If a village headman became aware of severe concerns about a study participant's well-being and health, he/she was instructed to contact the study team through the IKI hot-line for a follow-up through the research team.

Overall, to put the concerns about the individual and social consequences of identifying subjects with depression and/or cognitive impairment into context, it is useful to report that during our extensive data collection with the MLSFH mature adult study population during 2012–18, there has not been a single adverse event that required reporting to the IRB (locally in Malawi as well as at the University of Pennsylvania). The project has experienced very low refusal rates (see Section A3 below), and respondents overwhelmingly have been willing to participate in the follow-up surveys as part of this project (Figure 1 and Section A3 below). All of this indicates that the study procedures for the MLSFH-MAC surveys are adequate, and that the survey has established a strong and trusting relationships with respondents and their communities.

## A2. Comparisons of the MLSFH-MAC study population with national representative samples

Because the MLSFH-MAC cohort was recruited from respondents of the MLSFH, the MLSFH-MAC inherits the sampling properties of the MLSFH (Section A1.5). While the initial sampling strategy of the MLSFH was not designed to be representative of the national population of rural Malawi, comparisons of the 2010 MLSFH study population with the rural samples of the Malawi DHS and Integrated Household Survey (IHS3) surveys reveal that the MLSFH study population continues to closely match the characteristics of nationally-representative cross-sectional surveys.[7] The MLSFH is thus broadly representative of the overall rural population in Malawi, and is similar in many socioeconomic and health conditions to other low-income countries in SSA.[57]

Focusing on MLSFH respondents aged 45 and older, similarly, the MLSFH-MAC study population closely matches the rural subsample in the 2010 national-representative IHS3 survey in key observable characteristics (Table A4). Differ-

**Table A4: Comparison of the 2012 (baseline) MLSFH-MAC and 2010 IHS3 (rural) study populations**

| | 45–64 | | | | 65+ | | | |
| | MLSFH MAC 2012 | | IHS3 2010–11 | | MLSFH MAC 2012 | | IHS3 2010–11 | |
| | N | % | N | % | N | % | N | % |
|---|---|---|---|---|---|---|---|---|
| *Demographic and Socioeconomic Characteristics* | | | | | | | | |
| Male | 360 | 41.4% | 1,924 | 48.1% | 171 | 46.7% | 785 | 43.2% |
| Any schooling | 585 | 67.2% | 2,483 | 62.1% | 207 | 56.7% | 745 | 41.0% |
| Married | 725 | 83.6% | 3,071 | 76.8% | 217 | 59.5% | 914 | 50.3% |
| Religion | | | | | | | | |
| *Christian* | 584 | 67.1% | 3,319 | 83.0% | 243 | 66.7% | 1,418 | 78.0% |
| *Muslim* | 232 | 26.7% | 441 | 11.0% | 100 | 27.5% | 241 | 13.3% |
| *Other* | 54 | 6.2% | 241 | 6.0% | 21 | 5.8% | 158 | 8.7% |
| Metal/tile roof | 266 | 30.6% | 1,253 | 31.3% | 114 | 31.3% | 537 | 29.6% |
| *Health Indicators* | | | | | | | | |
| Functional limitations and disability state | | | | | | | | |
|    Moderate Limitation | 233 | 26.8% | – | – | 134 | 36.7% | – | – |
|    Severe Limitation | 42 | 4.8% | – | – | 102 | 28.0% | – | – |
| ADL disabled | – | – | 783 | 19.6% | – | – | 895 | 49.3% |
| Average Age (45+) | 59.8 | | 59.8 | | | | | |
| Total | 870 | | 4,001 | | 365 | | 1,817 | |

*Notes:*
(1) IHS3 data description:The Integrated Household Survey is one of the primary instruments implemented by the Government of Malawi through the National Statistical Office (NSO) roughly every 5 years to monitor and evaluate the changing conditions of Malawian households. The IHS data have, among other insights, provided benchmark poverty and vulnerability indicators to foster evidence-based policy formulation and monitor the progress of meeting the Millennium Development Goals (MDGs) as well as the goals listed as part of the Malawi Growth and Development Strategy (MGDS). The Third Integrated Household Survey (IHS3) was conducted by the National Statistical Office (NSO) in March 2010-March 2011[78]. A stratified two-stage sample design was used for the IHS3. The IHS3 sampling frame is based on the listing information and cartography from the 2008 Malawi Population and Housing Census (PHC); it includes the three major regions of Malawi, namely North, Center and South; and is stratified into rural and urban strata. The rural subsample of the IHS3, which is used for the above analyses, includes residents from each of the 27 districts of Malawi, except those living in the urban centers of Lilongwe City, Blantyre City, Mzuzu City, and the Municipality of Zomba, and except for residents of the island of Likoma on Lake Malawi. The sampling frame excludes the population living in institutions, such as hospitals, prisons and military barracks.
(2) Health indicators: There are no directly comparable disability/health indicators in the MLSFH-MAC and IHS3. Functional limitations and disability states for the MLSFH are defined as follows: respondents who answered "somewhat limited" on either of the two MLSFH-MAC SF-12 questions about physical limitations are classified as *moderately limited*, and respondents who answered "limited a lot" on either question are classified as *severely limited* (see text for a detailed description). *ADL disabled* in the IHS3 is defined as having difficulty in any one of the following five activities of daily living (ADLs): Seeing, hearing, walking, remembering/concentrating, self-care (bathing/dressing).
(3) Comparisons between the IHS3 and the MLSFH-MAC are based on IHS3 and the MLSFH-MAC unweighted samples. All differences between the MLSFH-MAC and IHS3, except for the proportion male for 45–64 and 65+ and proportion with a metal/tile roof above 65+, are significant ($p < .05$) according to chi-square tests.

**Table A5: First available MLSFH Round for MLSFH-MAC participants in 2018**

| First available MLSFH Round | 2018 MLSFH-MAC Respondents | | | 2018 Age | | |
|---|---|---|---|---|---|---|
| | *Females* | *Males* | *Total* | *25$^{th}$ %tile* | *Mean* | *75$^{th}$ %tile* |
| 1998 | 52.1% | 58.7% | 55.8% | 49.0 | 56.5 | 63.0 |
| 2001 | 11.3% | 11.2% | 11.2% | 50.0 | 57.2 | 62.0 |
| 2004 | 3.4% | 3.9% | 3.7% | 50.0 | 58.9 | 67.5 |
| 2006 | 3.1% | 4.1% | 3.6% | 47.0 | 55.4 | 60.0 |
| 2008 | 30.2% | 22.1% | 25.6% | 65.0 | 72.1 | 81.0 |
| 2010 | – | – | – | – | – | – |
| *N* | 968 | 658 | 1,626 | | | |

ences arise in the distribution of religion, where Muslims are overrepresented in the MLSFH-MAC due to the fact that about 1/3 of the MLSFH-MAC study population is from the primarily Muslim region of Balaka, and individuals aged 65 and over in the MLSFH-MAC were somewhat more likely to have ever attended school than those in the IHS3). The MLSFH-MAC also contains a larger fraction of male respondents, and of respondents who are currently married, both of which are likely due to the initial 1998 MLSFH sample that focused on ever-married women and their spouses. Although the measures of physical limitations are not directly comparable, this basic pattern of high levels of disability among mature adults that increase rapidly with age are also found in the IHS3.

In summary, therefore, neither the initial MLSFH sample selection that restricted the MLSFH-MAC to three rural regions, nor the MLSFH attrition and enrollment of new MLSFH respondents over time, nor the selection and enrollment of the MLSFH-MAC cohort based on the MLSFH, seem to have importantly affected the MLSFH-MAC in terms of their ability to represent the rural population of Malawi at mature adult ages. By design, the MLSFH-MAC is different from nationally-representative rural samples in terms of its age- and gender-distribution, and religious composition; where appropriate, the MLSFH-MAC can be weighted to match the age, gender and religious distribution of rural Malawi.

**A3. Analyses of attrition in the MLSFH-MAC**

To document the longitudinal origin of the MLSFH-MAC sample, Table A5 reports the *first* available survey round for participants in the 2018 MLSFH-MAC survey. It shows, that for more than 67% of the 2018 MLSFH-MAC participants, initial data are available from either 1998 or 2001. These mature adult respondents from 1998/2001 represent the relatively younger end of the MLSFH-MAC sample, with the 2018 interquartile age range for these respondents being 49–63 years (mean age: 56.5 years). The older part of the 2018 MLSFH-MAC sample, representing about 30% of of the 2018 study population with an interquartile age range from 65–81 years (mean: 72.1), was mostly added in 2008 as part of the MLSFH Parent Sample

(Section A1.5).

All longitudinal data collection projects face the inherent problem of sample attrition: the failure to find or reinterview individuals who were surveyed in an earlier wave of the study.[79–84] Attrition leads to decrease in sample sizes, which can reduce power in statistical analysis. More importantly, however, attrition may bias subsequent analyses if those who leave the sample are substantially and systematically different from those who do not—particularly on unobserved characteristics. Numerous events can lead to sample attrition, including short- or long-term mobility, mortality, failures to recontact respondents in the absence of reliable addresses, or refusal of respondents to participate in follow-up waves of the study. In rural sub-Saharan Africa, rates of attrition are often found to be relatively high due to high levels of mobility which is often work-related or related to marriage and/or divorce.[79,85,86]

Prior analyses of the MLSFH survey attrition reported in the MLSFH Cohort Profile[7] indicate that, even though respondent characteristics often differ significantly between those who were lost to follow-up and those who were re-interviewed and attrition was often predicted by key respondent characteristics, the coefficient estimates for standard family background variables in regressions and probit equations for the majority of the outcome variables were not affected significantly by attrition. The analyses in the MLSFH Cohort Profile thus conclude that the attrition levels observed in the MLSFH may not necessarily represent a general problem for obtaining consistent estimates of the coefficients of interest for most of these outcomes. These results, which are very similar to those documented in related MLSFH studies[72,87] and related other longitudinal studies,[79,80,88] lend support to the value of longitudinal cohort studies and suggest that multivariate estimates of behavioral relations in such longitudinal studies may not necessarily be biased due to attrition.

We augment the MLSFH attrition analyses reported elsewhere with some specific attrition analyses for the MLSFH-MAC, focusing on two aspects: (*i*) attrition and selectivity in the selection and enrollment of the MLSFH-MAC cohort during the baseline survey in 2012; and (*ii*) attrition during the MLSFH-MAC baseline and most recent survey wave, that is, attrition *during* the 2012–18 MLSFH-MAC.

### A3.1. Attrition and selectivity in the enrollment of the MLSFH-MAC cohort

One attrition-related concern in the MLSFH-MAC sample pertains to possible selectivity due to the eligibility criteria for inclusion in the 2012 (baseline) target sample. Besides the age restriction ($Age_{2012} \geq 45$), this eligibility criteria included the requirement that a respondent was interviewed in both 2008 and 2010 MLSFH waves. This restriction was imposed to ensure that at least three waves of data were available for each participant in the 2012 MLSFH-MAC, thereby facilitating a sufficiently large sample size for longitudinal analyses. However, to alleviate concerns that attrition from the MLSFH resulted in selection for the target and realized sample of the 2012 (baseline) MLSFH-MAC survey, we provide in this section additional analyses of attrition. We focus particularly on attrition since 2008, when

**Table A6: 2010 and 2012 MLSFH Survey outcome for all 2008 MLSFH respondents meeting mature-adult age-eligibility criteria (Age$_{2008} \geq 41$)**

| Mature adults surveyed in 2008 (Age$_{2008} \geq 41$): | | 2012 Outcome | | | |
| --- | --- | --- | --- | --- | --- |
| **2010 Outcome** | | Survey completed | Not surveyed/ not found | Dead | Not eligible/ not selected |
| Survey completed | 1,477 | 1,266 | 93 | 43 | 75 |
| Not surveyed/not found | 340 | 0 | 0 | 0 | 340 |
| Dead | 61 | 0 | 0 | 0 | 61 |
| Total | 1,878 | 1,266 | 93 | 43 | 476 |

the MLSFH Parent Sample, which provides the older subset of mature adults in MLSFH-MAC (Table A5), was added to the study population.

The 2010 and 2012 survey outcomes for all 2008 MLSFH respondents who were eligible for the 2012 baseline MLSFH-MAC survey are reported in Table A6. Among all age-eligible 2008 respondents, 340 were not included in the 2012 mature adult survey because they were not interviewed in 2010, and 61 respondents could not be included because they had died as of 2010. Among the 1,477 age-eligible 2008 respondents who were interviewed in 2010, and thus met all additional eligibility criteria for the 2012 MLSFH-MAC baseline survey, 1,266 were successfully surveyed in 2012, 43 had died by 2012, 54 moved or were absent during the 3 contact attempts, 39 were not found or not surveyed for other reasons.

Table A7 shows that 2008 age-eligible respondents who were surveyed in the 2012 MLSFH-MAC were somewhat younger than those who were not surveyed in 2012. They were more likely to be currently married, were less likely to be from the central and more likely to be from the northern region, were less likely to be HIV+, had slightly higher levels of subjective well-being, and were of slightly better physical health. Several of these univariate differences between attritors and non-attritors are related to the age and regional pattern of attrition, and in all cases in Table A7, the differences in 2008 respondent characteristics are no longer statistically different after controlling for region, age, age$^2$ and gender. In multivariate analyses (Table A8), age, region and being HIV+ are primary predictors of not being surveyed in 2012. Attrition is therefore mostly predicted by a set of fixed/predetermined respondent characteristics that are also strongly associated with mortality during 2008–12. Our analyses also suggest that attrition among MLSFH-MAC study participants is less selective than attrition in the overall MLSFH where selective migration a is more important factor for loss-to-follow-up among younger respondents.[7]

An important focus of MLSFH-MAC analyses has been on mental health.[12] In additional attrition analyses, we therefore assess if the analyses of the deter-

**Table A7: Comparison of 2008 respondent characteristics for 2008 age-eligible respondents depending on whether they were surveyed in the 2012 (baseline) MLSFH-MAC survey or not**

| 2008 Respondent Characteristics | Surveyed 2012 (baseline) MLSFH-MAC survey | | | |
| | Yes | No | Total | Signif. Diff. |
| --- | --- | --- | --- | --- |
| Female | 0.572 | 0.536 | 0.560 | − |
| Age | 55.23 | 58.57 | 56.30 | * |
| | (11.92) | (14.96) | (13.06) | |
| Age Group | | | | |
| *< 45* | 0.194 | 0.170 | 0.186 | − |
| *45-54* | 0.343 | 0.243 | 0.311 | * |
| *55-64* | 0.246 | 0.248 | 0.247 | − |
| *65-74* | 0.138 | 0.185 | 0.153 | * |
| *75+* | 0.0795 | 0.154 | 0.103 | * |
| Schooling | | | | |
| *No formal schooling* | 0.368 | 0.398 | 0.378 | −,− |
| *Primary schooling* | 0.575 | 0.540 | 0.564 | −,− |
| *Secondary or higher* | 0.0568 | 0.0615 | 0.0583 | −,− |
| Muslim | 0.274 | 0.282 | 0.276 | −,− |
| Currently married | 0.818 | 0.766 | 0.801 | *,− |
| Wealth indicator: House has metal/tiled roof | 0.231 | 0.217 | 0.226 | −,− |
| HIV status | 0.0371 | 0.0615 | 0.0438 | *,− |
| Region of residence | | | | |
| *Central* | 0.302 | 0.359 | 0.321 | * |
| *South* | 0.366 | 0.408 | 0.380 | − |
| *North* | 0.333 | 0.232 | 0.300 | * |
| SF12 Mental Health Score | 52.89 | 52.88 | 52.89 | −,− |
| | (9.295) | (9.695) | (9.396) | |
| Subjective well-being | 3.881 | 3.764 | 3.851 | *,− |
| (1 = very unsatisfied, ..., | (0.956) | (1.020) | (0.974) | |
| 5 = very satisfied) | | | | |
| Depression/anxiety Index (DAX) | 0.442 | 0.481 | 0.452 | −,− |
| | (0.708) | (0.725) | (0.712) | |
| SF12 Physical Health Score | 50.05 | 48.35 | 49.61 | *,− |
| | (8.303) | (9.940) | (8.781) | |
| # of observations | 1,266 | 612 | 1,878 | |

*Notes:* Table includes all 2008 MLSFH respondents who were age-eligible for 2012 (baseline) MLSFH-MAC (i.e., $Age_{2008} \geq 41$). The column "Signif. Diff." indicates whether the difference in 2008 respondent characteristics is significantly different between those surveyed and those *not* surveyed in 2012. * before the comma indicates that the difference is significant at 5% or higher, − indicates that the difference is not statistically significant. [#] after the comma indicates that the difference is significant at 5% or higher after controlling for region, age, $age^2$ and gender, − indicates that the difference is not statistically significant. This second test is not performed for region, age, and gender, and none of the differences in the other variables remain significant at 5% after controlling for region, age, $age^2$ and gender. DAX is a depression/anxiety index derived from the SF12 questions, and is described in more detail elsewhere.[12]

**Table A8: Age-eligible 2008 respondents: Predictors of *not* being surveyed in 2012 MLSFH mature adult survey (odds ratios)**

| | Outcome: not being surveyed in 2012 | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Female | 0.84 | 0.77$^+$ | 0.86 | 0.84 |
| | (0.10) | (0.11) | (0.13) | (0.13) |
| Age (in 2008) | 0.90** | 0.87** | 0.89** | 0.88** |
| | (0.023) | (0.028) | (0.026) | (0.029) |
| $(Age/10)^2$ | 1.11** | 1.13** | 1.12** | 1.14** |
| | (0.023) | (0.030) | (0.027) | (0.032) |
| Schooling (Ref: No schooling) | | | | |
| *Primary schooling* | 1.06 | 1.09 | 1.24 | 1.26 |
| | (0.14) | (0.17) | (0.20) | (0.21) |
| *Secondary or higher* | 1.41 | 1.43 | 1.54 | 1.67 |
| | (0.36) | (0.43) | (0.50) | (0.56) |
| Muslim | 0.81 | 0.89 | 0.85 | 0.86 |
| | (0.14) | (0.19) | (0.19) | (0.20) |
| Currently married | 0.83 | 0.75$^+$ | 0.77 | 0.74 |
| | (0.12) | (0.13) | (0.13) | (0.14) |
| Region of residence (Ref: Central) | | | | |
| *South* | 1.08 | 1.10 | 1.04 | 1.08 |
| | (0.18) | (0.22) | (0.22) | (0.24) |
| *North* | 0.58** | 0.63** | 0.62** | 0.59** |
| | (0.082) | (0.10) | (0.11) | (0.11) |
| HIV status (based on all prior tests) | | 1.82* | | 1.74$^+$ |
| | | (0.49) | | (0.54) |
| Wealth indicator: House has metal/ | | 0.93 | 0.93 | 0.92 |
| tiled roof | | (0.14) | (0.15) | (0.15) |
| SF12 Mental Health Score | | | 1.01 | 1.00 |
| | | | (0.0073) | (0.0076) |
| Subjective well-being (1 = very | | | 0.91 | |
| unsatisfied, . . . , 5 = very satisfied) | | | (0.062) | |
| SF12 Physical Health Score | | | | 0.99 |
| | | | | (0.0081) |
| Observations | 1,813 | 1,462 | 1,385 | 1,286 |
| Proportion of 2008 respondents *not* surveyed in 2012 | 0.32 | 0.27 | 0.26 | 0.25 |

*Notes:* Analyses include all 2008 MLSFH respondents that are age-eligible for 2012 MLSFH-MAC survey (i.e., $Age_{2008} \geq 41$). Dependent variable is not being surveyed in 2012 (among age-eligible 2008 respondents). *p*-values: $^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$.

**Table A9: Attrition among MLSFH mature adults 2008–12: OLS analyses of the determinants of 2008 mental health and subjective well-being, with interaction for respondents who subsequently attrited during 2008–12**

| Outcome | (1) Depression/ anxiety index (DAX) | (2) SF12 mental health score | (3) Subj. well-being |
|---|---|---|---|
| Not surveyed in 2012 | 0.16 | -3.64 | -0.89** |
| | (0.25) | (2.90) | (0.33) |
| Age | 0.0097** | -0.14** | -0.018** |
| | (0.0020) | (0.025) | (0.0025) |
| Age × Not surveyed in 2012 | -0.0028 | 0.067 | 0.011** |
| | (0.0038) | (0.043) | (0.0044) |
| Female | 0.25** | -4.18** | -0.18** |
| | (0.043) | (0.58) | (0.063) |
| Female=1 × Not surveyed in 2012 | 0.093 | -1.08 | 0.026 |
| | (0.087) | (1.18) | (0.13) |
| Schooling (Ref: No schooling) | | | |
| *Primary schooling* | 0.0078 | 0.23 | 0.044 |
| | (0.052) | (0.66) | (0.073) |
| *Secondary or higher* | -0.065 | 1.22 | 0.084 |
| | (0.095) | (1.46) | (0.16) |
| *Primary schooling* × Not surveyed in 2012 | 0.010 | -0.30 | 0.25 |
| | (0.11) | (1.38) | (0.16) |
| *Secondary or higher* × Not surveyed in 2012 | 0.036 | -1.58 | 0.35 |
| | (0.19) | (2.95) | (0.30) |
| Region of residence (Ref: Central) | | | |
| *South* | 0.23** | -1.95** | -0.089 |
| | (0.052) | (0.66) | (0.072) |
| *North* | 0.25** | -3.05** | -0.068 |
| | (0.052) | (0.73) | (0.077) |
| *South* × Not surveyed in 2012 | -0.062 | 0.49 | 0.000078 |
| | (0.10) | (1.30) | (0.15) |
| *North* × Not surveyed in 2012 | -0.069 | 2.74[+] | -0.14 |
| | (0.11) | (1.53) | (0.17) |
| House has metal/tiled roof | -0.057 | 0.50 | 0.11 |
| | (0.050) | (0.68) | (0.071) |
| House has metal/tiled roof × Not surveyed in 2012 | 0.025 | -0.48 | 0.0046 |
| | (0.10) | (1.46) | (0.15) |
| Constant | -0.39** | 64.6** | 4.95** |
| | (0.13) | (1.66) | (0.17) |
| Observations | 1,394 | 1,385 | 1,396 |
| Proportion of age-eligible 2008 respondents *not* surveyed in 2012 | 0.25 | 0.26 | 0.26 |
| F-test (p-values) for $H_0$ that all interactions with *Not surveyed in 2012* are equal to zero | | | |
| including level effect (*Not surveyed in 2012*) | .93 | .53 | .28 |
| excluding level effect (*Not surveyed in 2012*) | .91 | .43 | .35 |

*Notes:* Analyses include all 2008 MLSFH respondents with non-missing observations that were age-eligible for the 2012 MLSFH-MAC survey (i.e., $\text{Age}_{2008} \geq 41$). *p*-values: $^{+}\ p < 0.10$, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$

minants and correlates of mental health in this paper are potentially affected by attrition among the MLSFH mature adults (BGLW test selective attrition[82]). Following earlier analyses of attrition in the MLSFH and other longitudinal cohort studies,[7,72,79,80,87] this assessment is based on regressions of 2008 mental-health measures—SF12 mental health score, subjective well-being and our depression/anxiety index (DAX)—for age-eligible 2008 MLSFH respondents ($Age_{2008} \geq 41$) on individual characteristics (measured in 2008), including an interaction of all included characteristics with an indicator for not being surveyed in the 2012 mature adult survey (Table A9). If the estimated relationships for these outcome variables differ between MLSFH respondents who are retained in the sample and those who are lost to follow-up, the interaction effects with attrition would be individually or jointly significant (this is referred to as the BGLW test for selective attrition; see[82]). The bottom rows of Table A9 report the fraction of age-eligible 2008 respondents that are *not* surveyed in 2012, and F-tests for the null hypothesis that all interaction effects are jointly equal to zero. None of the individual interaction effects is significant at the 5% level, and the $H_0$ that all interaction effects are jointly zero is not rejected in any of the models in Table A9.

