Gender Gap in Health Outcomes Among the Rural Working Age Individuals: Does Weather Effects Play a Role?

by Emily Injete Amondo

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Abstract:

The effects of weather variability and climate change on health are negative and not gender neutral. This study first assesses the total and direct effects of weather variability on illness and work days lost among men and women. Second, it evaluates the extent to which water collection 'time burden' mediate the relationship between weather variability and illness. Third, it investigates gender differential factors that explain the gender gap in illness, including differences in access to healthcare. Two-parts and nonlinear decomposition models were utilized in the different estimations, on a national representative dataset for Uganda. Results revealed that low rainfall below the long-term mean significantly increased the likelihood of illness and work days lost by 8 and 6 percentage points in women and men respectively. The indirect effect of low rainfall on illness through the water collection pathway was estimated at 0.2 and 0.04 percentage points in women and men respectively. Additionally, time spent on water collection fully mediated the relationship between negative rain and illness in women, and partially in men. Domestic rain water harvesting significantly reduced water time burdens and illness, whereas health care services reduced sick days and work days lost, and further accounted for a substantial magnitude to the total explained gender gap on days of illness. Therefore, strategies that promote health adaptation, water harvesting and women empowerment are recommended.

Keywords, Water collection time, water scarcity, health behaviors, extreme weather events, women health, Uganda

JEL codes: J16, I120, Q540

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1 Introduction

Health and gender equality are both fundamental human rights enshrined in the sustainable development goals, with synergies between them. While health is recognized as an asset that fosters economic growth and development (Bloom et al., 2019; Gallup & Sachs, 2001; Schultz, 2010). Gender equality is not only a key determinant of health (Commission on Social Determinants of Health, 2008; King et al., 2018; Shannon et al., 2019a), but also facilitates economic growth and development (Shannon et al., 2019a; World Bank, 2011), improved nutrition and food security (Agarwal, 2018; Meinzen-Dick et al., 2012), lowers fertility and child mortality (Shannon et al., 2019a). At the intersection of gender and health is access to safe and sufficient water which is also a fundamental human right (World Health Organization & United Nations Children's Fund, 2017). In developing counties, lack of access to sufficient and safe water is among the three most important factors for poor health (Geere et al., 2010), yet an estimated 400 million people in sub-Saharan Africa (SAA) have limited access to basic drinking water (Mason et al., 2019; United Nations Children's Fund & World Health Organization, 2019). The proportion of people facing water insecurity is further projected to increase in the near future due to climate change (The United Nations World Water Development Report, 2021; United Nations Children's Fund, 2021), translating to more health risks and adverse economic consequences in the future.

Weather events and changing climatic conditions plays a significant role as "a gender-based health inequality risk-multiplier" exacerbating the already existing gender differentials in health risks (Sorensen et al., 2018; van Daalen et al., 2020; World Health Organization, 2014). Therefore, in understanding the complex linkages between weather or climate events and gender differentiated health outcomes, it's important to first highlight the general pathways through which gender and associated inequalities are translated into health risks. These pathways include; differential susceptibility and exposures to injuries, diseases and disabilities (Shannon et al., 2019b; Vlassoff, 2007). Besides, differences in health behaviors and response of health systems to gender in terms of health care, financing and division of labor(Gupta et al., 2019; Manandhar et al., 2018; Shannon et al., 2019b; Vlassoff, 2007) constitute other pathways. The above mentioned are attributable to discriminatory values, beliefs, restrictive gender norms and roles (Gupta et al., 2019; Shannon et al., 2019b), which further lead to discriminations in access to resources (Neumayer & Plümper, 2007).

Gender roles in particular, contribute to the disparities in health among men and women (Ballantyne, 1999; King et al., 2018; Macintyre et al., 1996). For instance, the multiple roles in productive work and caregiving roles for women significantly burden them, and may contribute to high levels of anxiety, stress (Ballantyne, 1999; Shannon et al., 2019b), and subsequent infections for highly infectious diseases (World Health Organization, 2014). Furthermore, more involvement of women in reproductive or domestic roles rather than productive or paid work makes them to have less autonomy, low social status in the society, thus unable to afford some of the health care services (Vlassoff, 2007). On the other hand, men have fewer caring roles, enjoy economic independence and decision-making power (King et al., 2018; Vlassoff, 2007). However, the socially prescribed roles of men as breadwinners can potentially lead to increased anxiety and stress levels (Shannon et al., 2019b) and the risk of infection of diseases depending on their work environments (Vlassoff, 2007). Additionally, men are more involved in risk-taking roles and harmful health behaviors dictated by sociocultural norms, and associated with masculinity therefore, they experience high mortality risks (King et al., 2018; Manandhar et al., 2018; Sen & Östlin, 2008).

Focusing on climate, literature indicates that men and women are affected differently by disasters, and women life expectancy advantage is likely to be narrowed by natural disasters, especially in areas where women have low socio-economic status (Neumayer & Plümper, 2007; World Health Organization, 2014). Furthermore, women are affected more by other climate related health outcomes such as infectious diseases and malnutrition as compared to men (Preet et al., 2010; World Health Organization, 2014). Other health risks associated with climate events include heat stress, mental stress, respiratory illnesses and extreme weather events which are more pronounced on people working outdoors, rural residents and people with low socio-economic, cultural and political status (Gender & Alliance, 2016; Smith et al., 2014; Yusa et al., 2015).