In summary, two factors contribute to the fact that not all 2008 MLSFH respondents who met the age-eligibility criteria to be included in the MLSFH-MAC baseline were actually interviewed in 2012: (1) conventional attrition due to mortality, migration, refusal to be interviewed and other loss-to-follow-up, and (2) the additional eligibility criteria that required that members of the 2012 target sample had to be interviewed in both 2008 and 2010 MLSFH waves. Our analyses of attrition combined both of these reasons, and investigated whether attrition—specified here as the fact that an age-eligible 2008 respondent was *not* surveyed in 2012—resulted in selection and potential biases. Overall, the analyses of attrition in the MLSFH-MAC data 2008–12 in this Section (Tables A5–A9) confirm our earlier findings that attrition does not pose an important concern for analyses. 2008 MLSFH respondents who met the age-eligibility for the 2012 MLSFH-MAC survey, but were not interviewed in 2012, differ moderately in observed characteristics—including age, region of residence and HIV status—from those who were interviewed (Table A7). Controlling for age, region and gender, none of the differences in 2008 respondent characteristics between attritors and non-attritors remain statistically significant, and neither 2008 mental/physical health is a predictor of not being surveyed in 2012 (Table A8). Selective attrition based on observed characteristics is therefore less marked among the MLSFH-MAC population as compared to the overall MLSFH study population—in part because older individuals aged 45+ are less mobile than younger individuals.

Despite the fact that attrition during 2008–12 is predicted by some individual characteristics (Table A8), the coefficient estimates in relationships between mental health and individual characteristics are not affected by attrition. Specifically, for all of the mental health outcomes in Table A9, the null-hypothesis that the estimated coefficients in these relationships are identical for attriters and non-attriters

is not rejected (BGLW test for selective attrition[82]). Our analyses of attrition therefore allow the conclusion that, while the eligibility criteria for the 2012 MLSFH-MAC baseline survey and general loss-to-follow-up implied that a significant fraction of 2008 age-eligible respondents was not surveyed in the 2012 MLSFH mature adult survey, attrition among MLSFH-MAC study participants 2008–12 does not seem to bias the coefficients of our estimated relationships between mental health and its determinants.

### A3.2. Attrition in the MLSFH-MAC during 2012–18

Table 2 reports the attrition from MLSFH-MAC during 2012–18 for all respondents who were enrolled in the MLSFH-MAC baseline in 2012. Of 1,266 respondents interviewed at baseline, 86% were successfully found in 2018, and 11.8% of the 2012 respondents had died by 2018. Refusal to participate in the MLSFH-MAC, conditional on successfully contacting a respondent, is relatively rare (less than 1% at baseline). Temporary/permanent migration out of the MLSFH-MAC study areas is less common for mature adults aged 45+ years as compared to younger individuals, and after the MLSFH-MAC migration follow-up efforts, less than 1% of the 2012 respondents were lost due to migration. Excluding deceased respondents, the MLSFH-MAC successfully surveyed in 2018 a remarkable 97% of the respondents interviewed at baseline, providing a very high rate of retention of study participants in this cohort.

There are several significant predictors of attrition during the 2012–18 MLSFH-MAC cohort follow-ups (Table A10), and attrition is positively related to several baseline (2012) characteristics, including being male, being older, having no formal schooling, not being married in 2012, being poor, scoring low on the indicators of subjective well-being, mental or physical health, and being depressed. Several of these predictors of attrition remain statistically significant in multivariate analyses of 2012–18 attrition (Table A11).

Of the 181 respondents lost to follow-up during 2012–18, 149 died. Many of the characteristics predicting attrition are predictors of mortality as the most important reason for attrition in the MLSFH-MAC cohort during 2012–18. Table A12 therefore compares the 2012 baseline characteristics of respondents who were surveyed in 2018 to those that were not, excluding respondents who died during 2012–18. Only 32 baseline respondents were lost to follow-up by 2018 for reasons other than mortality, and non-mortality-related attrition has very few significant predictors. Attrition for reasons other than mortality is somewhat more frequent among younger and less educated baseline respondents, and it is more common among respondents who have poor mental health (or are depressed) or have poor physical health. Except for age, none of these characteristics predicts non-mortality attrition in multivariate analyses (Table A13).

Finally, we analyze in Table A14 if attrition during 2012–18 potentially distorts analyses of the determinants and correlates of mental health, which is an important area of research in for the MLSFH-MAC (BGLW test for selective attrition[82]). Results are only shown for overall attrition (mortality and other factors), and separate

**Table A10: Comparison of 2012 (baseline) MLSFH-MAC respondent characteristics depending on whether they were surveyed in the 2018 MLSFH-MAC follow-up or not**

| 2008 Respondent Characteristics | Surveyed 2018 MLSFH-MAC survey | | | |
|---|---|---|---|---|
| | Yes | No | Total | Signif. Diff. |
| Female | 0.583 | 0.503 | 0.572 | * |
| Age | 58.07 | 66.84 | 59.32 | * |
| | (10.35) | (12.97) | (11.19) | |
| Age Group | | | | |
| *< 45* | 0.023 | 0.0331 | 0.025 | − |
| *45-54* | 0.418 | 0.177 | 0.384 | * |
| *55-64* | 0.319 | 0.210 | 0.303 | * |
| *65-74* | 0.154 | 0.298 | 0.175 | * |
| *75+* | 0.086 | 0.282 | 0.114 | * |
| Schooling | | | | |
| *No formal schooling* | 0.341 | 0.486 | 0.362 | *,# |
| *Primary schooling* | 0.593 | 0.470 | 0.575 | *,# |
| *Secondary or higher* | 0.066 | 0.044 | 0.063 | −,− |
| Muslim | 0.269 | 0.300 | 0.274 | −,− |
| Currently married | 0.786 | 0.663 | 0.769 | *,− |
| Wealth indicator: House has metal/tiled roof | 0.317 | 0.243 | 0.306 | *,− |
| HIV status | 0.045 | 0.0678 | 0.048 | −,# |
| Region of residence | | | | |
| *Central* | 0.300 | 0.315 | 0.302 | − |
| *South* | 0.356 | 0.425 | 0.366 | − |
| *North* | 0.345 | 0.260 | 0.333 | * |
| SF12 Mental Health Score | 53.59 | 49.40 | 52.99 | *,# |
| | (9.49) | (11.33) | (9.88) | |
| Subjective well-being | 3.596 | 3.149 | 3.532 | *,# |
| (1 = very unsatisfied, …, | (0.980) | (1.123) | (1.013) | |
| 5 = very satisfied) | | | | |
| Depression/anxiety Index (DAX) | 0.475 | 0.834 | 0.526 | *,# |
| | (0.753) | (0.873) | (0.781) | |
| SF12 Physical Health Score | 48.58 | 42.27 | 47.67 | *,# |
| | (9.12) | (12.52) | (9.93) | |
| # of observations | 1,085 | 181 | 1,266 | |

*Notes:* Table includes all enrolled 2012 (basline) MLSFH-MAC respondents ($N = 1,266$). The column "Signif. Diff." indicates whether the difference in 2008 respondent characteristics is significantly different between those surveyed and those *not* surveyed in 2012. * before the comma indicates that the difference is significant at 5% or higher, − indicates that the difference is not statistically significant. # after the comma indicates that the difference is significant at 5% or higher after controlling for region, age, age$^2$ and gender, − indicates that the difference is not statistically significant. This second test is not performed for region, age, and gender, and none of the differences in the other variables remain significant at 5% after controlling for region, age, age$^2$ and gender. DAX is a depression/anxiety index derived from the SF12 questions, and is described in more detail elsewhere.[12]

**Table A11: 2012 (baseline) MLSFH-MAC respondents: Predictors of *not* being surveyed in 2018 MLSFH-MAC follow-up (odds ratios)**

|  | Outcome: not being surveyed in 2018 | | | |
|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) |
| Female | 0.53** | 0.54** | 0.49** | 0.46** |
|  | (0.11) | (0.12) | (0.11) | (0.10) |
| Age (in 2012) | 0.97 | 0.97 | 0.96 | 0.97 |
|  | (0.068) | (0.070) | (0.069) | (0.072) |
| $(Age/10)^2$ | 1.06 | 1.07 | 1.07 | 1.06 |
|  | (0.056) | (0.059) | (0.058) | (0.060) |
| Schooling (Ref: No schooling) |  |  |  |  |
| *Primary schooling* | 0.51** | 0.53** | 0.55** | 0.56** |
|  | (0.11) | (0.12) | (0.12) | (0.13) |
| *Secondary or higher* | 0.44+ | 0.48 | 0.54 | 0.58 |
|  | (0.20) | (0.22) | (0.24) | (0.27) |
| Muslim | 0.63 | 0.68 | 0.68 | 0.72 |
|  | (0.18) | (0.20) | (0.20) | (0.21) |
| Currently married | 0.75 | 0.80 | 0.87 | 0.87 |
|  | (0.17) | (0.19) | (0.21) | (0.21) |
| Region of residence (Ref: Central) |  |  |  |  |
| *South* | 1.32 | 1.28 | 1.38 | 1.36 |
|  | (0.37) | (0.36) | (0.39) | (0.39) |
| *North* | 0.99 | 1.01 | 0.97 | 0.98 |
|  | (0.23) | (0.24) | (0.23) | (0.24) |
| HIV status (based on all prior tests) |  | 2.15* |  | 2.01+ |
|  |  | (0.76) |  | (0.73) |
| Wealth indicator: House has metal/ tiled roof |  | 0.74 | 0.73 | 0.73 |
|  |  | (0.15) | (0.15) | (0.15) |
| SF12 Mental Health Score |  |  | 0.98* | 0.98+ |
|  |  |  | (0.0085) | (0.0089) |
| Subjective well-being (1 = very unsatisfied, . . . , 5 = very satisfied) |  |  | 0.79** |  |
|  |  |  | (0.071) |  |
| SF12 Physical Health Score |  |  |  | 0.97** |
|  |  |  |  | (0.0093) |
| Observations | 1,265 | 1,244 | 1,256 | 1,237 |
| Proportion of 2012 respondents *not* surveyed in 2018 | 0.14 | 0.14 | 0.14 | 0.14 |

*Notes:* Analyses include all enrolled 2012 (baseline) MLSFH-MAC respondents. Dependent variable is not being surveyed in 2018. *p*-values: $^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$.

**Table A12: Comparison of 2012 (baseline) MLSFH-MAC respondent characteristics depending on whether they were surveyed in the 2018 MLSFH-MAC follow-up or not, excluding respondents who died during 2012–18**

| | Surveyed in 2018 MLSFH-MAC survey | | | |
| 2008 Respondent Characteristics | Yes | No | Total | Signif. Diff. |
| --- | --- | --- | --- | --- |
| Female | 0.583 | 0.562 | 0.583 | − |
| Age | 58.07 | 59.97 | 58.12 | − |
| | (10.35) | (14.44) | (10.49) | |
| Age Group | | | | |
| *< 45* | 0.023 | 0.125 | 0.026 | * |
| *45-54* | 0.418 | 0.312 | 0.415 | − |
| *55-64* | 0.319 | 0.219 | 0.316 | − |
| *65-74* | 0.154 | 0.219 | 0.156 | − |
| *75+* | 0.086 | 0.125 | 0.087 | − |
| Schooling | | | | |
| *No formal schooling* | 0.341 | 0.469 | 0.345 | −,− |
| *Primary schooling* | 0.593 | 0.406 | 0.587 | *,− |
| *Secondary or higher* | 0.066 | 0.125 | 0.068 | −,− |
| Muslim | 0.269 | 0.312 | 0.270 | −,− |
| Currently married | 0.786 | 0.719 | 0.784 | −,− |
| Wealth indicator: House has metal/tiled roof | 0.317 | 0.156 | 0.312 | −,− |
| HIV status | 0.045 | 0.097 | 0.046 | −,− |
| Region of residence | | | | |
| *Central* | 0.300 | 0.312 | 0.300 | − |
| *South* | 0.356 | 0.469 | 0.359 | − |
| *North* | 0.345 | 0.219 | 0.341 | − |
| SF12 Mental Health Score | 53.59 | 49.08 | 53.46 | *,# |
| | (9.49 ) | (10.87) | (9.56) | |
| Subjective well-being | | *,− | | |
| (1 = very unsatisfied, ..., | 3.596 | 3.219 | 3.585 | |
| 5 = very satisfied) | (0.980) | (1.338) | (0.993) | |
| Depression/anxiety Index (DAX) | 0.475 | 0.844 | 0.485 | *,# |
| | (0.753) | (0.847) | (0.758) | |
| SF12 Physical Health Score | 48.58 | 43.75 | 48.44 | *,# |
| | (9.122) | (12.07) | (9.249) | |
| # of observations | 1,085 | 32 | 1,117 | |

*Notes:* Table includes all enrolled 2012 (baseline) MLSFH-MAC respondents who were alive in 2018. The column "Signif. Diff." indicates whether the difference in 2008 respondent characteristics is significantly different between those surveyed and those *not* surveyed in 2012. * before the comma indicates that the difference is significant at 5% or higher, − indicates that the difference is not statistically significant. # after the comma indicates that the difference is significant at 5% or higher after controlling for region, age, age[2] and gender, − indicates that the difference is not statistically significant. This second test is not performed for region, age, and gender, and none of the differences in the other variables remain significant at 5% after controlling for region, age, age[2] and gender. DAX is a depression/anxiety index derived from the SF12 questions, and is described in more detail elsewhere.[12]

**Table A13: 2012 (baseline) MLSFH-MAC respondents: Predictors of *not* being surveyed in 2018 MLSFH-MAC follow-up (odds ratios), excluding respondents who died during 2012–18**

|  | Outcome: not being surveyed in 2012 for reasons other than mortality | | | |
|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) |
| Female | 0.73 | 0.78 | 0.67 | 0.62 |
|  | (0.33) | (0.35) | (0.30) | (0.28) |
| Age (in 2012) | 0.75* | 0.79[+] | 0.77* | 0.81 |
|  | (0.087) | (0.10) | (0.091) | (0.11) |
| $(Age/10)^2$ | 1.25** | 1.21[+] | 1.22* | 1.17 |
|  | (0.11) | (0.12) | (0.11) | (0.12) |
| Schooling (Ref: No schooling) |  |  |  |  |
|   *Primary schooling* | 0.61 | 0.67 | 0.66 | 0.70 |
|  | (0.29) | (0.32) | (0.32) | (0.34) |
|   *Secondary or higher* | 1.94 | 2.40 | 2.49 | 2.89 |
|  | (1.45) | (1.83) | (1.88) | (2.21) |
| Muslim | 0.55 | 0.70 | 0.65 | 0.79 |
|  | (0.32) | (0.43) | (0.38) | (0.49) |
| Currently married | 0.80 | 0.95 | 1.02 | 1.05 |
|  | (0.41) | (0.50) | (0.55) | (0.57) |
| Region of residence (Ref: Central) |  |  |  |  |
|   *South* | 1.61 | 1.48 | 1.58 | 1.49 |
|  | (0.91) | (0.88) | (0.91) | (0.90) |
|   *North* | 0.58 | 0.63 | 0.62 | 0.67 |
|  | (0.32) | (0.35) | (0.34) | (0.37) |
| HIV status (based on all prior tests) |  | 2.03 |  | 1.70 |
|  |  | (1.34) |  | (1.16) |
| Wealth indicator: House has metal/ tiled roof |  | 0.40[+] | 0.41[+] | 0.42[+] |
|  |  | (0.20) | (0.21) | (0.22) |
| SF12 Mental Health Score |  |  | 0.97[+] | 0.97 |
|  |  |  | (0.018) | (0.019) |
| Subjective well-being (1 = very unsatisfied, …, 5 = very satisfied) |  |  | 0.83 |  |
|  |  |  | (0.15) |  |
| SF12 Physical Health Score |  |  |  | 0.96[+] |
|  |  |  |  | (0.020) |
| Observations | 1,117 | 1,099 | 1,108 | 1,092 |
| Proportion of 2012 respondents *not* surveyed in 2018 | 0.03 | 0.03 | 0.03 | 0.03 |

*Notes:* Analyses include all enrolled 2012 (baseline) MLSFH-MAC respondents who were alive in 2018. Dependent variable is not being surveyed in 2018. *p*-values: [+] $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

analyses for non-mortality-related attrition are not feasible given the small number of respondents lost-to-follow-up during 2012–18 for reasons other than mortality ($N = 32$). Results indicate, as in our analyses of 2008–12 attrition, that there are differences in mental health and well-being between those who attrit during 2012–18 and those who do not, but there is no evidence that attrition biases behavioral relations between mental health (well-being) and some of its key socioeconomic determinants.

The analyses of MLSFH-MAC attrition during 2012–18 in this section reach similar conclusions as the attrition analyses for enrolling the MLSFH-MAC cohort during the baseline survey in 2012 (Section A3.1). Despite the fact that attrition during 2012–18 is predicted by several individual characteristics (Table A11), the coefficient estimates in relationships between mental health and individual characteristics are not affected by attrition. Specifically, for all of the mental health outcomes in Table A14, the null-hypothesis that the estimated coefficients in these relationships are identical for attriters and non-attriters is not rejected (BGLW test for selective attrition[82]). Our analyses of attrition therefore allow the conclusion that, while the MLSFH-MAC cohort experience attrition during 2012–18, attrition among MLSFH-MAC study participants 2012–18 does not seem to bias the coefficients of our estimated relationships between mental health and its determinants.

In summary, during 2012–18, the MLSFH-MAC cohort experienced rising mortality as a result of aging, and mortality accounts for 149 of the 181 baseline (2012) respondents who were lost to follow-up by 2018. Among 2012 baseline respondents, only 32 attrited for reasons other than mortality, and more than 97% of surviving baseline respondents were followed up at the most recent MLSFH-MAC survey in 2018. Attrition during 2012–18 has several predictors, as is expected based on the overwhelming contribution of mortality, including being male, being older, having no formal schooling, not being married in 2012, being poor, scoring low on the indicators of subjective well-being, mental or physical health, and being depressed. In multivariate analyses, schooling, physical and mental health continue to predict attrition during 2012–18.

## A4. Selected features of the MLSFH-MAC data and study design

### A4.1. Overview of MLSFH-MAC health and socioeconomic measures

MLSFH-MAC surveys are conducted in the local languages (Chichewa, Chiyao and Chitumbuka) by carefully trained interviewers and/or HIV testing counselors. The survey instruments (Table 4) are a combination of previously-existing MLSFH instruments and newly developed survey instruments covering in particular aging-related topics such as cognitive and mental health, NCDs, NCD-related health literacy, etc. This survey design offers the advantage of allowing longitudinal comparability of cohort data since 1998, thereby facilitating life-course studies (Table 3), while also allowing for an expansion of the survey into new aging and NCD-related dimensions for which prior data do not exist (Table 4). New survey modules (i.e., mental/cognitive health instruments) were extensively pretested during

**Table A14: Attrition among MLSFH mature adults 2012–18: OLS analyses of the determinants of 2012 mental health and subjective well-being, with interaction for respondents who subsequently attrited during 2012–18**

| | (1) | (2) | (3) |
|---|---|---|---|
| Outcome | Depression/ anxiety index (DAX) | SF12 mental health score | Subj. well-being |
| Not surveyed in 2018 | -0.18 | -1.48 | 0.096 |
| | (0.37) | (4.65) | (0.55) |
| Age | 0.012** | -0.13** | -0.014** |
| | (0.0024) | (0.031) | (0.0029) |
| Age × Not surveyed in 2018 | 0.0092$^+$ | -0.070 | -0.0065 |
| | (0.0052) | (0.067) | (0.0073) |
| Female | 0.25** | -2.97** | -0.24** |
| | (0.049) | (0.61) | (0.064) |
| Female=1 × Not surveyed in 2018 | -0.086 | 1.34 | -0.0091 |
| | (0.14) | (1.84) | (0.19) |
| Schooling (Ref: No schooling) | | | |
| *Primary schooling* | 0.062 | -0.88 | 0.079 |
| | (0.060) | (0.73) | (0.077) |
| *Secondary or higher* | -0.023 | -0.19 | -0.0075 |
| | (0.11) | (1.43) | (0.16) |
| *Primary schooling* × Not surveyed in 2018 | -0.18 | 5.07* | 0.31 |
| | (0.16) | (2.19) | (0.21) |
| *Secondary or higher* × Not surveyed in 2018 | -0.35 | 6.95 | -0.51 |
| | (0.32) | (4.58) | (0.57) |
| Region of residence (Ref: Central) | | | |
| *South* | 0.013 | -1.36$^+$ | 0.10 |
| | (0.060) | (0.72) | (0.079) |
| *North* | 0.0053 | -0.56 | -0.034 |
| | (0.059) | (0.75) | (0.079) |
| *South* × Not surveyed in 2018 | -0.14 | 1.58 | -0.041 |
| | (0.16) | (2.16) | (0.21) |
| *North* × Not surveyed in 2018 | 0.12 | -3.48 | -0.11 |
| | (0.20) | (2.72) | (0.27) |
| House has metal/tiled roof | -0.0068 | 0.68 | 0.10 |
| | (0.049) | (0.64) | (0.065) |
| House has metal/tiled roof × Not surveyed in 2018 | 0.087 | -0.93 | -0.30 |
| | (0.16) | (2.32) | (0.21) |
| Constant | -0.40* | 64.1** | 4.42** |
| | (0.16) | (2.05) | (0.20) |
| Observations | 1,262 | 1,257 | 1,264 |
| Proportion of enrolled 2012 respondents *not* surveyed in 2018 | 0.14 | 0.14 | 0.14 |
| F-test (p-values) for $H_0$ that all interactions with *Not surveyed in 2018* are equal to zero | | | |
| including level effect (*Not surveyed in 2018*) | .011 | .028 | .002 |
| excluding level effect (*Not surveyed in 2018*) | .439 | .358 | .144 |

*Notes:* Analyses include all enrolled 2012 MLSFH respondents with non-missing observations. p-values: $^+$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

focus-group interviews and pilot tests. In most cases, newly implemented instruments were also harmonized as much as possible with other aging studies (such as the *Health and Retirement Survey* and its sister-studies) that provide wide-ranging multidisciplinary data on aging in high- and middle-income countries.[10]

*Mental and cognitive health* of the MLSFH-MAC cohort were assessed using multiple survey instruments that are discussed in more detail below (Sections A4.2–Section A4.3). Instruments to assess respondents' *physical health* status include: (*a*) grip strength as a measure of physical performance; (*b*) measured weight/ height, hip and waist circumference; (*c*) gait speed or time walk (2017); (*d*) measured blood pressure and fasting blood glucose (the latter only in 2017); (*e*) self-reports of activities of daily living (ADLs), experience of acute and chronic pain, medical diagnosis of selected cardio-vascular diseases (CVDs). The fieldwork procedures for obtaining the measured physical health indicators are described in Section A1.8.

NCD- and aging-related *health-literacy* is assessed by knowledge about symptoms of, and treatment options for several NCDs, as well as by questions about the survival-implications of being affected by different NCDs. The MLSFH-MAC continues to collect instruments on *subjective risks assessments* and probabilistic expectations, using an innovative MLSFH expectations module focused on mortality and HIV-related risk perceptions. *Other instruments* measure respondents social capital and resource networks, social, demographic and economic background, work efforts, productivity, consumption and related household income/expenditure measures (for additional details, see MLSFH Cohort Profile[7]). MLSFH-MAC also measures exposure to *behavioral risk factors* such as alcohol consumption, smoking and sexual partnerships and sexual risk taking. In 2018, MLSFH-MAC collected information on *egocentric health conversation networks*, measuring how mature adults interact about NCDs, including mental health, with others within and outside of their households. The MLSFH-MAC has conducted repeated *HIV testing and counseling* (HTC) in 2012 and 2017 at respondents' homes, and it has collected information about access to, and use of antiretroviral treatment (ART).

In the subsequent sections, we provide detailed information about selected, and to a large extent innovative, features of the MLSFH-MAC data and study design that have been relevant to a broad set of ongoing MLSFH-MAC analyses.

### A4.2. Mental health

The MLSFH-MAC collects extensive assessments of different dimensions of mental health and allow us to assess both the presence and the severity of depression and anxiety disorders. The following measures are available: *SF12 mental health score included in MLSFH since 2006:* this is a widely used measure of overall mental health that has been validated in many different contexts.[89,90] Higher SF-12 scores reflect better mental health. The SF12 score, however, 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, the MLSFH collected additional measures of mental health in 2012 and 2013: the *depression and anxi-*

*ety modules of the Patient Health Questionnaire (PHQ-9)*. The PHQ-9 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.[91,92] The *depression module* (*PHQ-9*) includes nine questions 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* (**GAD-7** includes seven questions if 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. Response categories for all questions in the PHQ-9 and GAD-7 modules range from "0" (not at all) to "3" (nearly every day).

An *overall depression score* (PHQ-9 score) is computed as the total score calculated from the PHQ-9 instrument. Based on this PHQ-9 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).[91] Similarly, an *overall anxiety score* (GAD-7 score) is computed as the total score calculated from the GAD-7 instrument. The official guidelines specify scores of 5, 10, and 15 as cutpoints for mild, moderate, and severe anxiety, respectively.[91] A score larger than 10 is recommended for further evaluation when GAD-7 is used as a screening instrument for anxiety disorders.

To facilitate longitudinal analyses of depression and anxiety based on data collection waves 2006–18, of which only the MLSFH-MAC 2012 and onward waves include PHQ-9 and GAD-7 scores, 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 depression and anxiety, 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. The DAX is related to the SF12 mental health score, with a correlation of about -.8 in 2012–13, but it has the advantage for our analyses that it is more explicitly focused on depression and anxiety.

**Table A15: Summary statistics for MLSFH-MAC mental health indicators**

| | Mean (std dev) | | | Correlation across measures | | | |
|---|---|---|---|---|---|---|---|
| | Females | Males | Total | PHQ-9 | GAD-7 | SF12 | Well-being |
| **2012** | | | | | | | |
| PHQ-9 Depression Score | 3.57 (3.97) | 2.58 (3.58) | 3.15 (3.84) | – | – | – | – |
| GAD-7 Anxiety Score | 2.88 (2.66) | 2.22 (2.45) | 2.59 (2.59) | 0.68 | – | – | – |
| SF12 Mental Health Score | 52.0 (10.4) | 54.3 (9.10) | 53.0 (9.90) | -0.55 | -0.65 | – | – |
| Subj. Wellbeing | 3.45 (0.97) | 3.65 (1.06) | 3.53 (1.02) | -0.29 | -0.29 | 0.30 | – |
| DAX depression/ anxiety index | 0.61 (0.81) | 0.42 (0.74) | 0.53 (0.79) | 0.50 | 0.59 | -0.79 | -.28 |
| **2018** | | | | | | | |
| PHQ-9 Depression Score | 4.31 (4.29) | 2.99 (3.67) | 3.77 (4.10) | – | – | – | – |
| GAD-7 Anxiety Score | 3.49 (3.34) | 2.45 (2.86) | 3.06 (3.20) | 0.80 | – | – | – |
| SF12 Mental Health Score | 50.0 (10.2) | 52.5 (9.96) | 51.0 (10.2) | -0.55 | -0.50 | – | – |
| Subj. Wellbeing | 3.62 (1.07) | 3.96 (1.11) | 3.76 (1.10) | -0.37 | -0.36 | 0.31 | – |
| DAX depression/ anxiety index | 0.86 (0.86) | 0.66 (0.85) | 0.78 (0.86) | 0.50 | 0.47 | -0.75 | -.30 |

*Notes:* Analyses include respondents aged 45+. Subjective well-being ranges from 1 = very unsatisfied to 5 = very satisfied.

Table A15 reports summary statistics for PHQ-9 depression score, GAD-7 anxiety score and SF12 score for an overall mental health in 2012 and 2018. Subjective well-being is reported for comparison, as is the DAX depression/anxiety index derived from two questions of the SF12. Columns 1–3 report the mean scores and standard deviations, and columns 4–7 report the cross-sectional correlations among the five scores in 2012 and 2018.

All three measures indicate marked gender differences, with women having worse mental health and subjective well-being than men (Table A15), and a significant decline of mental health occurs with age (Figure 2). The relatively low levels of the PHQ-9 and GAD-7 scores in Table A15 are noteworthy given that the scales range from zero to 27 (for the PHQ-9) and zero to 21 (for the GAD-7), and informal observations during fieldwork indicated relatively widespread problems with poor mental health. The mean SF12 mental health score of 53 is also not substan-

tially 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. Based on the official PHQ9 and GAD7 classification guidelines, about 25% (2012) to 29% (2018) of respondents exhibit mild or higher levels of depression, and 22% (2012) and 25% (2018) express mild or higher levels of anxiety. Moderately-severe and severe depression, and moderate-severe anxiety are fairly rare, affecting only about 3% of mature adult respondents (Table A15, Columns 1–3).

These low reported levels of depression and anxiety 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,[93] and individuals thus tend to under-report anxiety, depression and poor mental health; or, they may tend to understate feelings of depression and anxiety 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,[94] 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, our prior MLSFH-MAC analyses[12] have shown that the presence of depression and anxiety is importantly associated with lower subjective well-being, less food (protein) consumption, less sexual activity, lower earnings and savings, and reduced work efforts in this study population. The effects are sizable, with mild depression in 2012/13 associated with 11% decline in the number of days on which individuals consume chicken, fish or meat, a 15% reduction 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, depression and anxiety have independent effects in multivariate analyses.

Within each wave, the correlation coefficients (absolute values) for the PHQ-9, GAD-7 and SF12 scores range between .55–.80 (Columns 4–5 in Table A15), indicating that depression, anxiety and overall mental health are affected by common stressors such as social or economic shocks (such as poor crop yields and morbidity/mortality of adult 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–.27, indicating that subjective well-being does not adequately capture these dimensions of mental health. Our combined DAX depression/anxiety index is correlated at .47–.59 with the more detailed PHQ-9 and GAD-7 measures of depression and anxiety, indicating that this simple index already captures significant variation in depression and anxiety.

**Table A16: Cohort change in PHQ-9 depression score and GAD-7 anxiety score during 2012–18**

| | Prevalence | Change in Score 2012-18 | | |
|---|---|---|---|---|
| | in 2012 | worse | const. | better |
| **Depression** | | | | |
| *None to Minimal depression* | 0.77 | 0.46 | 0.41 | 0.13 |
| *Mild depression* | 0.17 | 0.25 | 0.22 | 0.53 |
| *Moderate depression* | 0.05 | 0.14 | 0.10 | 0.76 |
| *Moderately severe depression* | 0.01 | 0.10 | 0.10 | 0.80 |
| *Severe depression* | 0.00 | 0.00 | 0.00 | 1.00 |
| # of observations | 1,044 | | | |
| **Anxiety** | | | | |
| *No anxiety* | 0.29 | 0.48 | 0.52 | 0.00 |
| *Some anxiety symptoms* | 0.51 | 0.34 | 0.46 | 0.19 |
| *Mild anxiety* | 0.18 | 0.22 | 0.21 | 0.57 |
| *Moderate/severe anxiety* | 0.01 | 0.00 | 0.00 | 1.00 |
| # of observations | 1,060 | | | |

*Notes:* Analyses include respondents aged 45+ in 2012 who were also surveyed in 2018. The 2012–18 change in score is classified as *worse* if the PHQ-9 or GAD-7 score increases by more than 1 during 2012–18 (thus indicating higher levels of depression/anxiety in 2018 as compared to 2012); the change in score is classified as *better* if the PHQ-9 or GAD-7 score declines by more than 1 during 2012–18 (thus indicating lower levels of depression/anxiety in 2018 as compared to 2012). The change is considered constant if the difference in the 2012–18 scores equals one or less.

Table A16 completes our analyses of mental health by documenting the cohort changes in PHQ-9 depression score and GAD-7 anxiety score during 2012–18 for 2012 MLSFH-MAC respondents who were followed-up in 2018. The 2012–18 change in score is classified as *worse* (*better*) if the PHQ9 or GAD7 score increases (decreases) by more than 1 during 2012–18. These analyses indicate that elevated levels of depression and anxiety, across a five-year time period, are often transitory, indicating that many of these influences on depression, anxiety and overall mental health are relatively short-term, and often dissipate during the course several years.

### *A4.3. Cognition and cognitive health*

In contexts such as Malawi, established cognition scales are difficult to implement because of low schooling levels. Locally adapted measures and assessments of cognitive health are therefore important, rather than merely an application of western scales and cut-points. The MLSFH-MAC therefore developed and pre-tested a comprehensive instrument designed to capture a wide range of cognitive abilities, spanning from high cognitive functioning to severe cognitive impairment. The survey instrument was aimed to be suitable for a little-schooled and partially illiterate study population, and implementable by well trained, albeit lay interviewers.

After extensive testing and development, the MLSFH-MAC implemented in 2012 a modified version of the International Cognitive Assessment (ICA), a brief screening test designed to be relatively culture-free and appropriate for populations with limited access to formal schooling. The MLSFH-MAC adaptation of the ICA Questionnaire is provided in Section A5.1 below. It assesses six cognitive domains: basic language ability, orientation, visual/constructional skills, attention/working memory, executive functions, and delayed memory (recall/recognition). The maximum ICA score is 30, corresponding to highest (best) cognitive assessment.

Examples of how the ICA was modified for the MLSFH-MAC include: Basic language ability was assessed by having the respondent identify several pictures (shoe, banana, and snake), ability to precisely repeat a simple sentence, and ability to immediately recall five provided words. Orientation was assessed by asking the respondent to identify the current season and current president of Malawi. To assess visual/constructional skills and non-verbal memory, subjects were required to copy and draw from memory simple geometric designs. Attention and working memory were assessed using forward and backward digit recall and an auditory vigilance test for a spoken target number. Executive functioning was assessed using both verbal and visual measures including a visual vigilance test and a verbal fluency assessment. The visual sequencing portion of the ICA is a variation on several widely used visual sequencing tests (Trail Making Tests A and B, Color Trails[95]) designed to assess psychomotor speed, attention, sequencing, and visual scanning efficiency. Delayed recall was assessed at the end of the ICA questionnaire.

The full MLSFH-MAC ICA instrument was implemented in 2012, 2013 and 2017, while in 2018, to allow for the collection of other data, the study implemented a shortened version that focused on memory and language ability. The word-recall questions were expanded in 2017 from five to 10 words, to allow are more finely-grained measurement of memory recall. The MLSFH-MAC ICA cognition instrument is included in Sections A5.1–A5.2.

Interviewers screened subjects for visual and hearing impairments that might interfere with their ability to perceive stimuli or hear questions, and these individuals were removed from our analysis sample. Only a small number ($< 1\%$) of respondents were affected by this exclusion criteria, with some additional missing values occurring due to item non-response. and the overall ICA score is available for 1,248 of 1,266 respondents in 2012, 1,219 of 1,257 respondents in 2013, and 1,584 of 1,606 respondents in 2017 (subscores may be available for additional respondents).

Table A17 provides summary statistics and correlations for the total ICA score and the sub-scores in 2012 and 2018, and Figure A4 shows the age pattern of the overall ICA cognitive score in 2012 and 2018. Overall mean ICA scores are 18.6 (women) and 21.6 (men) in 2012, and 19.4 (women) and 22 (men) in 2017. As with mental health and some physical health measures, women at mature adult ages

## Table A17: Summary statistics for total ICA score and sub-scores

|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
|  | Mean (std dev) | | | Corelation. across measures | | | | | |
|  | Fem. | Mal. | Tot. | Lang. | Orient. | Visual | Atten. | Exec. | Mem. |
| **2012 ICA scores, by domain and total:** | | | | | | | | | |
| Language (7) | 6.25 | 6.64 | 6.42 | – | – | – | – | – | – |
|  | (1.12) | (0.75) | (1.00) | | | | | | |
| Orientation (2) | 1.70 | 1.87 | 1.77 | 0.36 | – | – | – | – | – |
|  | (0.57) | (0.37) | (0.50) | | | | | | |
| Visual (4) | 1.62 | 2.54 | 2.02 | 0.42 | 0.35 | – | – | – | – |
|  | (1.33) | (1.23) | (1.37) | | | | | | |
| Attention (3) | 1.23 | 1.62 | 1.40 | 0.36 | 0.26 | 0.47 | – | – | – |
|  | (0.97) | (0.99) | (1.00) | | | | | | |
| Exec. func. (6) | 3.93 | 4.58 | 4.21 | 0.49 | 0.39 | 0.48 | 0.48 | – | – |
|  | (1.37) | (1.14) | (1.31) | | | | | | |
| Memory (8) | 3.75 | 4.28 | 3.98 | 0.29 | 0.31 | 0.51 | 0.40 | 0.38 | – |
|  | (2.08) | (2.16) | (2.13) | | | | | | |
| Total score (30) | 18.6 | 21.6 | 19.9 | 0.63 | 0.51 | 0.79 | 0.68 | 0.74 | 0.79 |
|  | (5.35) | (4.57) | (5.25) | | | | | | |
| # of observations | 712 | 536 | 1,248 | | | | | | |
| **2017 ICA scores, by domain and total:** | | | | | | | | | |
| Language (7) | 6.19 | 6.49 | 6.31 | – | – | – | – | – | – |
|  | (1.12) | (0.86) | (1.04) | | | | | | |
| Orientation (2) | 1.56 | 1.82 | 1.67 | 0.30 | – | – | – | – | – |
|  | (0.66) | (0.43) | (0.59) | | | | | | |
| Visual (4) | 1.60 | 2.34 | 1.89 | 0.34 | 0.33 | – | – | – | – |
|  | (1.30) | (1.29) | (1.35) | | | | | | |
| Attention (3) | 1.18 | 1.52 | 1.32 | 0.33 | 0.34 | 0.46 | – | – | – |
|  | (0.87) | (0.92) | (0.91) | | | | | | |
| Exec. func. (6) | 4.07 | 4.60 | 4.28 | 0.43 | 0.40 | 0.47 | 0.49 | – | – |
|  | (1.37) | (1.21) | (1.34) | | | | | | |
| Memory (8) | 4.71 | 5.20 | 4.90 | 0.38 | 0.38 | 0.56 | 0.50 | 0.54 | – |
|  | (1.87) | (1.89) | (1.89) | | | | | | |
| Total score (30) | 19.4 | 22.0 | 20.5 | 0.61 | 0.55 | 0.76 | 0.69 | 0.78 | 0.84 |
|  | (5.29) | (4.66) | (5.21) | | | | | | |
| # of observations | 954 | 629 | 1,583 | | | | | | |

*Notes:* The word-recall questions were expanded in 2017 from five to 10 words, to allow are more finely-grained measurement of memory recall. To be comparable to the 2012 score, the analyses is this table use only the recall of the first 5 words in 2017.

**Figure A4: Age patterns of overall ICA cognition score for MLSFH-MAC mature adults, 2012 and 2017**
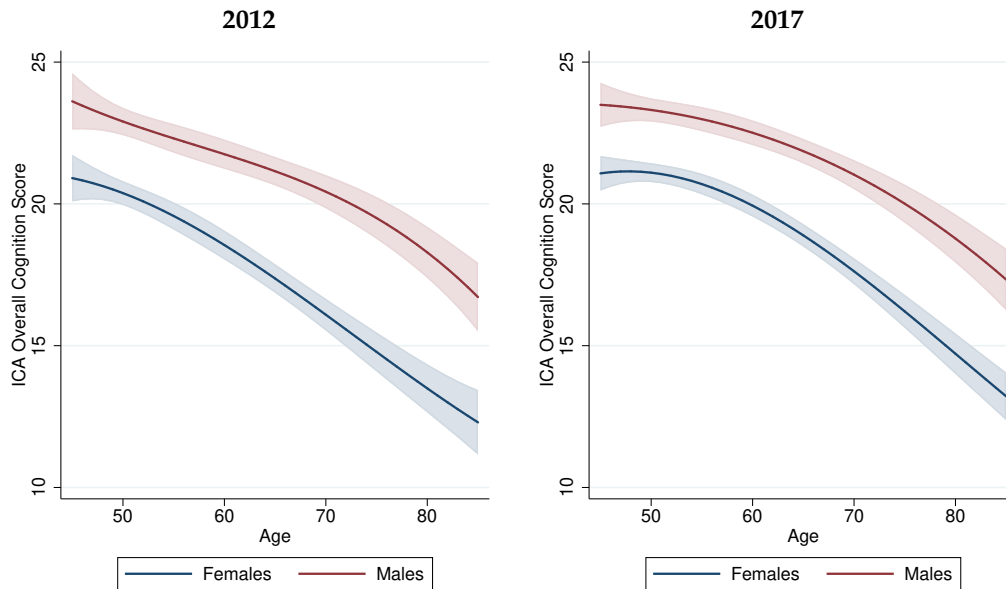


*Notes:* Marginal means (with 95% confidence intervals) obtained by regressing the respective cognitive health score on a cubic function of age, separately by sex and controlling for schooling and region. To be comparable to the 2012 score, the analyses use only the recall of the first 5 words in 2017.

have worse outcomes in terms of their cognitive health, and cognitive health declines markedly with age, starting already at youngest mature adult ages. The overall ICA scores is moderately to strongly correlated with the ICA subscores, with correlations ranging between .51–.84. The individual sub-scales in the ICA are correlated with each other in the range of 0.30 to 0.56, suggesting that while they do have similar characteristics, each sub-score is measuring a distinctive element of cognitive health.

### *A4.4. Probabilistic expectation data in the MLSFH-MAC*

The MLSFH-MAC continued the collection of probabilistic expectations data previously developed and implemented in the parent MLSFH study. Specifically, starting in 2006, the MLSFH has included a module eliciting *probabilistic expectations*, that is, expectations that are measured on a well-defined numerical scale, are comparable across domains, and can be consistently interpreted as probabilities.[24] These expectations data cover domains such as own and village-level mortality risks within 5- and 10-year periods, 5-year mortality for a healthy man/woman living in the same context as the respondent, a man/woman infected with HIV but not on treatment and a man/woman infected wit HIV and on ART.

In order to elicit probabilistic expectations in the relatively low literacy and numeracy context of rural Malawi, interactive procedures for elucidating subjective

**Table A18: MLSFH-MAC subjective expectations: Mortality risk and HIV infection**

| | 2012 | 2013 | 2017 | | | 2018 |
|---|---|---|---|---|---|---|
| | Surv. | Surv. | Surv. | HTC[d] | BK[e] | Surv. |
| Pick the number of peanuts that reflects how likely you think it is that... | | | | | | |
| X1a *a person of your sex and age in your community will die within 5 years.* | X | X | X | X | – | X |
| X2a *you think it is that you are infected with HIV/AIDS now.* | X | X | X | – | – | X |
| X2b *your spouse or romantic partner is infected with HIV/AIDS now.* | X | X | X | – | – | X |
| Consider a healthy man/woman in your village who currently does not have HIV. Pick the number of peanuts that reflects how likely you think it is that he/she will become infected with HIV...[a] | | | | | | |
| X3c *within the next 12 months if he/she is married to someone who is infected with HIV/AIDS.* | – | – | – | – | – | X |
| X3d *within the next 12 months if he/she has several sexual partners in addition to his/her spouse.* | – | – | – | – | – | X |
| I want you to think how likely it is that you will die in the near future. We believe that there is nothing bad that will happen to you. But something bad might happen in the near future years to come, even though you prevent it to happen. If you don't want, you can refuse to answer these questions. | | | | | | |
| X6a *Pick the number of peanuts that reflects how likely you think it is that you will die within a five-year period beginning today.[b]* | X | X | – | – | – | – |
| X7a *Pick [Add][c] the number of peanuts that reflects how likely you think it is that you will die within a five-year period beginning today.[b]* | X | X | X | X | X | X |
| X7b *Add the number of peanuts that reflects how likely you think it is that you will die within a ten-year period beginning today.* | X | X | X | X | X | X |

*Notes:* Prior to 2017, these questions were worded in terms of "beans;" from 2017 onward, the questions were worded in terms of "peanuts," allowing respondents to split peanuts to indicate probabilities in 5-percentage point increments. (*a*) "Man/woman" and "he/she" is selected to match the respondent's gender *b* Interviewer is instructed to leave peanuts on plate. (*c*) In 2012 and 2013, when X6 was asked, the question was phrased as "Add the number..."; in 2017 and 2018, the question was phrased as "Pick the number...". (*d*) Expectation questions were asked *after* HIV testing and after HIV test result was revealed to respondent. (*e*) Benefits of Knowledge (BenKnow) survey.

**Table A19: MLSFH-MAC subjective expectations: Survival of hypothetical persons**

| | Implmentation in MLSFH-MAC survey wave: | | | | | |
| | 2012 | 2013 | 2017 | | | 2018 |
| | Surv. | Surv. | Surv. | HTC[d] | BK[e] | Surv. |
|---|---|---|---|---|---|---|
| Finally, I would like you to consider the likelihood that somebody else dies as time goes by. I am going to ask you about an imaginary person living in the same context like you, and I am going to describe her to you. Pick the number of peanuts that reflects how likely you think it is that one of the following persons will die within a five-year (5-year) period beginning today.[a] | | | | | | |
| X8a  *A man/woman your age who is healthy and does not have HIV.[b]* | – | – | X | – | X | X |
| X8b  *A man/woman your age who is infected with HIV.[b]* | – | – | X | – | X | X |
| X8c  *A man/woman your age who is sick with AIDS.[b]* | – | – | X | – | X | X |
| X8d  *A man/woman your age who is sick with AIDS and who is treated with antiretroviral treatments (ART).[b]* | – | – | X | – | X | X |
| In a previous question I asked you about the chances that a man/woman your age who is healthy and does not have HIV dies within 5 years. You have put [X8a] peanuts on the plate.[b,c] I'd now like to ask you about the chances of dying within 5 years for this person if he (she) is HIV negative but has some other diseases. Pick the number of peanuts that reflects how likely you think it is that one of the following persons will die within a five-year period beginning today.[a] | | | | | | |
| X8e  *A man/woman your age who has hypertension or high blood pressure and does not take medication for this condition.[b]* | – | – | – | – | – | X |
| X8f  *A man/woman your age who has hypertension (or high blood pressure) and now takes medication to treat high blood pressure.[b]* | – | – | – | – | – | X |
| X8g  *A man/woman your age who has diabetes or high blood sugar and does not take medication for this condition.[b]* | – | – | – | – | – | X |
| X8h  *A man/woman your age who was diagnosed with diabetes (high blood sugar) and now takes diabetes medication.[b]* | – | – | – | – | – | X |

*Notes:* Prior to 2017, these questions were worded in terms of "beans;" from 2017 onward, the questions were worded in terms of "peanuts," allowing respondents to split peanuts to indicate probabilities in 5-percentage point increments. BK refers to 2017 BenKnow project (*a*) Interviewer is instructed to start with an empty plate for each question. (*b*) "Man/woman" and "he/she" is selected to match the respondent's gender *b* Interviewer is instructed to leave peanuts on plate. (*c*) Response (number of peanuts) from question X8a is inserted. (*d*) Expectation questions were asked *after* HIV testing and after HIV test result was revealed to respondent. (*e*) Benefits of Knowledge (BenKnow) survey.

**Table A20: Summary statistics for MLSFH-MAC subjective expectations questions in 2018**

|  | Women | Men | Total |
|---|---|---|---|
| # of observations | 957 | 653 | 1,610 |
| **Subjective probabilistic expectations about:** | | | |
| X11: 5-year mortality of person in community | 0.35 | 0.33 | 0.34 |
|  | (0.23) | (0.24) | (0.24) |
| X2a: Own infection with HIV | 0.21 | 0.17 | 0.20 |
|  | (0.27) | (0.27) | (0.27) |
| X2b: Spouse's infection with HIV | 0.22 | 0.18 | 0.20 |
|  | (0.27) | (0.26) | (0.27) |
| X3c: Infection with HIV within 12 months if married to HIV+ person | 0.51 | 0.50 | 0.51 |
|  | (0.27) | (0.26) | (0.26) |
| X3d: Infection with HIV within 12 months if several sexual partners in addition to spouse | 0.57 | 0.56 | 0.57 |
|  | (0.27) | (0.27) | (0.27) |
| X7a: 5-year mortality (own) | 0.41 | 0.34 | 0.38 |
|  | (0.27) | (0.27) | (0.27) |
| X7b: 10-year mortality (own) | 0.67 | 0.55 | 0.62 |
|  | (0.30) | (0.32) | (0.31) |
| X8a: 5yr mortality of healthy person not infected with HIV (hypothetical) | 0.36 | 0.31 | 0.34 |
|  | (0.23) | (0.24) | (0.23) |
| X8b: 5yr mortality of HIV+ person (hypothetical) | 0.48 | 0.45 | 0.47 |
|  | (0.24) | (0.24) | (0.24) |
| X8c: 5yr mortality of person sick with AIDS (hypothetical) | 0.65 | 0.61 | 0.64 |
|  | (0.26) | (0.27) | (0.26) |
| X8d: 5yr mortality of person sick with AIDS and treated with ART (hypothetical) | 0.44 | 0.42 | 0.43 |
|  | (0.25) | (0.25) | (0.25) |
| X8e: 5yr mortality of person with hypertension, not treated with medication (hypothetical) | 0.56 | 0.56 | 0.56 |
|  | (0.26) | (0.26) | (0.26) |
| X8f: 5yr mortality of person with hypertension, treated with medication (hypothetical) | 0.38 | 0.36 | 0.37 |
|  | (0.22) | (0.22) | (0.22) |
| X8g: 5yr mortality of person with diabetes with medication (hypothetical) | 0.58 | 0.57 | 0.58 |
|  | (0.27) | (0.27) | (0.27) |
| X8f: 5yr mortality of person with diabetes, treated with medication (hypothetical) | 0.38 | 0.36 | 0.37 |
|  | (0.22) | (0.22) | (0.22) |

*Notes:* Responses in terms of "number of peanutes" converted to probabilities (with values between zero and one).

expectations is based on asking respondents to allocate up to ten peanuts on a plate to express the likelihood that an event will be realized. The MLSFH-MAC expectations module is introduced with the following text, and then several questions are asked about the respondent's perception that several events occur (Tables A18–A19). Summary statistics for all 2018 subjective expectations questions are reported in Table A20.

*Interviewer: Recount the number of peanuts and check that you have 10 peanuts in the plate. As you provide the explanation below, add the peanuts into the plate to illustrate what you say.*

I will ask you several questions about the chance or likelihood that certain events are going to happen. There are 10 peanuts in the cup. I would like you to choose some peanuts out of these 10 peanuts and put them in the plate to express what you think the likelihood or chance is of a specific event happening. One peanut represents one chance out of 10. If you do not put any peanuts in the plate, it means you are sure that the event will NOT happen. As you add peanuts, it means that you think the likelihood that the event happens increases. For example, if you put one or two peanuts, it means you think the event is not likely to happen but it is still possible. If you pick 5 peanuts, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick 6 bins, it means the event is slightly more likely to happen than not to happen. If you put 10 peanuts in the plate, it means you are sure the event will happen. There is not right or wrong answer, I just want to know what you think.

Let me give you an example. Imagine that we are playing Bawo. Say, when asked about the chance that you will win, you put 7 peanuts in the plate. This means that you believe you would win 7 out of 10 games on average if we play for a long time. If you think that you will win slightly more than 7 games but less than 8 games on average, then you can break the peanut in half and put 7 1/2 peanuts (7.5 peanuts) on the plate.

*Interviewer: Report for each question the number of peanuts put in the plate. After each question, replace the peanuts in the cup (unless otherwise noted).*

This question format has the advantage of being visual, relatively intuitive and fairly engaging for respondents, and can be designed to improve the consistency of answers. Prior to 2017, this expectations module was implemented using beans, and starting in 2017, the implementation was switched to peanuts. This change allowed respondents to split a peanut in half and allocated values between 2 peanuts (e.g., 5.5 peanuts, etc.). If a respondent puts "0" or "10" peanuts, the interviewer prompted this respond and recorded the final answer. The prompting is implemented only in this question in this module and serves the purpose to ensure that the respondent correctly understands the concept.

The mortality questions were designed to ensure that respondents provided answers that would allow us to construct well-defined survival curves. In particular, respondents were first asked to pick the number of beans that reflects how likely it is that they will die within a 5-year period beginning today. Then, with the peanuts of the previous question still on the plate, they were asked to *add* more beans to reflect how likely it is that they would die within a ten-year period. This ensured that respondents provided weakly increasing answers when the time horizon increased. These questions about perceived mortality risk are available since 2006, and Figure 5 reports the implied distribution of 5-year survival changes during 2006–18 for the MLSFH-MAC cohort, including a comparison to the respective survival risks based on current life-tables for Malawi.

Respondents reported a community-level mortality risk within five years of about 34%, and and own mortality risk of 38% (5 years) to 62% (10 years) (Table A20). Women are frequently more pessimistic than men about mortality. Respondents perceive a subjective probability of being infected with HIV of around

**Table A21: Data quality assessments for MLSFH-MAC subjective expectations**

| | N | Mean | P25 | P50 | P75 |
|---|---|---|---|---|---|
| **A. Probability of HIV infection (X2a), by self-reported likelihood of HIV infection (2017)** | | | | | |
| No likelihood | 848 | 0.10 | 0.00 | 0.00 | 0.10 |
| Low | 298 | 0.20 | 0.10 | 0.10 | 0.30 |
| Medium | 128 | 0.30 | 0.10 | 0.20 | 0.50 |
| High | 114 | 0.63 | 0.30 | 0.70 | 1.00 |
| Missing/Don't know | 204 | 0.20 | 0.00 | 0.10 | 0.40 |
| Total | 1592 | 0.19 | 0.00 | 0.10 | 0.30 |
| **B. Probability of HIV infection (X2a), by HIV status (2017)** | | | | | |
| HIV-negative | 1451 | 0.15 | 0.00 | 0.10 | 0.20 |
| HIV-positive | 133 | 0.58 | 0.20 | 0.50 | 1.00 |
| Total | 1584 | 0.19 | 0.00 | 0.10 | 0.30 |
| **C. Probability 5-year own mortality (X7a), by HIV status (2017)** | | | | | |
| HIV-negative | 1393 | 0.33 | 0.10 | 0.30 | 0.50 |
| HIV-positive | 131 | 0.38 | 0.10 | 0.40 | 0.50 |
| Total | 1524 | 0.33 | 0.10 | 0.30 | 0.50 |
| **D. Probability 5-year mortality healthy person (X8a), by HIV status (2017)** | | | | | |
| HIV-negative | 1393 | 0.31 | 0.10 | 0.30 | 0.50 |
| HIV-positive | 131 | 0.32 | 0.10 | 0.30 | 0.50 |
| Total | 1524 | 0.31 | 0.10 | 0.30 | 0.50 |
| **E. Probability of death during 2012–18, by subjective probability 5-year own mortality (X7a) measured in 2012** | | | | | |
| X7a (2012) $< .5$ | 392 | 0.09 | – | – | – |
| X7a (2012) $\geq .5$ | 860 | 0.13 | – | – | – |
| Total | 1252 | 0.12 | – | – | – |

20%, which is higher than the actual HIV prevalence in 2018 (8.3%). Individuals mortality perceptions about hypothetical persons correctly reflect the relationships between HIV infection, ART and mortality, reporting average 5-year mortality risks of 34%, 47%, 64% and 43% for hypothetical persons who are, respectively, healthy, infected with HIV, sick with AIDS, and sick with AIDS and treated with ART.

In addition to subjective mortality expectations and perceived risk of HIV infection, the MLSFH-MAC also collected mortality expectations for hypothetical persons affected by non-communicable diseases, such as hypertension and diabetes, in order to capture the mature adults' awareness of new diseases that are gaining importance as individuals age. For example, respondents reported a 56% 5-year mortality risk for a person with hypertension, reduced to 37% it is treated with medication. Very similar patterns are reported for persons affected with diabetes.

Response rates are typically very high; the vast majority of respondents respect in their answers basic properties of probabilities; expectations vary with characteristics in the same way, at least qualitatively, as actual outcomes vary with those characteristics; past outcomes experienced by individuals are correlated with expectations about future outcomes; and the elicited expectations influence behavior in various domains including health, education, agricultural production and mi-

gration.

The validity of the MLSFH and MLSFH-MAC expectations data has been studied extensively, and our prior analyses have concluded expectations vary with characteristics in the same way, at least qualitatively, as actual outcomes vary with those characteristics; past outcomes experienced by individuals are correlated with expectations about future outcomes; and the elicited expectations influence behavior in various domains including health, education, agricultural production and migration.[24,96] Table A21 lends further support to these conclusions by comparing subjective expectations to other measured outcomes in the MLSFH. Panel A illustrates the correspondence of subjective probabilities of HIV infection with the commonly asked verbal scale "In your opinion, what is the likelihood (chance) that you are infected with HIV/AIDS now?", documenting that respondents who provided a higher likelihood of being infected using the verbal scale were also more likely to state a higher subjective probability of HIV infection (X2a). The subjective probability of HIV infection is also significantly higher for respondents who are HIV-positive (Panel B); yet, it falls far short of certainty despite the fact that most HIV+ respondents have been informed about their HIV status during prior MLSFH-MAC HIV tests. Own mortality perceptions (X7a) are slightly higher for respondents who are HIV+ (Panel C), consistent with the fact that most HIV+ respondents are now on ART, and the mortality expectations of a hypothetical health person not infected with HIV (X8a) does not vary by respondents own HIV status (Panel D). Own mortality expectations (X7a) measured in 2012 are also weakly predictive of actual mortality during 2012–18, with 13% of respondents dying among those with 2012 mortality expectations of 50% or higher, while only 9% died during 2012–18 among respondents with a 2012 perceived mortality risk below 50%.

### A4.5. Household/family rosters in the MLSFH-MAC

In 2012 and 2017, MLSFH-MAC collected detailed information on households and family members of the mature adults implementing the module developed by the parent study. Specifically, the MLSFH-MAC household and family roster included not only all individuals who currently live in the household as frequently done in other studies, but it also asked information about all parents and children independent of their survival and resident status (Table A22), including selected demographic, socioeconomic characteristics and information about the household/family members health as known to/perceived by the respondent (Table A23). To improve the longitudinal linkage of individuals listed in the MLSFH-MAC household/family rosters, in 2012, the paper questionnaire was prefilled with information about spouses, parents and children who were listed on respondent's 2008–10 MLSFH household/family rosters, followed by prompts to list additional individuals who meet the inclusion criteria in Table A22. In 2017, when MLSFH-MAC data collection started to use RedCap, the household/family roster initially confirmed the accuracy, vital status and residence of respondent's children, spouses and parents who were listed in the 2012 household/family rosters, followed by various prompts to add additional individuals who meet the inclusion criteria in

**Table A22: Categories of individuals included in the MLSFH-MAC Household/family roster**

| Categories of individuals included in MLSFH-MAC Household/family roster |
| --- |

1. Respondent
2. Spouse(s) of respondent (if respondent is not currently married, most recently deceased or divorced spouse; for polygamous men, all wives are included)
3. Respondents parents (included even if parents are deceased)
4. Spouses parents (included even if parents are deceased; for polygamous men, parents of all wives are included)
5. All children of the respondent (children ever born, including children who are no longer alive or do not live in respondents household)
6. Other children who usually live in the respondent's household (including non-biological children, grandchildren, nieces & nephews)
7. Other persons who usually live in respondent's household

Table A22.

In addition, for all persons listed on the family/household roster, MLSFH-MAC asked questions where they usually live (same household, same compound, same village, same Traditional Authority (TA), same district, or in one of the big cities), their health status in the past 12 months, their current marital status, highest completed level of schooling, their main way of earning money (Table A23). For persons who were reported as having died during the previous two years on the MLSFH household/family roster, the MLSFH also asked more detailed information about when the death occurred, how old the person was when he/she died, the health prior to the dying, and the likelihood (as perceived by the respondent) that the death was due to AIDS.

For all persons listed on the MLSFH-MAC household/family roster who were above age 15 and alive at the time of the survey (or had died within less than two years prior to the survey), the MLSFH-MAC asked a set of questions about transfers given to and received from the respondent (Table A23). Since the quantitative measurement of transfers in contexts such as Malawi is inherently difficult, the MLSFH-MAC did not attempt to monetize the financial and non-financial transfers between respondents and their children or parents. Instead, for all alive parents and children above age 15, MLSFH-MAC respondents were asked a set of questions about financial and non-financial assistance during the last two years, including: (*i*) "*In the past two years, have you given [name] any money or financial assistance?*", with responses ranging from: 0 = no; 1 = yes, a little; 2 = yes, some; and 3 = yes, a lot; (*ii*) "*In the past two years, have you given [name] any non-financial help? This could include help that takes time like collecting firewood, cooking, taking care of people, or helping with farming.*", with responses ranging from 0 = no; 1 = yes, once; 2 = yes, several times a year; 3 = yes, at least once a month; 4 = yes, at least once a week; and 5 = Yes, daily; (*iii*) "*In the past two years, has [name] given you any money or financial assistance?*", with responses ranging from: 0 = no; 1 = yes, a little; 2 = yes, some;

**Table A23: Socioeconomic and health information reported by respondents for each individual included in the household/family roster (MLSFH-MAC 2017)**

Information about each person listed on the MLSFH-MAC household/family roster

**Individual characteristics:**
Q2      What is [name's] relationship to you?
Q3      Is [name] male or female?
Q4      Is [name] alive? If [name] is dead, when did he/she die?
        (*Note:* Questions Q5–15 were not asked for persons who had died)
Q5      How old is [name]? Or, in what year was [name] born?
Q6      Where does [name] usually live?
Q9      Has [name] been ill in the past 12 months? If yes, for how long?
Q10     How would you rate [name's] health in general?
Q12a    What is [name's] current marital status?
Q12b    Is [name] married to another household or family member?
Q13     What is the highest level of schooling [name] completed?
Q14     How many grades (in years) did [name] complete at that level?
Q15     If age > 10: What is [name's] main way of earning money?

**Financial and non-financial transfers:**
(only asked for family/household members aged 15+, or members who have died within two years of survey)
T1      In the past two years, have you given [name] any money or financial assistance? If YES, to you the money was...
T3      In the past two years, have you given [name] any non-financial help? This could include help that takes time like collecting firewood, cooking, taking care of people, or helping with farming? If YES, how often did you help [name]?
T4      What type of help did you give to [name]? List the two most important types of help
T6      In the past two years, has [name] given you any money or financial assistance? If YES, to you the money was...
T8      In the past two years, has [name] given you any nonfinancial help? This could include help that takes time like collecting firewood, cooking, taking care of people, or helping with farming. If YES, how often did [name] help you?
T9      What type of help did [name] give you? List the two most important types of help:
T12     Did [name] help you because you were in poor health?

**For deceased family/household members:**
MX4     How old was [name] when he/she died? If not sure, give approximate age.
MX8     Has [name] been sick prior to his/her death?
MX10    Do you think that [name] has died of AIDS, or was infected with HIV/AIDS when he/she died?

**Figure A5: Net financial/non-financial transfers from respondent to living adult children (LAC), MLSFH-MAC 2017**
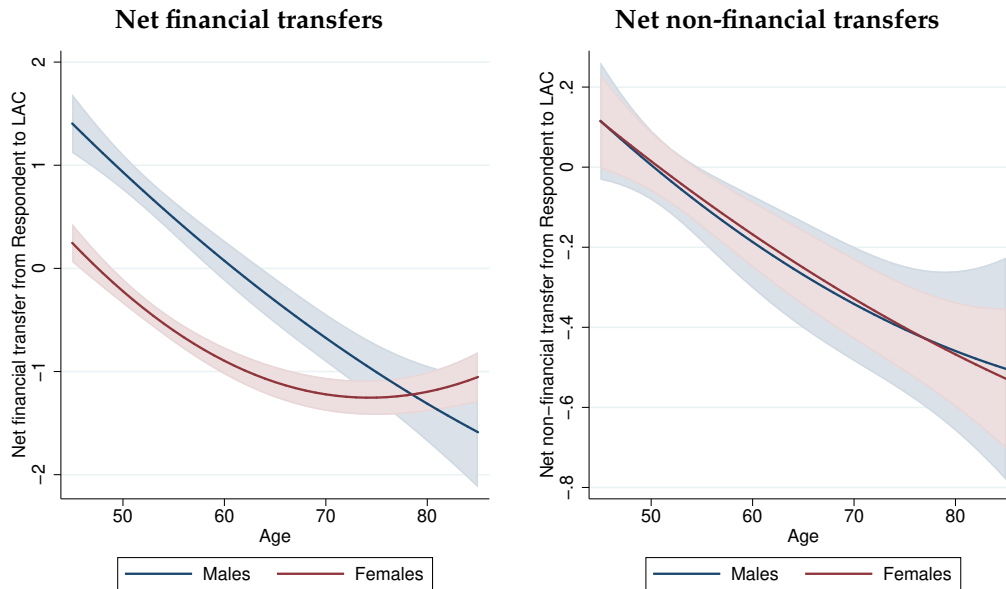


*Notes:* LAC = living adult children aged 15+. Net financial and non-financial transfers are calculated based on transfers given/received during 2-years prior to the 2017 MLSFH-MAC survey, following prior methods for aggregating MLSFH transfer rosters.[97] Specifically, to calculate net transfers, initially a *net financial transfer* is calculated for each living adult child (LAC) as follows: it equals one (1) if the respondent has given a substantial amount ("a lot") of financial assistance to a child, and received from this child no or only a little financial assistance in the last two years; it equals zero (0) if the respondent has given a substantial amount of financial assistance a child and has also received a substantial amount of financial assistance from this child; it equals also zero (0) if the respondent has given no or only little financial assistance and has also received little financial transfers, or if a respondent has no living adult children; finally, the variable equals minus one (-1) if the respondent has given no or only a little financial assistance, but has received a substantial amount of financial assistance from a child. Analogously, a *net non-financial transfer* is calculated using help that occurs monthly or weekly as a substantial transfer. To obtain the net financial/non-financial transfers of a respondent to all LAC, the respective net transfer variable is aggregated across all LAC. Positive values indicate a transfer from respondents to their children, and negative values indicate transfers from children to the respondents. The graphs depicts marginal means (with 95% confidence intervals) obtained by regressing the net financial (or non-financial transfer) on a quadratic function of age, separately by sex and controlling for schooling and region.

and 3 = yes, a lot; and (*iv*) "*In the past two years, has [name] given you any non-financial help? This could include help that takes time like collecting firewood, cooking, taking care of people, or helping with farming.*", with responses ranging from 0 = no; 1 = yes, once; 2 = yes, several times per year; 3 = yes, at least once a month; 4 = yes, at least once per week; and 5 = yes, daily.

These data provide insights into intergenerational relations in a low-income context where such data are rare.[97,98] Figure A5 for example shows that net financial and non-financial transfers to children decline rapidly for older respondents,

and are negative across most mature adult ages. Women above age 50 and men above age 60 are net recipients of financial transfers, and essentially all mature adults aged above the early 50s are recipients of non-financial transfers.

### A4.6. MLSFH-MAC Benefits of Knowledge (BenKnow) Study on Mortality Expectations

In 2017–18 the MLSFH-MAC implemented a study on mortality expectations, focusing in particular the determinants and implications of pessimistic subjective expectations about the probability of surviving. Details, analyses and key findings of this "*Benefits of Knowledge*" (BenKnow) study are elaborated elsewhere,[11] and in this section we provide information on aspects of the study design and implementation that are relevant for general analyses of the MLSFH-MAC data.

The motivation of this BenKnow study is related to the fact that, in contrast to the recent trends that have given rise to a cautiously-optimistic outlook about curtailing the consequences of the HIV/AIDS epidemic,[99] there is consistent evidence that mature adults in Malawi have distorted and overly-pessimistic survival expectations: they substantially *underestimate* their own survival probabilities (Figure 5).[11,24] This pessimism about survival is particularly widespread at younger mature adult ages, when life-table probabilities of survival are relatively high and where most of our sample is concentrated (Figure A6), and underestimation of survival becomes less common at older ages where objective survival risks are lower.

At the core of the BenKnow study was a intervention that provided age- and gender-specific information about mortality and survival to respondents, along with general information about changing mortality levels in Malawi. This Ben-Know intervention, described in more detail below, was implemented by a separate team within two weeks subsequent to the 2017 MLSFH-MAC Main Survey. Shortly after the BenKnow health-information intervention, a HIV Testing and Counseling (HTC) team visited the respondents in both the treatment and control group to administer a HIV testing and counseling sessions followed by a short survey.

The BenKnow intervention assigned 2017 MLSFH-MAC randomly to a treatment and a control group, with randomization occurring at the village-level to avoid spill-over effects between treatment and control group. Within each of the three study regions, villages were paired by size starting from the two biggest villages, followed by the two second biggest, etc. Then we randomly assigned treatment status to one village in each pair. The procedure guaranteed a similar sample size in the treatment group ($N = 779$) and control group ($N = 774$). The response rate for the BenKnow intervention was more than 98% (among 2017 survey respondents), resulting in 770 respondents enrolled in the treatment group. Table A24 reports summary statistics for the BenKnow analysis sample,[11] along with a comparison of key characteristics between the treatment and control groups.

The BenKnow health-information intervention started by reminding respondents about the 5-year and 10-year own mortality expectations that they reported in the 2017 MLSFH-MAC Main Survey, followed by introductory questions about whether respondent were aware of recent changes in mortality levels. About 45%

**Figure A6: 10-year survival probabilities 1970–2020 (Malawi), and subjective prob. of surviving 5 years for MLSFH-MAC respondents**

**(A) Subjective vs. lifetable survival probabilities, 2017 MLSFH-MAC respondents**
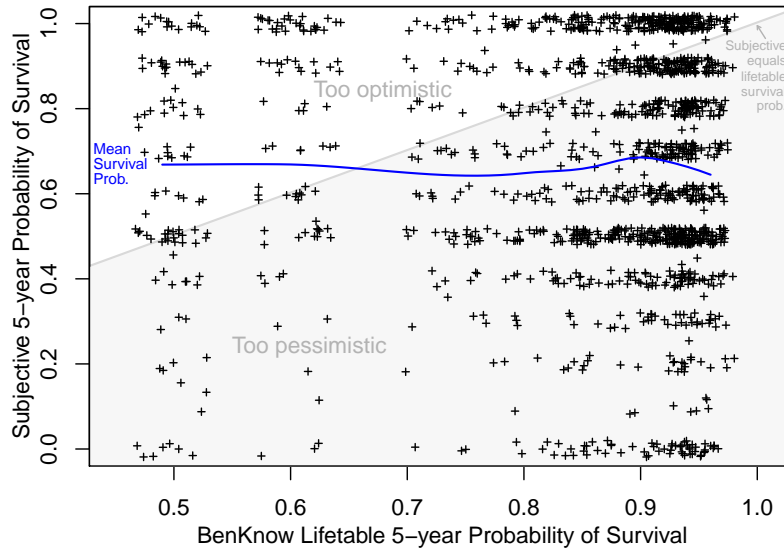


**(B) Proportion 2017 MLSFH-MAC respondents too pessimistic**
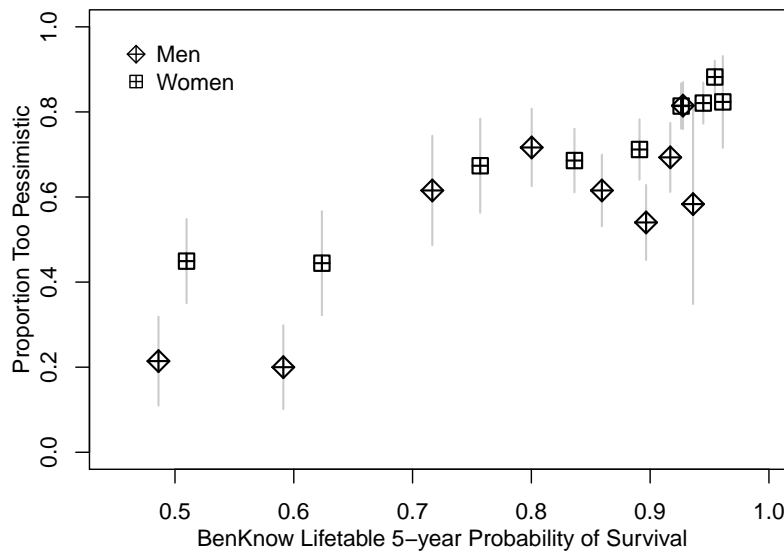


*Panel A:* 2017 Subjective 5-year survival probabilities vs. BenKnow (life-table based) 5-year survival probabilities (jitter added to separate markers): dots below the gray line indicate that respondents are too pessimistic regarding their survival (subj. survival < life-table survival probability). *Panel B:* Proportion of 2017 MLSFH-MAC respondents who are too pessimistic regarding their survival (with 90% confidence intervals) as a function of Benknow (life-table based) 5-year survival probabilities. In Panels A+B, younger mature adults tend to be towards the right (relatively high survival probs), while older mature adults are towards the left (relatively low survival probabilities).

**Table A24: Descriptive statistics by treatment status and p-value for difference**

|  | | | All | | | HIV- | | |
|---|---|---|---|---|---|---|---|---|
|  | Mean | Obs | Control | Treated | p-val | Control | Treated | p-val |
| Age | 59.1 | 1481 | 58.8 | 59.4 | .300 | 59.3 | 59.9 | .384 |
| Male % | 40.0 | 1481 | 40.0 | 40.0 | 1 | 40.5 | 39.3 | .653 |
| Married % | 73.4 | 1481 | 74.1 | 72.7 | .557 | 75.4 | 73.3 | .391 |
| Divorced % | 8.8 | 1481 | 7.9 | 9.7 | 0.222 | 7.0 | 9.2 | .148 |
| Widow % | 17.8 | 1481 | 18.0 | 17.6 | 0.821 | 17.6 | 17.5 | .958 |
| Years of schooling | 3.5 | 1481 | 3.5 | 3.6 | .547 | 3.5 | 3.6 | .694 |
| Cognitive score | 20.3 | 1481 | 20.2 | 20.4 | .415 | 20.2 | 20.3 | .651 |
| HIV+ % | 7.5 | 1442 | 6.3 | 8.7 | .088 | | | |
| **Expectations %** | | | | | | | | |
| Own survival (5 yrs) | 67.0 | 1410 | 66.9 | 67.0 | .964 | 67.3 | 67.7 | .763 |
| Own survival (10 yrs) | 44.1 | 1407 | 43.6 | 44.6 | .577 | 44.1 | 45.1 | .586 |
| Pop. survival (healthy) | 70.0 | 1444 | 70.7 | 69.4 | .321 | 71.0 | 69.9 | .399 |
| Pop. survival (HIV+) | 62.0 | 1439 | 63.1 | 60.9 | .093 | 63.7 | 61.6 | .123 |
| Pop. survival (AIDS) | 49.2 | 1439 | 50.2 | 48.1 | .212 | 50.9 | 48.7 | .195 |
| Pop. survival (ART) | 56.9 | 1439 | 57.7 | 56.1 | .266 | 58.4 | 56.6 | .275 |
| Pop survival (uncond) | 69.0 | 1463 | 68.8 | 69.2 | .746 | 69.0 | 69.2 | .859 |
| HIV probability | 18.6 | 1469 | 17.1 | 20.1 | .022 | 14.6 | 15.9 | .253 |
| HIV probability spouse | 18.2 | 1354 | 16.9 | 19.5 | .064 | 15.3 | 16.4 | .387 |
| **Sexual behavior %** | | | | | | | | |
| no sex | 35.5 | 1481 | 34.2 | 36.8 | .294 | 34.0 | 37.4 | .195 |
| single partner | 56.9 | 1481 | 57.6 | 56.2 | .583 | 57.9 | 56.4 | .586 |
| multiple partners, condom | 1.2 | 1481 | 1.5 | 1.0 | .366 | 1.0 | 0.6 | .405 |
| multiple partners, no condom | 6.3 | 1481 | 6.7 | 6.0 | .591 | 7.0 | 5.5 | .255 |

The table presents summary statistics for the main variables used in the empirical analysis for the whole sample and separately by treatment group and by HIV status. The variables refer to the 2017 MLSFH-MAC main survey. Control and treatment show the mean for the BenKnow control and the treatment groups. p-val shows the p-value of a t-test where the null hypothesis is that the difference in means between treatment and control group is zero. The first five coulmns refer to the whole sample while the last 3 refer to those tested negative for HIV during the HTC.

of respondents reported noticing that people lived longer than they did five or 10 years ago (Table B1), and among those, the most common reasons for these improvements were that AIDS treatment have become available nearby (44% of respondents) and that health services have improved (36%). The core of the Ben-Know intervention then consisted of the following two components, with the complete interviewer script and additional information provided in Section A5.4.

**Narratives about changing mortality provided by video clips:** Respondents were initially shown 3 video clips with a duration of about four minutes each. In these short video clips, individuals (trained local actors following a prepared script) explained how they noticed that people nowadays live longer in rural Malawi. The first video depicts a carpenter in his workshop, the second a female tailor in her shop sitting at a sewing machine and the third an old man sitting in front of his house. The videos emphasize overall that people live longer due to better access to food, health care, and availability of ART. Studies support that video narratives are a useful way to convey scientific information to non-experts by

**Table A25: Benknow life-table based probabilities of dying within 5-years and 10-years**

| | Benknow Probabilities of Dying | | | |
| | Men | | Women | |
| Age group | 5 years | 10 years | 5 years | 10 years |
|---|---|---|---|---|
| < 45 | 0.06 | 0.13 | 0.04 | 0.08 |
| 45-49 | 0.07 | 0.15 | 0.05 | 0.10 |
| 50-54 | 0.08 | 0.18 | 0.06 | 0.13 |
| 55-59 | 0.10 | 0.23 | 0.07 | 0.17 |
| 60-64 | 0.14 | 0.31 | 0.11 | 0.25 |
| 65-69 | 0.20 | 0.43 | 0.16 | 0.37 |
| 70-74 | 0.28 | 0.58 | 0.24 | 0.53 |
| 75-79 | 0.41 | 0.71 | 0.38 | 0.68 |
| 80+ | 0.51 | 0.76 | 0.49 | 0.74 |

*Notes* Mortality probabilities, by age group and gender, that were conveyed during the Benefits-of-Knowledge health-information intervention using information sheets as shown in Section A5.3. Lifetable datawas obtained from obtained the Global Burden of Disease Study 2016 (GBD 2016), available at http://ghdx.healthdata.org/gbd-results-tool.

increasing comprehension, interest, and engagement.

**Life-table survival probabilities conveyed via visual aids:** Subsequent to the videos, respondents were shown a health-information sheet with visual information on 5-year and 10-year life-table survival probabilities for individuals of the same gender and within the same 5 year age group, with different figures conveying how many persons, out of 10 alive at the time of the intervention, could be expected to be alive five or ten years in the future. Lifetable survival probabilities were obtained from the Global Burden of Disease Collaborative Network (http://ghdx.healthdata.org/gbd-results-tool.) A BenKnow health-information sheet is illustrated in Section A5.3, Table A25 reports the complete set of Ben-Know age- and gender-specific 5 and 10 year survival and death probabilities. The statistics purposely emphasized both the survival and mortality risk to avoid anchoring. While the videos conveyed a general narrative of improved survival, the life-table probabilities provide precise statistical information about survival risk.

### A4.7. Ego-centric social networks and NCD-related-conversation networks

Social network research has a long tradition in the MLSFH,[7] and in 2018, the MLSFH-MAC continued this tradition by implementing a new module on ego-centric social support networks and NCD-related-conversation networks. The aim of this social network module was to document social interactions about mental health and other NCDs, which are relatively new health concerns for mature adults in Malawi, and study how social interactions affect knowledge about mental health/NCDs and their determinants, and how social interactions can help mature adults in cop-

ing with potentially poor mental health/NCDs.

The name generators for these ego-centric social networks is provided in Table A26, covering initially specific conversation networks related to hypertension and depression & anxiety, that is, two domains for which the MLSFH-MAC has collected extensive data on all respondents, followed by conversation networks about general health. A general social network was elicited by asking about the persons whose house the respondents visits, and the network module concluded by prompting respondents to list individuals who might be most suitable for diffusing information pertaining to the health of mature adults.

For each person listed as part of this ego-centric social network module, the questionnaire also asked about age and gender, residence, schooling, relationship to respondent, frequency of interactions, village committee membership, and financial and non-financial help given to and received from the respondent.

Preliminary analyses of these MLSFH-MAC social networks data show that talking about hypertension is fairly common, both within and outside of the household.[100] The top panel of Table A27, for example, shows that roughly 1/3 of men and women talk about high blood pressure within their own households, most frequently with the spouse, followed by adult children who are a particularly relevant set of convesation partners for women. The bottom panel of Table A27 shows that 36% to 40% of men and women also discuss hypertension with members of their social networks outside of the household. These network partners are most commonly friends, with more men (39%) than women (33%) talking to close friends, siblings (15% and 12% respectively), other family members (18 to 20%) living outside of the household. Adult children living outside of the household are not a common conversation partner with whom elderly men and women are discussing high blood pressure, which is in a sharp contrast to the interactions with children within the own household.

Table A28 additionally shows that, overall, about 40% of respondents talk about issues related to hypertension with social network partners outside of their household, and that the majority of respondents has these conversations with individuals of the same sex (89%). About half of the social network partners are within the same village (57%), and 65% are younger than the respondents. The flow of information related to hypertension is more or less reciprocal: about 83% of respondents provide information about high blood pressure to their social network partners, and 83% of respondents stated that they received similar information from their alters, and there are no substantial differences in network composition depending on whether hypertension-related information is provided or received.

### *A4.8. MLSFH-MAC Qualitative Study on Mental Health and Aging*

In 2018, the MLSFH-MAC implemented a *Qualitative Study on Mental Health and Aging* to complement the MLSFH-MAC survey data with qualitative insights to aid the interpretation and contextualization of findings. The specific inclusion criteria for this 2018 qualitative study were as follows: *Mature Adults:* 60 individuals aged 45 and older who lived in the MLSFH study region, but have not been

**Table A26: Name generators for 2018 ego-centric social support networks and NCD-related-conversation networks in MLSFH-MAC**

Name generator for ego-centric network

SN1   In the last 12 months, with whom did you talk about issues related to hypertension among individuals living in your household? Check all that apply: (*i*) Spouse, (*ii*) Parents, (*iii*) Children/grandchildren, (*iv*) Siblings, (*v*) Co-wife, (*vi*) other relatives, (*vii*) other.

SN2   In the last 12 months, with whom did you talk about issues related to hypertension among individuals NOT living in your household? List up to 3 individuals, starting with the one with whom you talk about this most frequently.

SN3   Did NAME give you information about hypertension?

SN4   Did you give NAME information about hypertension?
  In the last 12 months, to how many additional persons (not mentioned above and not living in your household) did you talk about issues related to hypertension? Please provide a total number.

SN5   In the last 12 months, with whom did you talk about issues related to depression and anxiety among individuals living in your household? Check all that apply: (*i*) Spouse, (*ii*) Parents, (*iii*) Children/grandchildren, (*iv*) Siblings, (*v*) Co-wife, (*vi*) other relatives, (*vii*) other.

SN6   In the last 12 months, with whom did you talk about issues related to depression or anxiety among individuals NOT living in your household? List up to 3 individuals, starting with the one with whom you talk about this most frequently.

SN7   Did NAME give you information about depression and anxiety?

SN8   Did you give NAME information about depression and anxiety?
  In the last 12 months, to how many additional persons (not mentioned above and not living in your household) did you talk about issues related to depression or anxiety? Please provide a total number.

SN9   In the last 12 months, with whom did you talk about other issues related to your own health among individuals living in your household? Check all that apply: (*i*) Spouse, (*ii*) Parents, (*iii*) Children/grandchildren, (*iv*) Siblings, (*v*) Co-wife, (*vi*) other relatives, (*vii*) other.

SN10   In the last 12 months, with whom did you talk about other issues related to your own health among individuals NOT living in your household? List up to 3 individuals, starting with the one with whom you talk about this most frequently.

SN11   Which issues related to you own health did you discuss with NAME? Check all that apply: (*i*) Communicable disease (infections, malaria, tuberculosis, HIV; (*ii*) Nutritional deficiencies; (*iii*) Acute conditions (diarrhea, fever, flu, headaches, cough, other; (*iv*) Injury (not work related; (*v*) Surgery; (*vi*) Sleep problems; (*vii*) Occupation/work related condition/injury; (*viii*) Chronic pain in your joints/arthritis (joints, back, neck; (*ix*) Diabetes or related complications; (*x*) Problems with your heart including unexplained pain in chest; (*xi*) Problems with your mouth, teeth or swallowing; (*xii*) Problems with your breathing; (*xiii*) Stroke/sudden paralysis of one side of body; (*xiv*) Generalized pain (stomach, muscle or other nonspecific pain; (*xv*) Cancer; (*xvi*) Other.
  In the last 12 months, to how many additional persons (not mentioned above and not living in your household) did you talk about issues related to your own health? Please provide a total number.

SN13   In your free time, whose house do you visit? List up to 3 individuals, starting with those you see most frequently.

SN15   If we want to spread health related information relevant for individuals age 45 and older in your village, to whom do you suggest we speak? List up to 3 individuals, starting with the most important one.

**Table A27: Ego-centric social conversation networks about hypertension (MLSFH-MAC 2018)**

|                                                                | Male | Female |
|----------------------------------------------------------------|------|--------|
| **Conversations about hypertension within household (SN1)**    |      |        |
| Talked about hypertension with household members               | .36  | .33    |
| *Among respondents who talked with household members:*         |      |        |
| Respondent talked to:                                          |      |        |
| Spouse                                                         | .95  | .61    |
| Parents                                                        | .04  | .06    |
| Children                                                       | .18  | .50    |
| Siblings                                                       | .05  | .10    |
| **Conversations about hypertension with other social network partners** (not residing in respondent's household, SN2) |      |        |
| Talked about hypertension with others                          | .361 | .401   |
| *Among respondents who talked with others:*                    |      |        |
| Respondent talked to:                                          |      |        |
| Child                                                          | .030 | .078   |
| Parent                                                         | .038 | .099   |
| Sibling                                                        | .153 | .122   |
| Other family                                                   | .195 | .175   |
| Close friend                                                   | .394 | .330   |
| Distant friend                                                 | .071 | .100   |
| Other                                                          | .120 | .096   |

*Source:* Kohler et al.[100]

**Table A28: Characteristics of hypertension conversation network partners (SN2), overall and by information given or received (MLSFH-MAC 2018)**

|                        | Rate % | Same sex % | Younger % | Same village % |
|------------------------|--------|------------|-----------|----------------|
| Overall                | .386   | .890       | .652      | .570           |
| Give information to    | .831   | .892       | .660      | .572           |
| Receive information from | .825 | .891       | .655      | .561           |

*Source:* Kohler et al.[100]

selected for the MLSFH-MAC survey. *Village headmen:* 12 village headmen (4 per MLSFH region), randomly selected from the MLSFH study villages. *Members of village health committees:* 12 members of village health committees in selected MLSFH study villages (chair and one additional member in 2 villages per MLSFH region). *Health care providers:* 1 health care provider from the District Hospital in each of the 3 MLSFH study regions, and 2 health care providers from health care centers/facilities in each of the 3 MLSFH study regions that are most closely located to the MLSFH study villages. The study guides used by the qualitative interviewers for mature adults and for health workers, village health committee members, and village headmen is provided in Section A5.5.

### A4.9. Health Care Provider and Health Care Facility Data for MLSFH-MAC Study Areas

To complement MLSFH-MAC data on health-care utilization and access (Table 4), the MLSFH implemented in 2019 additional Health Care Provider Surveys and Health Care Facility Surveys, covering facilities and providers in the MLSFH-MAC study areas. Specifically, a MLSFH Health Care Facility Survey was conducted with respresentatives of all district hospitals serving the MLSFH-MAC study regions, and with all health care centers within an approximately 10km radius of the MLSFH-MAC study areas (that is, health care facilities that are most frequently utilized by the MLSFH-MAC respondents). This included 4 district hospitals, and 14 local government health centers, health posts, and dispensaries; 2 CHAM health centers; 2 private clinics. Topics of the survey cover characteristics and infrastructure of the health care facility, recent staff training courses, human resources at the facility, available health care services and their utilization, qualitative assessment about health conditions affecting the local community, availability of medications at facility, facility approach to dealing with the increasing prevalence of NCDs such as CVD and poor mental/cognitive health, and potential gaps or unmet needs in the local health care provision.

The MLSFH Health Care Provider Survey was conducted with Health Surveillance Assistants (HSAs) serving the MLSFH study areas, and up to three nurses and one doctor and/or clinician from the health care facilities serving the MLSFH study areas. A total of 108 Health Care Provider Surveys were collected in 2019. Topics of the survey cover characteristics of the villages served by health care provider, visits to communities and community relations, health service demand in communities provided, recent staff training courses, community activities and services provided in general and for some specific diseases (e.g., HIV/AIDS, CVD, diabetes, mental health), availability of medications and equipment, potential gaps or unmet needs in the local health care provision, and provider's workload, stress and job satisfaction.

### A4.10. Village Head Survey

In 2019, the MLSFH also implemented a Village Head Survey that provides additional information on the MLSFH-MAC study villages, including aspect such as:

general village characteristics (e.g., population size and growth, overall and by major age groups; local transportation; local marriage traditions; village committees; availability of electricity; local NGO representation and NGO-supported activities), village leadership and conflict resolution, land ownership and land sales/transfers, village development, village receipt of fertilizer subsidies, village migration, gender norms and child marriage, gender-based violence in village, changes in village conditions, village-level adverse shocks/events, and environmental changes and environmental pollution affecting the village community. Village Head surveys were collected in about 97 MLSFH-MAC study villages (30–35 per MLSFH-MAC study region), focusing on villages with the largest concentration of MLSFH respondents. In the case when the village head was absent during the fieldwork, the survey was conducted with his/her designated representative.

**A5. MLSFH-MAC: Selected Study Instruments**

### A5.1. MLSFH-MAC implementation of the International Cognitive Assessment (ICA) scale (2012–13 version)

# MLSFH-MAC International Cognitive Assessment (ICA) Questionnaire (2012/13)

## Section 2: Screening Questions

| | | |
|---|---|---|
| SCR1 | **Kodi mumamva zanzi, kuwotcha kapena kubayabaya kwa zanzi m'manja mwanu kapena dzala zanu?**<br>*Do you have numbness, burning or tingling feelings in your hands or fingers?* | Yes…………………..1<br>No……………..……..0 |
| SCR2 | **Kodi mumamva kupweteka mmanja mwanu kapena dzala zanu kosakhala chifukwa choti mwavulala posachedwa?**<br>*Do you have pain in your hands/fingers (not due to recent injury)?* | Yes…………………..1<br>No……………..……..0 |
| SCR3 | **Kodi ndikovuta kwa inu kuti mugwiritse ntchito manja anu monga kuwongola manja kapena kukunga chibakera?**<br>*Is it difficult for you to use your hands (e.g. straighten hands or make a fist)?*<br>**INTERVIEWER: Please demonstrate hand positions.** | Yes…………………..1<br>No……………..……..0 |
| SCR4 | **INTERVIEWER: Is respondent missing any fingers?** | Yes…………………..1<br>No……………..……..0 |
| SCR5 | **INTERVIEWER: Do the respondent's joints of the hands/fingers look enlarged or crooked like the photos of hands with arthritis?**<br>(Note: check pictures in training manual Appendix A) | Yes…………………..1<br>No……………..……..0 |
| SCR6 | **INTERVIEWER: Is respondent obviously blind?** | Yes…………………..1 → **SCR10**<br>No………………….......0 |
| SCR7 | **Kodi mumavutika kuwona?**<br>*Do you have difficulty seeing?* | Yes…………………..1<br>No………………....…..0 |
| SCR8 | **INTERVIEWER:** As you hold one finger directly in front of the respondent about one arm length from their face, ask the respondent:<br>**Kodi mukuona dzala zingati?**<br>*How many fingers do you see?* | Zero………………….0 → **SCR9**<br>One………………….....1 → **SCR9**<br>Two or more…………..2 |

| | | 1. Left eye covered: | 2. Right eye covered: |
|---|---|---|---|
| SCR8a | **Tsekani diso lanu lakumanzere. Kodi mukuona dzala zingati?**<br>*Please cover your left eye. How many fingers do you see?*<br>**Tsekani diso lanu lakumanja. Kodi mukuona dzala zingati?**<br>*Please cover your right eye. How many fingers do you see?* | Zero…………………..0<br>One…………………..1<br>Two or more………...2<br>Blind…………………3 | Zero………………..……0<br>One…………………..…1<br>Two or more…………..2<br>Blind…………………...3 |

| | | |
|---|---|---|
| SCR9 | **INTERVIEWER**: Demonstrate with the sample pictures on **card #0 SCR9.**<br>**Kadi lililonse lili ndi zithunzi ziwiri. Chithuzi chimozi chili ndi chilembo pakati, ndipo chinacho chilibe**<br>*Each card has two pictures. One picture has a figure in the center, and the other picture does not.*<br>**INTERVIEWER**: Show the respondent the vision screening cards (1-6), one pair at a time.<br>**Lozani chithunzi chimene chili ndi chilembo**<br>*Point to the picture with the figure in it.*<br>**INTERVIEWER**: Repeat this for each card. If correct, circle the number of the card below. | Total number correct………. [_____] |

| Card | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Correct response | Bottom | Top | Top | Bottom | Top | Bottom |

| | | |
|---|---|---|
| SCR10 | **Kodi mumavutika kumva? Mwachisanzo pamene akubanja kwanu/ anzanu akamakulankhulisani, kapena pamene mwana wapafupi nanu akulira, kapena kumva zinyama?**<br>*Do you have trouble hearing? For example, when family/friends talk to you, when a baby is crying, or when hearing animals?* | Yes…………………..1<br>No……………..……..0 |
| SCR11 | **Kodi dzanja limene mumagwilisira ntchito kwambiri ndi liti? Mwachisanzo dzanja lomwe mumagwilisa ntchito kugwira mpeni mukama dula nyama kapena masamba pokonza chakudya, kapena pozimeta.**<br>*Which is your dominant hand? For example, which hand do you use to hold a knife when cutting meat or vegetables to prepare food, or shaving yourself.* | Right hand………….…........……….....1<br>Left hand…………………….......………2<br>Both hands equally dominant…………3 |

## Section 3: Language and Orientation

**INTERVIEWER: If respondent is obviously blind, do not administer. Go to question ICA_L3.**

**Tsopano ndikuwonetsani zithunzi.**
*Now I will show you some pictures.*

| | |
|---|---|
| **ICA_L1** **INTERVIEWER**: Show respondent **card #7** (**ICA_L1**). Point to each picture on the card and say: **Ndiuzeni dzina laichi** *Tell me the name of this.* | <table><tr><td></td><td></td><td>Incorrect</td><td>Correct</td></tr><tr><td>a)</td><td>**Nsapato** shoe</td><td>..0..</td><td>..1</td></tr><tr><td>b)</td><td>**Nthochi** banana</td><td>..0..</td><td>..1</td></tr><tr><td>c)</td><td>**Njoka** snake</td><td>..0..</td><td>..1</td></tr></table> |

| | | | |
|---|---|---|---|
| **ICA_L2** **INTERVIEWER**: Show respondent **card #8** (**ICA_L2**) **Yang'anani zithunzi zakuda ndi zoyera zozungulira ndi zamakona anayi. Ndikupemphani kuti muzigwire chimodzimodzi ndi momwe nditakuwuzireni** *Look at these black and white circles and squares. I want you to touch them exactly as I tell you to.* **INTERVIEWER**: Then slowly and clearly read aloud (one at a time) each of the sentences on the right side of the page. If the respondent asks for the command to be repeated, you may repeat the command **ONE TIME** only. | | Incorrect | Correct | Correct w/ Repetition |

| | Incorrect | Correct | Correct w/ Repetition |
|---|---|---|---|
| a) **Gwirani chizindikiro choyera, chozungulira ndipo chaching'ono** *Touch the small white circle*....0 | | 1 | 2 |
| b) **Gwirani chizindikiro chamakona anayi chimene chili pakati pa zizindikiro zozungulira** *Touch the square in between the circles*....0 | | 1 | 2 |
| c) **Poyamba gwirani chizindikiro chachikulu, chakuda ndipo chamakona anayi kenako kachizindikiro kamakona anayi koyera komanso kakang'ono.** *Touch first the large black square, then the smaller white square*....0 | | 1 | 2 |

| | |
|---|---|
| **ICA_L3** **Ndikuwerengarani chiganizo. Ndikamaliza ndikupemphani kuti mubwereze chimodzimodzi ndi momwe ndiwerengere.** *I am going to read a sentence. When I finish, repeat it after me, <u>exactly</u> as I say it.* **INTERVIEWER:** Read the sentence aloud slowly and clearly. If necessary, you may repeat the sentence **<u>ONE TIME</u>**. **"Mwana akuthamangitsa mbuzi"** *"The child is chasing the goat."* ☐ **Kumbukirani chiganizochi chifukwa ndizakupemphani kuti muchinenenso kanthawi kena.** (INTERVIEWER: Make sure you place a check mark in the box) Remember this sentence for later because I will ask you to recall it later. | Incorrect....0 Correct ....1 Correct with repetition...2 |
| **ICA_O1** **Kodi mtsogoleri wadziko lino pakali pano ndani?** *Who is the President of Malawi now?* | Incorrect....0 Correct... ....1 |
| **ICA_O2** **Nyengo ino ndi nyengo yanji?** *What season is it?* | Incorrect....0 Correct ....1 |

## Section 4: Visual/Constructional

**ICA_VC1**  **INTERVIEWER**: If respondent is obviously blind, do not administer. Go to **SECTION 5, QUESTION ICA_M1.**

**INTERVIEWER**: Point to the sample item on **card #9 ICA_VC1.**

**Muli dontho limodzi muchithunzi chamakona anayi chomwe chili pansipa ndi madontho angapo muchithunzi chamakona anayi chomwe chilipamwambapa. Lodzani dontho muchithunzi chamakona anayi chimene chilipamwambapa lomwe lilipamalo <u>ofanana</u> ndi dontho lomwe liri muchithunzi chapansichi.**
*There is one dot in the bottom square and several dots in the top square. Point to the dot in the top square that is in the <u>SAME</u> location as the dot in the bottom square.*

**INTERVIEWER:** If the respondent points to the correct dot say, **Ncholondola** *(That is correct).* If the respondent makes an error or is unable to identify the correct dot, point to the correct dot and say, **Dontho lomwe liri pamalo ofanana ndi dontho lomwe liri muchithunzi chapansipa chamakona anayi. Madontho ena awiri Sali olondola chifukwa lina liri kutali kumbali yamanzere ndipo lili mmwamba kwambiri kuchokera pansi, ndipo dontho lina liri kutali mbali yakumanja ndipo liri mmwamba kwambiri kuchokera pansi.**
*This dot is in the same location as the dot in the bottom square. The other two dots are not correct because one is too far on the left and too high from the bottom, and the other one is too far on the right and too high from the bottom.*

**INTERVIEWER:** Administer the following two questions for Figures A and B.
**Muli dontho limodzi muchithunzi chamakona anayi chomwe chili pansipa ndi madontho angapo muchithunzi chamakona anayi chomwe chilipamwambapa. Lodzani dontho muchithunzi chamakona anayi chimene chilipamwambapa lomwe lilipamalo <u>ofanana</u> ndi dontho lomwe liri muchithunzi chapansichi.**
*There is one dot in the bottom square and several dots in the top square. Point to the dot in the top square that is in the <u>SAME</u> location as the dot in the bottom.*

**INTERVIEWER**: Do **NOT** identify the correct dot after the respondent makes his/her choice.

                        **Incorrect    Correct**
a)    Figure A………..0……………1
b)    Figure B………..0……………1

---

**ICA_VC2**  **INTERVIEWER**: Provide the respondent with a pencil. Point to the first figure below.
**Jambulani chithunzi ndipo muyetsetse kuti chifanane ndi chithunzi ichi m'malo omwe mwapatsidwa pansipa**
*Draw the same figure as accurately as you can in the space below.*

**INTERVIEWER**: If the respondent is not accustomed to using a pencil, then instruct him/her to draw the figure with their finger/stick in the dirt/sand. Repeat instructions for the second figure.

**FIGURE A**                              **FIGURE B**

| | |
|---|---|
| **ICA_VC2**<br>(continued) | After both figures have been drawn, say:<br>**Chonde kumbukirani zithunzizi chifukwa mupemphedwanso kuti mujambule nthawi ina osawonera.**<br>**(INTERVIEWER: Please mark a check in the box)**<br>*Please remember these figures because I will ask you to draw them later from memory.* ☐<br><br>**INTERVIEWER:** If the respondent cannot use a pencil, then have him/her draw the figures in the dirt. Copy their drawing in the space above and mark "On the ground" in **ICA_VC3,** and then erase the figures by smoothing the dirt/sand.<br><br>**Figure A Scoring Criteria**<br>All lines are drawn<br>No extra lines are added<br>The circle should be to the left of the diamond, shape is round and closed, an oval shape is acceptable<br>The diamond shape has four corners and is in the correct orientation<br>**The two figures overlap**<br><br>**Figure B Scoring Criteria**<br>All lines are drawn<br>No extra lines are added<br>The drawing is a square or rectangle<br>The arrow bisects 2 corners of the square<br>The arrow points above the upper right corner of the square<br><br>                          **Incorrect    Correct**<br>a)   Figure A…………..0…………..1<br>b)   Figure B…………..0…………..1 | |
| **ICA_VC3**  **INTERVIEWER: Where did the respondent draw the figures?** | On the ground………………….……0<br>On the paper………………………..1 |

## Section 5: Memory

**Awa ndi mayeso okhuzana ndikukumbukira, ndikuwerengerani mndandanda wa mawu, ndikamaliza kuwerenga mawuwa kuchokera pamndandandawu, mundiwuze mawu amene mungakumbukire m'mene mungathere mndandanda wa momwe mungawa tchulire mawuwa ulibe tchito.**
*"This is a memory test. I am going to read a list of words. After I read all the words from the list, tell me as many words as you can remember. The order you say them does not matter."*

**INTERVIEWER**: Read aloud the list of the five words below at a rate of one word per second. For each word correctly recalled, write a 1 in the box below. For each word incorrectly recalled, write a 0 in the box below. At the end of the trial, count the number of words correctly recalled in **trial 1** and enter in **ICA_M1f**. After the respondent has told you all the words he/she can remember, say:

**Ndikuwerengerani mndandanda omwe wuja wamau, yesani kukumbukira ndipo munditchulire mawuwa m'mene mungathere. Yesesani kutchura onse omwe mukukumbukira, ngakhale mawu omwe munatchura poyambirira paja. mndandanda wa momwe mungawa tchulire mawuwa ulibe tchito.**
*"I am going to read the same list of words. Try to remember and tell me as many words as you can. Make sure you say all the words you remember, even words that you said the first time. The order does not matter."*

**INTERVIEWER**: For each word correctly recalled, write a 1 in the box below. For each word incorrectly recalled, write a 0 in the box below. At the end of the trial, count the number of words correctly recalled in **trial 2** and enter in **ICA_M1f**.

| **Scoring** | **ICA_M1** | **ICA_M1a** | **ICA_M1b** | **ICA_M1c** | **ICA_M1d** | **ICA_M1e** | **ICA_M1f** |
|---|---|---|---|---|---|---|---|
| | | **Mwezi**<br>Moon | **Basiketi**<br>Basket | **Chobiriwira**<br>Green | **Dzanja**<br>Hand | **Mayi**<br>Mother | **TOTAL** |
| **Incorrect = 0** | **Trial 1** | | | | | | |
| **Correct = 1** | **Trial 2** | | | | | | |

**Yesetsani kukumbukira mawuwa chifukwa ndikufunsaninso kuti muwakumbukire pamapeto pama yesowa (INTERVIEWER: Please mark a check in the box.)**
*"Try to remember these words because I will ask you to recall them again at the end of the test."*  ☐

## Section 6: Attention/Working Memory

| | |
|---|---|
| **ICA_AM1 Ndikutchulirani mundandanda wa manambala, mubwereze kutchura manambalawa <u>chimodzimodzi</u> m'mene atchulidwire.**<br>*I am going to read some numbers. When I finish, repeat the numbers in the <u>SAME</u> order.*<br>**INTERVIEWER**: Read numbers at the rate of one number per second. **Do NOT** repeat numbers.<br>**5 – 1 – 3 – 6 – 2** | Incorrect..........0<br>Correct............1 |

| | |
|---|---|
| **ICA_AM2 Ndikutchulirani mndandanda wamanambala, mubwerenze kutchura manambalawa motembenuza, kapena kuti <u>chobwerela m'mbuyo</u>. Mwachitsanzo, ndikanena kuti 7-3, inu muziti 3-7.**<br>*I am going to read some numbers. When I finish, repeat the numbers to me backwards, that is, in <u>reverse</u> order. For example, if I say 7-3, you would say [pause] 3-7.*<br>**INTERVIEWER**: Read numbers at the rate of one number per second. **Do NOT** repeat the numbers.<br>**4 – 6 – 1**  (<u>Note</u>: correct response is 1 – 6 – 4) | Incorrect..........0<br>Correct............1 |

**ICA_AM3 Ndikutchurilani mndandanda wa manambala. Nthawi iliyonse yomwe ndingatchure kuti 2, muziwomba m'manja kamodzi, musaombe m'manja ndikatchura nambala ina iliyonse kupataula 2.**
*I am going to read a list of numbers. Every time I say the number TWO (2), clap your hands once. Do NOT clap for any other numbers.*
**INTERVIEWER**: Read numbers at the rate of one per second. Mark **all** numbers at which the respondent claps.

7 1 **2** 4 1 7 **2 2** 5 3 6 1 **2** 6 **2** 3 3 4 **2 2 2** 5 **2** 6 1 3 **2 2** 5 4

All number "2"s are circled or 1 error..........1
Two or more errors.....................................0

## **Section 7: Executive Functions**

| | |
|---|---|
| **ICA_E1** | INTERVIEWER**: If respondent is obviously blind, do not administer. Go to question ICA_E2.** |
| | **Ndikuwonetsani chala chimodzi kapena zala ziwiri. Ndikakuwonesani chala chimodzi, ombani m'manja kamodzi, ndikakuwonetsani zala ziwiri musawombe m'manja.** |
| | *I am going to show you one or two fingers.  If I show one finger, you clap your hands once.  If I show two fingers, you should not clap.* |
| | **INTERVIEWER**: To ensure that the respondent understands the task, demonstrate the task 2 times and have the respondent respond. When it is clear that the respondent understands the task, show him/her the number of fingers as in the sequence below (e.g., 2 fingers, 1 finger, 2 fingers, etc). **Please mark <u>all</u> numbers at which the respondent claps.** |
| | **INTERVIEWER**: **Do NOT** say the numbers out loud. |

<p align="center" style="font-size:2em"><b>2 1 2 1 1 2 1 2 1 2 2 2 1 2 1 1 2 1 1 1</b></p>

| | |
|---|---|
| | **INTERVIEWER**:   An error occurs when the respondent does not clap when you present one finger. An error occurs when the respondent claps when you show two fingers. |

<div align="center">

No errors or one error…………………………..0
Two or more errors…………………….…………1

</div>

| | |
|---|---|
| **ICA_E2** | **Ndiwuzeni nyama zosiyana siyana zochuluka m'mmene mungathere mwachangu m'ene mungazitchulire kufikira nditakuwuzani kuti musiye.** *Tell me as many different animals as you can as quickly as you can say them, until I tell you to stop.* <br><br> **INTERVIEWER**: Set timer for 1 minute. <br><br> **Yambani** *Start!* <br><br> **INTERVIEWER**: Write down the respondent's answers in the space below. Stop respondent at 1 minute. Only count each animal once. | Total number of animals……. [_____] |

| | | |
|---|---|---|
| **ICA_E3a** | **INTERVIEWER**: If respondent is obviously blind, do not administer. Go to question **ICA_D1.** <br> **Welengani kuyambira 1 mpaka 7.** <br> *Please count aloud from 1 to 7.* | Incorrect………0 → **ICA_E4** <br> Correct ……….1 |
| **ICA_E3b** | **Kodi mukhoza kuzindikira manambala kuyambira 1 mpakana 7?** <br> *Can you recognize the numbers from 1 to 7?* | Yes…………….1 <br> No……………...0 → **ICA_E4** |

| **ICA_E3c** | **Apa pali zithunzi zozungulira zakuda ndi zoyera zomwe ziri ndi manambala mkati mwawo.  Ndikufuna inu kuti mulumikize zithunzi zozungulira pogwiritsa ntchito pensulo mu ndondomeko yake kuchokera kuchoyera kupita kuchakuda. Muchokere kuchozungulira choyera chomwe chili ndi wani (1)  kupita kuchozungulira chakuda chomwe  chili 2. Ndipo mupitiliza kufikira nambala yomaliza. Muyambire apa (Mulodzereni wayankhayo pomwe pali 1) ndipo lumikizani nambala mundondomeko posemphanisa zozungulira zoyera ndi zakuda.** <br> *Here are black and white circles with numbers in them. I want you to use the pencil to connect the circles in order by going from white to black. Go from the white circle with 1 to the black circle with 2 and so on until you reach the last number. Begin here* **(INTERVIEWER: point to white circle with "1")** *and connect the numbers in order, alternating white and black circles.* <br><br> **INTERVIEWER: Do NOT** correct if the respondent makes an error. Do not allow respondent to erase errors. If the respondent corrects an error – it is still scored as incorrect. | Incorrect……….0 <br> Correct………...1 |
|---|---|---|

| | |
|---|---|
| **ICA_E4** | **INTERVIEWER**: Verify from SCR11 on pg. 8 which is the respondent's dominant hand (_____hand). ***Copy the opposite hand into the spaces below and record in ICA_E4a***. If response was "both hands equally", then ask respondent to use his left hand and copy "left" into the space below. Demonstrate the three hand positions.<br>    **1)** Clench hand to make a fist on a flat surface<br>    **2)** Put hand on flat surface with palm down<br>    **3)** Put hand perpendicular with fifth digit (little finger) on flat surface.<br>**Gwirlitsani tchito mkono wanu _____ kuti mubwelenze zomwe ndakuwonetsani zija kawri**<br>*Please use your _____ hand and copy the demonstrated hand positions two times.*<br>**INTERVIEWER**: Set timer for 10 seconds.<br>**Tsopano gwiritsani ntchito mkono wanu wa _____ kuti mupange zomwe ndakuwonetsani zija mmene mungathere**<br>*Please now perform the demonstrated hand positions with your _____ hand as many times as you can.*<br>(Note: For a flat surface, use a table, the ground, or clipboard. Every time the respondent does the correct <u>sequence</u>, make a tallymark/slash (\|\|\|) in the space below. |

| | |
|---|---|
| Total number of correct sequences……..[____] | |
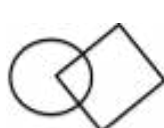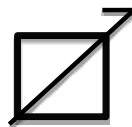
**ICA_E4a**

Which hand did respondent use?

Left …………………..1
Right…………….…....2

---

**ICA_E5**   **PRACTICE TEST:**

**INTERVIEWER**: Show **sample card #10 (ICA_E5)**. Point to the two items in the top row of the sample card and ask: **Izi ndizofanana chifukwa zonse ndi? (***These are all alike because they are all what?)*

**INTERVIEWER:** If respondent is not able to recognize a picture, the interviewer should provide the name of the picture (for both the sample and test items).

**INTERVIEWER**: If the respondent responds correctly (fruit), say:
**Inde mukulondola zonsezi ndizipatso.** (*Yes, that is correct. They are all fruit.)*

**INTERVIEWER**: If the respondent does not respond or gives an incorrect answer, explain:
**Izi ndizofanana chifukwa zonse ndi zipaso.  Yang'anani zithunzi izi zomwe zili pansi ndipo lodzani chithunzi chimene chili mugulu lazithunzi zimene zili pamwambapa**
*They are all alike because they are all fruit. Look at the pictures in the lower row and point to the one that goes with the pictures above.*

**INTERVIEWER**: If the respondent points to the correct answer (mango), say:
**Inde mukulondola chifukwa ndichipatso.** (*Yes, that is correct because it is a fruit)*

**INTERVIEWER**: If the respondent makes an error by picking a picture other than the fruit or is not sure of the correct answer, point to the mango and say:
**Ili ndi bango ndichipatsonso. Ndichimodzi mwazipatso zili pamwambapa**
*This is a mango, it is also a fruit. So it goes with the fruit category.*

---

**TEST:**

**INTERVIEWER**: First, show the respondent **card #11 (ICA_E5a)**, by pointing and say:
**Zithunzi zonse zili pamwambapa zimagwira ntchito imodzi, sankhani chithunzi chimodzi kuchokera pazithunzi pansiapa chimene chili mgulu limodzi ndi zithunzi zomwe zili pamwambapa**
*All of the pictures on the top are alike in some way, pick the one picture from below that goes with the items above.*

INTERVIEWER**: Do not provide any additional help or correct the respondent's answers. Show the respondent card #12 ICA_E5b and repeat the test.**

         a)  Incorrect………………0   b)  Incorrect…………….0
             Correct.………………1       Correct……………...1

## Section 8: Memory Delayed Recall

| | | |
|---|---|---|
| **ICA_D1** | **Mbuyomu ndinakuwuzani kuti muzikumbukira chiganizo chinachake.Tsopano mundibwelezele chiganizo chija**<br>*Earlier, I told you to remember a sentence. Can you please repeat this sentence?*<br><br>**INTERVIEWER**: The correct response is **Mwana akuthamangitsa mbuzi** (*"The child is chasing the goat"*). **Do NOT** say the sentence to the respondent. Record response below. Response is correct if close to the original sentence. It is correct if the respondent provides the main idea or basic meaning of the sentence. For example, responses like "**The goat was chased by the child**" or "**Children chased the goats**" are correct.<br><br>**Record response:**_____ | Incorrect.........0<br>Correct...........1 |
| **ICA_D2** | **INTERVIEWER**: If respondent is obviously blind, do not administer. Go to question **ICA_D3a.**<br>INTERVIEWER: Give the respondent a pencil and say:<br>**Kumbukirani munajambula mowonera zithunzi ziwiri m'mbuyomu, zomwe ndinakupemphani kuti muzizikumbukira. Tsopano muzijambulenso zithunzi ziwiri zija munsimu.**<br>*You copied two figures earlier, which I asked you to remember. Draw both figures below.*<br><br>INTERVIEWER: If the respondent first drew the figure on sand/dirt, then instruct him/her to draw it again with their finger/stick in the dirt/sand. If the respondent draws the figures in the dirt, copy their drawing in the space above, and then erase the figures by smoothing the dirt/sand. | |

> Both figures wrong............ 0
> Only Figure A correct........ 1
> Only Figure B correct........ 2
> Both figures correct .......... 3

| | | |
|---|---|---|
| **ICA_D2**<br>**(continued)** | **Figure A Scoring Criteria**<br>All lines are drawn<br>No extra lines are added<br>The circle should be to the left of the diamond, shape is round and closed, an oval shape is acceptable<br>The diamond shape has four corners and is in the correct orientation<br>**The two figures overlap**<br><br>**Figure B Scoring Criteria**<br>All lines are drawn<br>No extra lines are added<br>The drawing is a square or rectangle<br>The arrow bisects 2 corners of the square<br>The arrow points above the upper right corner of the square | **A**<br><br><br>**B** |
| **ICA_D2c** | **INTERVIEWER**: Show respondent **card #13 (ICA_D2c).**<br>**Ndichiti mwazithunzi izi mukuganiza kuti ndichomwe ndinakupemphani kuti muzichikumbukira? Lodzani chomwe mwachikumbukira.**<br>*Which of these figures do you think was the one that I asked you to remember? Point to the one that you recognize.* | Incorrect.........................0<br>Correct...........................1 |
| **ICA_D2d** | **INTERVIEWER**: Show respondent **card #14 (ICA_D2d).**<br>**Ndichiti mwazithunzi izi mukuganiza kuti ndichomwe ndinakupemphani kuti muzichikumbukira? Lodzani chommwe mwachikumbukira.**<br>*Which of these figures do you think was the one that I asked you to remember? Point to the one that you recognize.* | Incorrect............................0<br>Correct...........................1 |

**ICA_D3a**  **Ndinawerenga mndandanda wamawu m'mbuyomu amene ndinakupemphani kuti muziwakumbukira, nditchulireni mawu amene mukuwakumbukira m'mene mungathere.**
*I read a list of words to you earlier, which I asked you to remember. Tell me as many of those words as you can remember.*
**INTERVIEWER**: Record if the word was recalled or not. Prompt if the respondent remembers any more words. If not, then go to question ICA_D3b for the words that have not been recalled. It does not matter what order the words are recalled.

| ICA_D3a | ICA_D3a1 | ICA_D3a2 | ICA_D3a3 | ICA_D3a4 | ICA_D3a5 |
|---|---|---|---|---|---|
| | **Mwezi** Moon | **Basiketi** Basket | **Chobiriwira** Green | **Dzanja** Hand | **Mayi** Mother |
| *Not recalled = 0 Correct = 1* | | | | | |

**ICA_D3b**  **INTERVIEWER**: For words that were scored as "0" in ICA_D3a, ask:
**Mwa mawu awa ndi ati amene mukuganiza kuti anali pa mndandanda wa mawu amene ndinakuwuzani kuti muziwakumbukira, anali (tchurani mau amene ali mubokosimo)?**
*Which of the following words do you think was on the list I asked you to remember,* was it (read list the words in the box)?
**INTERVIEWER**: Correct words are underlined.

| ICA_D3b | ICA_D3b1 | ICA_D3b2 | ICA_D3b3 | ICA_D3b4 | ICA_D3b5 |
|---|---|---|---|---|---|
| | **Nyenyezi** (star) **Dzuwa** (sun) **Mwezi** (moon) | **Kapu** (cup) **Basiketi** (basket) **Bakuli** (bowl) | **Choyera** (white) **Chobiriwira**(green) **Chofiira** (red) | **Chala** (finger) **Diso** (eye) **Dzanja** (hand) | **Mayi** (mother) **Chewali** (sister) **Bambo** (father) |
| *Incorrect = 0 Correct = 1* | | | | | |

## Card 0 (SCR12)

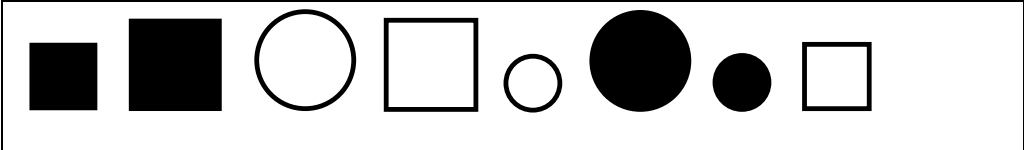## SAMPLE ITEM
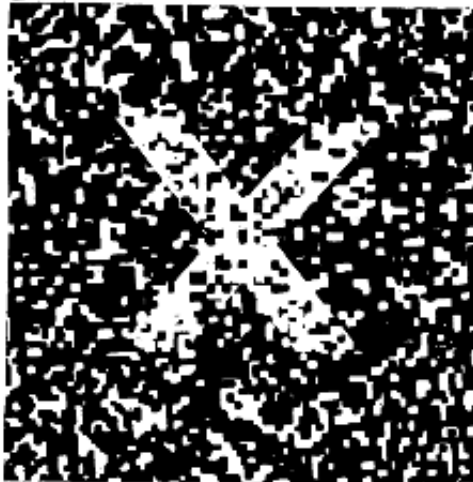
**Card 1**
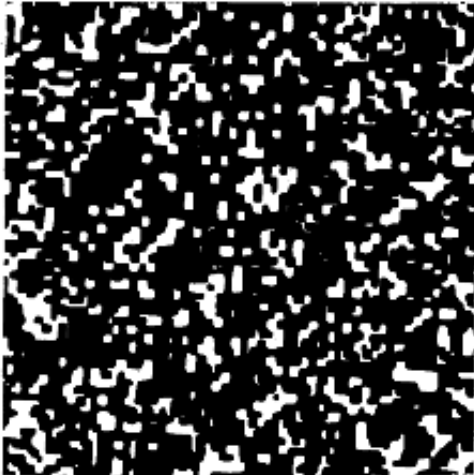
## Card 2
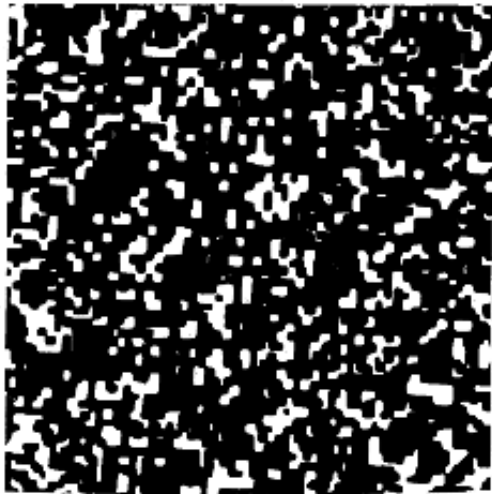
**Card 3**

## Card 4
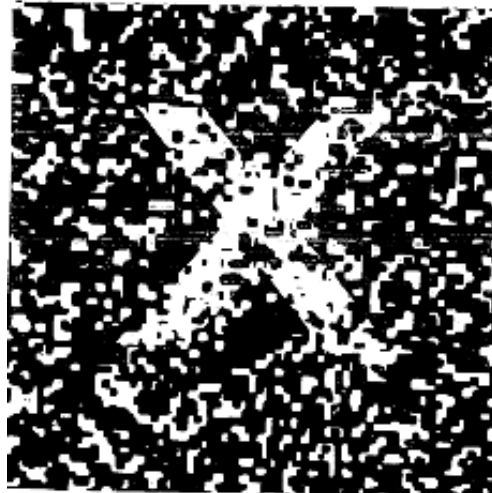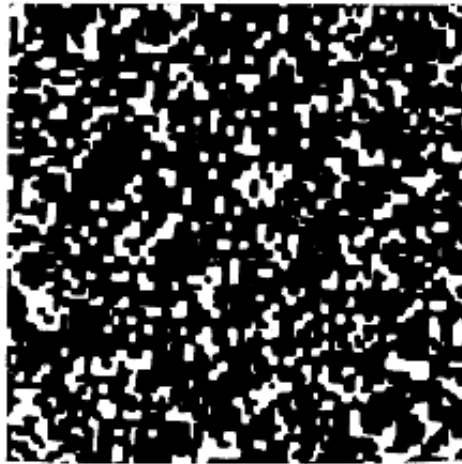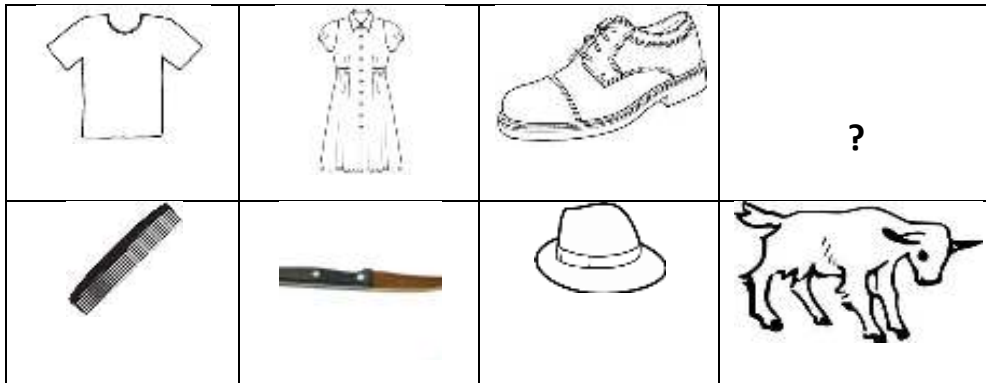
## Card 5
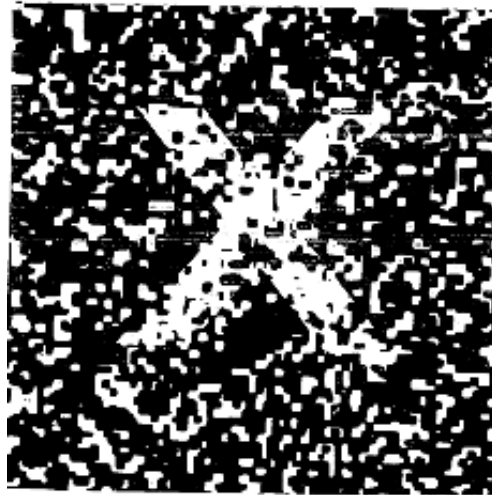
## Card 6
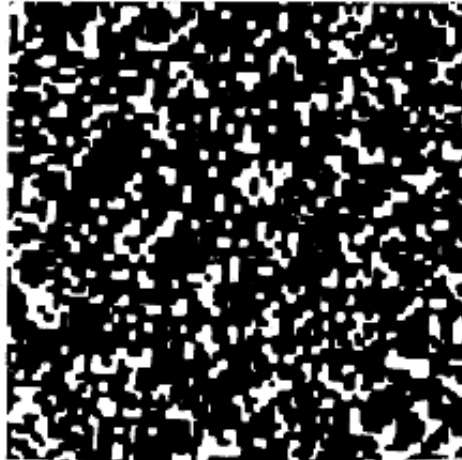
# Card 7 (ICA_L1)
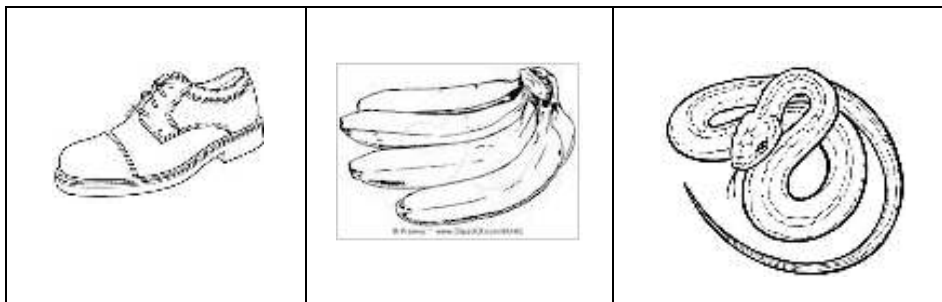
## Card 8 (ICA_L2)

**Card 9 (ICA_VC1)**

Sample

Figure A

Figure B
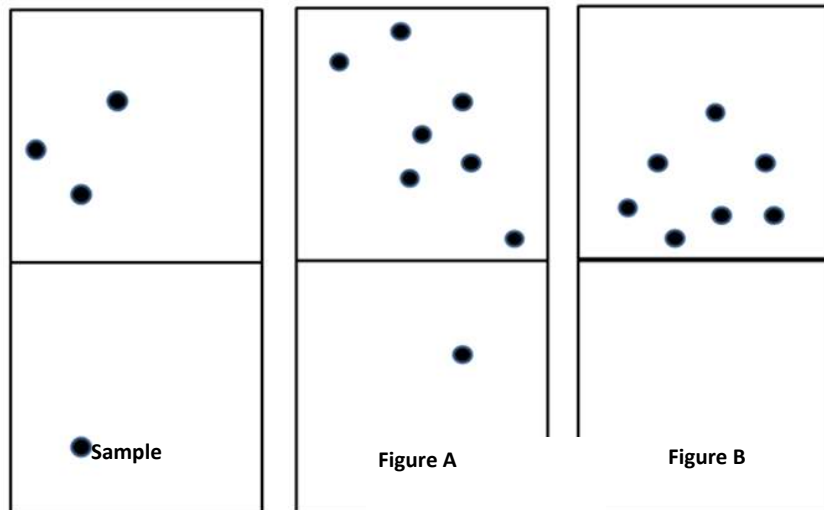
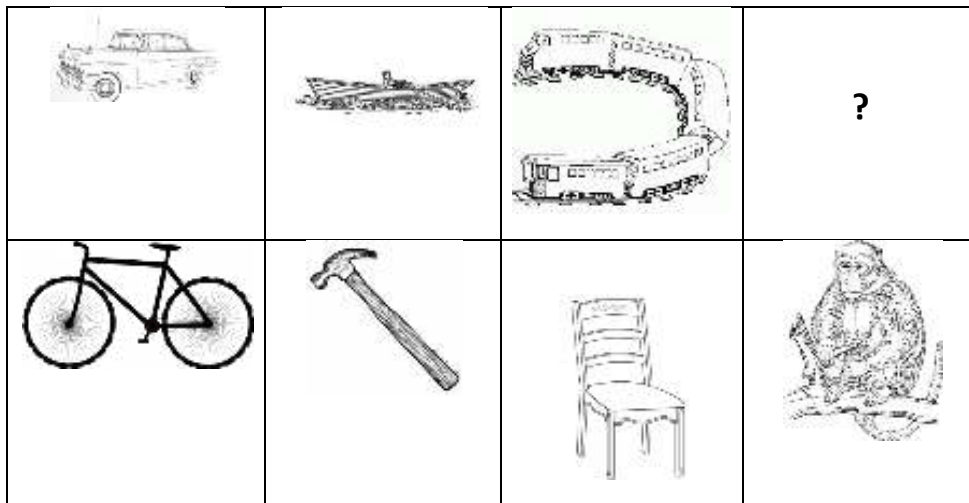## Card 10 (ICA_EC5)

**Example**
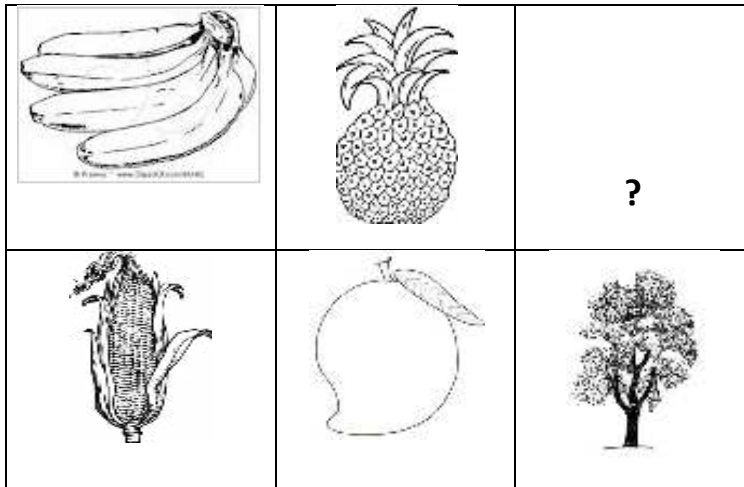
## Card 11
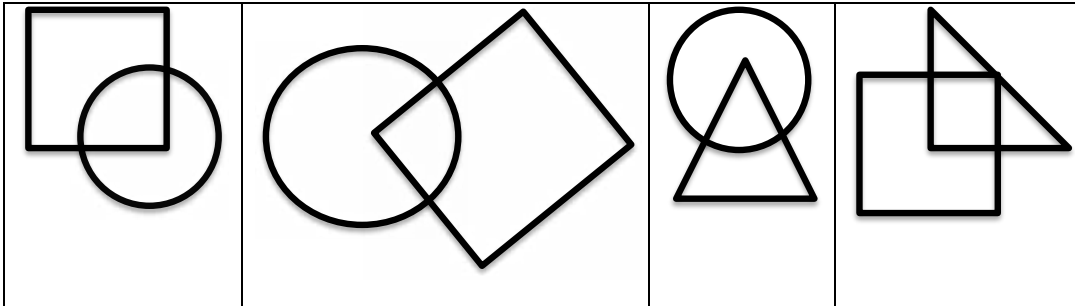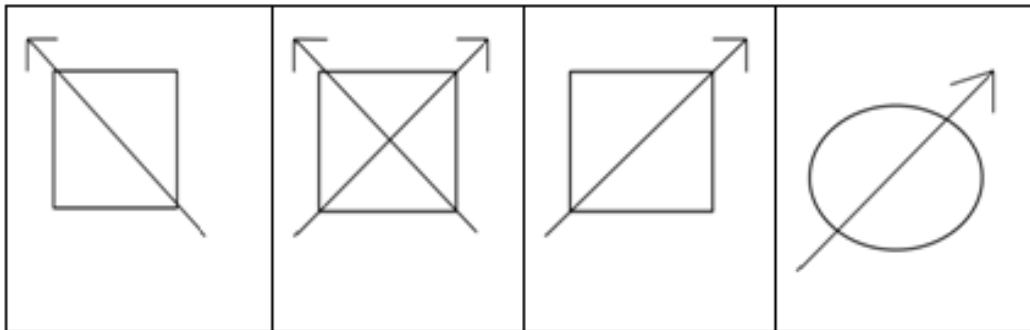
### ICA_E5a

## Card 12

## ICA_E5b

## Card 13 (ICA_D2c)

## Card 14 (ICA_D2d)

### A5.2. MLSFH-MAC ICA modification for 2017 onwards

The MLSFH-MAC ICA scale was modified for the 2017 and subsequent MLSFH-MAC data collection by expanding the word-recall questions (ICA Questions M1, D3a, D3b) from five to 10 words. The modified questions for the MLSFH-MAC data collections since 2017 are provided below; all other questions of the MLSFH-MAC ICA scale are continued from 2012/13 (see Section A5.1).

**2017 MLSFH-MAC Cognitive Health Module: Changes as compared to 2012/13 MLSFH-MAC**

### <u>Section 5: Memory</u>

**Awa ndi mayeso okhudza kukumbukira. Ndikuwerengerani mndandanda wa mawu. Ndikamaliza kuwerenga mndandanda wa mawuwa, ndikupemphani kuti munditchulire m'mene mungathere mawu amene mungakumbukire. Mndondomeko wa momwe mungawatchulire mawuwa ulibe tchito.**
*"This is a memory test. I am going to read a list of words. After I read all the words from the list, tell me as many words as you can remember. The order you say them does not matter."*

**INTERVIEWER**: Read aloud the list of the ten words below at a rate of one word per second. For each word correctly recalled, write a 1 in the box below. For each word incorrectly recalled, write a 0 in the box below. At the end of the trial, count the number of words correctly recalled in **trial 1** and enter in **ICA_M1k**. After the respondent has told you all the words he/she can remember, say:

**Ndiwerenganso mndandanda wa mawu omwe aja, yesani kukumbukira ndipo munditchulire mawuwa m'mene mungathere. Yesesani kutchula mawu onse omwe mukukumbukira, ngakhale mawu omwe munatchula kale poyamba paja. Mndondomeko wa momwe mungawatchulire mawuwa ulibe tchito.**
*"I am going to read the same list of words. Try to remember and tell me as many words as you can. Make sure you say all the words you remember, even words that you said the first time. The order does not matter."*

**INTERVIEWER**: For each word correctly recalled, write a 1 in the box below. For each word incorrectly recalled, write a 0 in the box below.

| Scoring | ICA_M1 | ICA_M1a | ICA_M1b | ICA_M1c | ICA_M1d | ICA_M1e | ICA_M1f | ICA_M1g | ICA_M1h | ICA_M1i | ICA_M1j | ICA_M1k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Mwezi** Moon | **Basiketi** Basket | **Chobiriwira** Green | **Dzanja** Hand | **Mayi** Mother | **Mtsinje** River | **Dotolo/ dokotala** Doctor | **Njinga** Bicycle | **Nkhuku** Chicken | **Mpunga** Rice | **TOTAL** |
| **Incorrect = 0** | **Trial 1** | | | | | | | | | | | |
| **Correct = 1** | **Trial 2** | | | | | | | | | | | |

**Yesetsani kukumbukira mawuwa chifukwa ndikufunsaninso kuti muwakumbukire pamapeto pamayesowa (INTERVIEWER: Please mark a check in the box.)**
*"Try to remember these words because I will ask you to recall them again at the end of the test."* ☐

## Section 8: Memory Delayed Recall

**ICA_D3a**   **Ndinawerenga mndandanda wamawu m'mbuyomu amene ndinakupemphani kuti muwakumbukire, nditchulireni m'mene mujngathere mawu amene mukuwakumbukira.**
*I read a list of words to you earlier, which I asked you to remember. Tell me as many of those words as you can remember.*
**INTERVIEWER**: Record if the word was recalled or not. Prompt if the respondent remembers any more words. If not, then go to question ICA_D3b for the words that have not been recalled. It does not matter what order the words are recalled.

| ICA_D3a | ICA_D3a1 | ICA_D3a2 | ICA_D3a3 | ICA_D3a4 | ICA_D3a5 | ICA_D3a6 | ICA_D3a7 | ICA_D3a8 | ICA_D3a9 | ICA_D3a10 | ICA_D3a11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | **Mwezi** Moon | **Basiketi** Basket | **Chobiriwira** Green | **Dzanja** Hand | **Mayi** Mother | **Mtsinje** River | **Dotolo/ dokotala** Doctor | **Njinga** Bicycle | **Nkhuku** Chicken | **Mpunga** Rice | **TOTAL** |
| *Not recalled = 0 Correct = 1* | | | | | | | | | | | |

**ICA_D3b**   **INTERVIEWER**: For words that were scored as "0" in ICA_D3a, ask:
**Mwa mawu awa ndi ati amene mukuganiza kuti anali pa mndandanda wa mawu amene ndinakuwuzani kuti muwakumbukire, anali (tchurani mau amene ali mubokosimo)?**
*Which of the following words do you think was on the list I asked you to remember,* was it **(read the list of the words in the box)**?
**INTERVIEWER**: Correct words are underlined.

| ICA_D3 b | ICA_D3b1 | ICA_D3b2 | ICA_D3b3 | ICA_D3b4 | ICA_D3b5 | ICA_D3b6 | ICA_D3b7 | ICA_D3b8 | ICA_D3b9 | ICA_D3b10 |
|---|---|---|---|---|---|---|---|---|---|---|
|  | **Nyenyezi** (star) | **Kapu** (cup) | **Choyera** (white) | **Chala** (finger) | **Mayi** (mother) | **Nyaja** (lake) | **Dotolo/ dokotala** (doctor) | **Njinga** (bicycle) | **Nkhanga** (guineafowl) | **Mpunga** (rice) |
|  | **Dzuwa** (sun) | **Basiketi** (basket) | **Chobiriwira** (green) | **Diso** (eye) | **Chemwali** (sister) | **Mtsinje** (river) | **Namwino** (nurse) | **Galimoto** (car) | **Nkhunda** (pigeon) | **Nsima** (Nsima) |
|  | **Mwezi** (moon) | **Bakuli** (bowl) | **Chofiira** (red) | **Dzanja** (hand) | **Bambo** (father) | **Chitsime** (well) | **Mzamba** (midwife) | **Mthuthuthu** (motorbike) | **Nkhuku** (chicken) | **Nyemba** (beans) |
| *Incorrect = 0 Correct = 1* | | | | | | | | | | |

### A5.3. Example of BenKnow Health-Information Sheet

The following are two examples of the health-information sheets that were used to convey age- and gender-specific mortality and survival information to respondents during the MLSFH-MAC BenKnow study

## Man Aged 45 to 49 Years Old
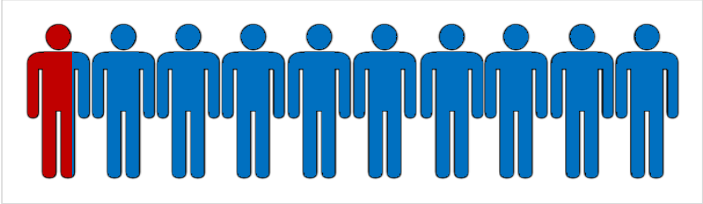### Mwamuna wa zaka zapakati pa 45 ndi 49 zakubadwa

### Today/Lero
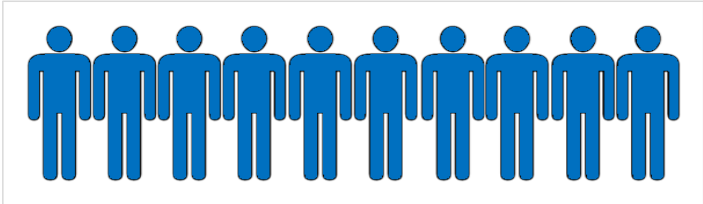


10 persons your age and sex alive today

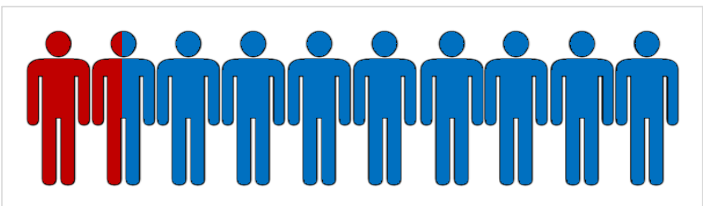**Anthu 10 aamuna ndipo a zaka ngati inu amene ali moyo lero**

## 5 Years from today/Zaka 5 kuchokera lero



Less than 1 person will have DIED

**Munthu ochepera mmodzi adzakhala ATAMWALIRA**

More than 9 persons will still be ALIVE

**Anthu oposera 9 adzakhala adakali MOYO**

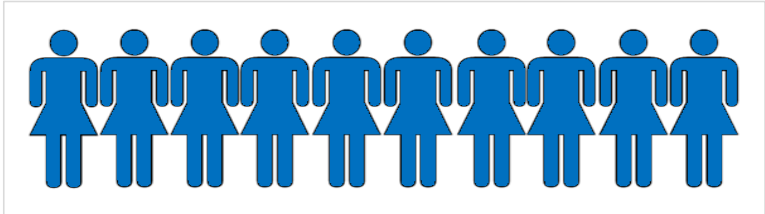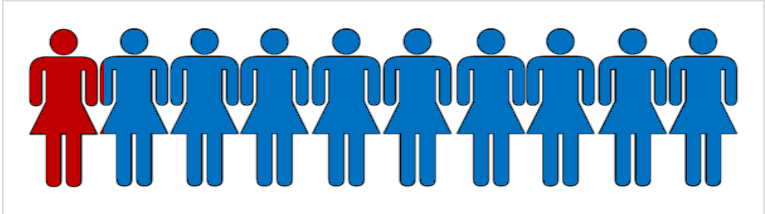## 10 Years from today/Zaka 10 kuchokera lero



Between 1 and 2 persons will have DIED

**Pakati pa munthu mmodzi kapena awiri adzakhala ATAMWALIRA**

Between 8 and 9 persons will still be ALIVE

**Pakati pa anthu 8 kapena 9 adzakhala adakali MOYO**

## Woman Aged 60 to 64 Years Old
### Mkazi wa zaka zapakati pa 60 ndi 64 zakubadwa

### Today/Lero



10 persons your age and sex alive today

**Anthu 10 aakazi ndipo a zaka ngati inu amene ali moyo lero**

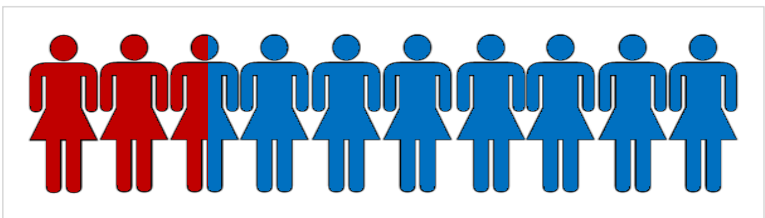### 5 Years from today/Zaka 5 kuchokera lero



Approximately 1 person will have DIED

**Pafupifupi munthu mmodzi adzakhala ATAMWALIRA**

Approximately 9 persons will still be ALIVE

**Pafupifupi anthu 9 adzakhala akadali MOYO**

### 10 Years from today/Zaka 10 kuchokera lero



Between 2 to 3 persons will have DIED

**Pakati pa anthu awiri kapena atatu adzakhala ATAMWALIRA**

About 7 to 8 persons will still be ALIVE

**Pakati pa anthu 7 kapena 8 adzakhala akadali MOYO**

### A5.4. BenKnow Video Scripts

The BenKnow videos featured the following text:

**Introduction:** I would like to show you a video showing that people in Malawi are living longer nowadays than 5 or 10 years ago. These videos have been recorded by actors and the information in these videos is consistent with recent health and mortality trends in Malawi.

**Video 1 – Davie the carpenter):** A middle-aged man, working it his carpenters shop, talks: Hi, my name is Davie and I have a bit of land where I grow maize. I also know how to work with wood. I am lucky because both my parents are still alive. They are both in their 70ies and are doing well. They are taking care of themselves: they have enough food, they are in good health and they dont need to go often to the hospital and they actively participate in village activities. They also teach important things about life to me and my children. They knew that they could live longer than their parents and with the little they were earning they bought some livestock to support themselves in their old days. My brothers and I also help them sometimes. My aunties and uncle also died very old. They were more than 65. And I see a lot of other families in our village with old family members that are still alive. My grand-parents were not so lucky and they were dead when they were my age. Yes, I really notice that people are living longer nowadays. And it is a good thing for everyone.

**Video 2 (Story 2 – Rose):** A middle-aged woman, working in her tailoring shop , talks: Hi, my name is Rose. I work in the field to plant cassava. When I have time, I do a bit of tailoring. I am married and I have four children who also help me in the field. The younger two go to school if they do not help at home. Five years ago, my husband got tested for HIV and he found out that he was HIV-positive. This was really a shock, and I was worried about the future of the family. How could we manage if my husband died soon? However, we have been lucky because my husband has had access to antiretroviral treatment (ART) in the local clinic. He takes his medicine regularly as the doctor explained him and I make sure he does not forget. He also often goes to the clinic for refill and check-ups. He looks really healthy and fit and does not show any sign of the disease. We do not know what will happen but we are very grateful for the availability of treatment. Ten years ago, my brother had HIV and he became very sick very quickly and died rapidly. Nowadays, there is more hope for people with HIV thanks to the availability of treatment. They can expect a longer life.

**Video 2 – Rose:** A middle-aged woman, working in her tailoring shop , talks: Hi, my name is Rose. I work in the field to plant cassava. When I have time, I do a bit of tailoring. I am married and I have four children who also help me in the field. The younger two go to school if they do not help at home. Five years ago, my husband got tested for HIV and he found out that he was HIV-positive. This was really a shock, and I was worried about the future of the family. How could we manage if my husband died soon? However, we have been lucky because my husband has had access to antiretroviral treatment (ART) in the local clinic. He takes his medicine regularly as the doctor explained him and I make sure he does not forget.

He also often goes to the clinic for refill and check-ups. He looks really healthy and fit and does not show any sign of the disease. We do not know what will happen but we are very grateful for the availability of treatment. Ten years ago, my brother had HIV and he became very sick very quickly and died rapidly. Nowadays, there is more hope for people with HIV thanks to the availability of treatment. They can expect a longer life.

**Video 3 – Old man:** An old man seating at home: I am lucky because I am more than 60 years old and I am still alive and feel healthy. I am not the only luck one. My neighbor next door is more than 70. And think about the popular musician Giddes Chalamanda. He is over 85 years old, and is still performing for the people. Last year, he even made is long-held dream of going to America come true, giving several shows across the USA. My parents were not so lucky because they died when they were in their 40ies. I think things are better nowadays. The kids, they do not die so frequently anymore. They get their immunization and many sleep under bed nets. They do not get sick so often. The adults, they do not die from HIV so rapidly anymore. The treatments, they really help. Also, people are not so hungry anymore and they eat more. When I was a kid, we were often hungry. My children and grand-children, they have almost always their meal on the table. It helps to build your health and keep you strong and prevent you from being unwell. Yes, things have changed quite a lot and people are less sick and live longer.

*A5.5. Study Guides for MLSFH-MAC Qualitative Study on Mental Health and Aging*

*A5.5.a. Study Guide for Mature Adults:*
1. What is your definition of a mature person?
2. What has been your experience as a mature person?
3. What changes have you noticed in your life as a mature person and how have they affected you?
4. What is the most difficult part of being a mature person?
5. What fears do you experience of being a mature person?
6. What are some of the things you appreciate about being a mature person?
7. How has your economic status/ situation changed by being a mature person?
8. Do you have enough to meet all your economic needs?
9. What is your greatest expenditure?
10. Are you able to provide economic support to other family members?
11. To what extent are you financially dependent on financial support from others?
12. How have your social networks/ encounters changed as a mature person?
13. How do you see the relationship between you and the community as a mature person?
14. What are you now able to do in the community that you were unable to do before? What are you no longer able to do that you were able to do?
15. Have you experienced any stigma as a mature person?
16. What has your health been like?
17. Do you worry about HIV/AIDS?
18. Do you think you are at risk of HIV infection? Why or why not?
19. Are you satisfied with the way your life is now? Elaborate
20. Are you happy with the conditions of your life right now? Explain
21. What is one thing you might want to change about your life if you could?
22. What are some of the things that sadden you?
23. What makes you anxious?
24. What has occupied your thinking over the past several weeks?
25. What is a traumatic or very painful experience you underwent within the past two years? How did you cope with it?
26. How has your sleeping been?
27. How is your appetite? Tell us about your eating habits?
28. May you describe your daily energy levels?
29. Have you ever thought of ending your life? Tell us more
30. How do you cope with stress? What do you do to manage life challenges?
31. Do you experience pain? If yes, how does it affect your daily life?

32. Who do you go to first when you are ill?
33. What health conditions do you take to the hospital?
34. How are you treated in the health care facilities? How satisfied are you with medical providers? Do you feel they address your needs?

*A5.5.b. Study Guide for Health Workers, Village Health Committee Members, and Village Headmen*

1. What is your definition of a mature person?
2. From your work as health care provider, what has been your experience of mature persons?
3. What do you imagine is the most difficult part of being a mature person in your community?
4. What fears do you think mature persons experience?
5. What are some of the things that are appreciated about mature persons in your community?
6. What is the contribution of mature people to your community?
7. How do you see the relationship between you as health worker and the mature in your community?
8. Are you aware of mature persons experiencing any stigma in your community? If so, tell us more.
9. What do you know of the common health challenges they experience?
10. What do you think are the common mental health challenges they experience?
11. What are some of the things that sadden them?
12. What makes them anxious?
13. What do you know of their sleeping, appetite and energy levels?
14. How are mature persons treated by health care workers?
15. Do you feel you have the capacity to help mature persons with their health needs? What do you need to be able to service the mature persons?
16. Do you feel you have the capacity to help mature persons with their mental health needs? What do you need to be able to service the mature persons?
17. What changes have you noticed in the way your community treats mature persons?
18. Tell us a success story of a mature person you have encountered. (include this question with the chiefs as well)

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