In SSA most women are engaged in agricultural production and provide more agricultural labor than men, (Doss, 2001, 2018), therefore spent most of the time outdoors. Women and girls are also custodians of water collection activities (Graham et al., 2016; Sorensen et al., 2018), and suffer more during periods of water scarcity caused by drought or shifting rainfall patterns (World Health Organization, 2014). These meteorological conditions limit water access making individuals responsible for water collection travel long distance to water collection points or increase time spent on water collection activities beyond 30 minutes for round trip, which is above the WHO/UNICEF Joint monitoring program (JMP) cutoff points for basic water access (World Health Organization & United Nations Children's Fund, 2017). Long distance and more time at water collection points exposes women to heat (Sorensen et al., 2018) and the risk of violence which have health consequences (Graham et al., 2016; Sommer et al., 2015; World Health Organization, 2014). Furthermore carrying heavy containers of water over long distance may lead to spinal, back, head and neck pains (Geere et al., 2010), and potential cumulative damages on the muscles (World Health Organization, 2014) and other joints, leading to early arthritis and related disabilities due to pressure exerted on the skeletal system (Graham et al., 2016). More time on water collection activities has adverse economic consequences limiting access to health-related inputs such as education, labor income and other livelihood opportunities (Sorensen et al., 2018; World Health Organization, 2014). These costs may further hinder adaptation and general response to illness, thus exacerbating women vulnerability to other health outcomes.

Apart from the burden of accessing water, women caregiving roles and workloads are increased with extreme weather events as a result of increased illness of other household members (especially children), and also difficulties in accessing food for the household. Exposure to contaminated water sources and insufficient water during weather extremes increases the risk of water-borne and water-washed diseases (World Health Organization, 2014). Men also face difficulties in providing for families during drought period and this affects negatively their health (World Health Organization, 2014).

In view of the above discussions, analyses in this paper focuses on linkages between climate variability and health outcomes with a gender perspective, using sex disaggregated data. To my knowledge, there exist inadequate empirical evidence on the effects of weather variability on the health of the working age men and women, the indirect effect of weather events through water collection time pathway, gender health gap and the magnitude of the contribution of weather variables and health seeking behaviors to the gender health gap in the Ugandan context. Therefore, this study seeks to fill this gap by combining objective weather data and nationally representative socio-economic dataset to address the following research questions;

1. What is the effect of temperature and rainfall variabilities on health outcomes of men and women in the working age group?
2. Is the association between weather variability and illness among men and women mediated through water collection time pathway?
3. What is the association between healthcare services and health outcomes among men and women?
4. What is the contribution of weather variability and health care services in explaining the gender gap in health outcomes?

The rest of the paper is organized as follows; the next section (two) presents the methodology, descriptive statistics, empirical findings are outlined in section three while section four discusses the findings and concludes.

2 Methodology

2.1 Study Area

2.1.1 Demographics

According to the World Bank data, approximately 50.7% of the total population of Uganda (44 million) in 2019 were female, and at least 75% of the inhabitants were residing in rural areas (World Bank, n.d). The country is currently experiencing demographic transition with approximately 51.5% (22.8M) of its population in the working age category (15-64 years) as of 2019 (World Bank, n.d), which is further projected to increase over the coming years until 2070 (UNICEF 2019). The working age category was dominated by the female 11.7M (52% of female population) in 2019. The Age dependency ratio as a percentage of the working-age population was estimated at 94% (World Bank, n.d).

2.1.2 Gender gaps and health - disease burden in Uganda

Just like other Sub-Saharan African (SSA) countries, gender inequalities in Uganda are still persistent with detrimental effects on development. Globally, Uganda was ranked position 65 out of 153 countries with a score of 0.717 in progress towards achievement of gender parity, in the recent global gender gap report (World Economic Forum, 2020). This score denotes significant progress as compared to 2016 where the gender gap index was at 0.680, even though Uganda was ranked in a better position (47 out of 144 countries) in 2016 (World Economic Forum, 2016). However, the country performed better in 2017 and 2018 where the gender gap indices were 0.721 and 0.724 respectively, and in positions 45/144 and 43/149 respectively (World Economic Forum, 2017, 2018). One of the major progress contributing to a better position and index in 2018 was progress made in health, in terms of life expectancy (World Economic Forum, 2018). In the recent ratings, Uganda outperformed its neighboring countries, ranked in positions 68, 109 and 149 globally for Tanzania, Kenya, and Democratic republic of Congo respectively (World Economic Forum, 2020).

In comparison to women, infant mortality rates, under-five mortality rates and adult mortality rates have historically been higher in male as shown in Figure 1. For instance, infant mortality rates in males were estimated at 36.9 per 1,000 live births in 2019 as compared to the average rate of 33.4 deaths, while under-five male mortality rates were estimated at 50.5 deaths per 1,000 as compared to the average of 45.8 and 41 deaths per 1,000 live births in female (World Bank, n.d). Adult mortality rates were also higher in males at 302.4 per 1,000 male adults aged 15-60 years while female mortality rates were at 233.27 in 2018 (World Bank, n.d). A reduction in maternal mortality rates was recorded in 2014 at 360 per 100, 000 as compared to 2011 where the rate was 438 per 100,000 (Ministry of Health, 2015).

The aforementioned factors have substantially contributed to increased life expectancy in the country for both men and women (Ministry of Health, 2015). Compared to 40 years of life expectancy in 1950, there was a substantial increase of over 20 years by 2018 where life expectancy at birth was estimated at 63 years, with female having higher life expectancy than men at 65.2 and 60.7 years respectively as shown in Figure 1 (World Bank, n.d).

The Global Burden compare estimates that neonatal disorders contributed to 16.8% of the total disability-adjusted life years (DALYs) in Uganda in 2019 while malaria, HIV/AIDs, lower respiratory infections and diarrhea were also among the top 10 causes contributing to 11.19%, 7.52%, 5.27% and 4.26% of the DALYs (Institute for Health Metrics and Evaluation, 2019).

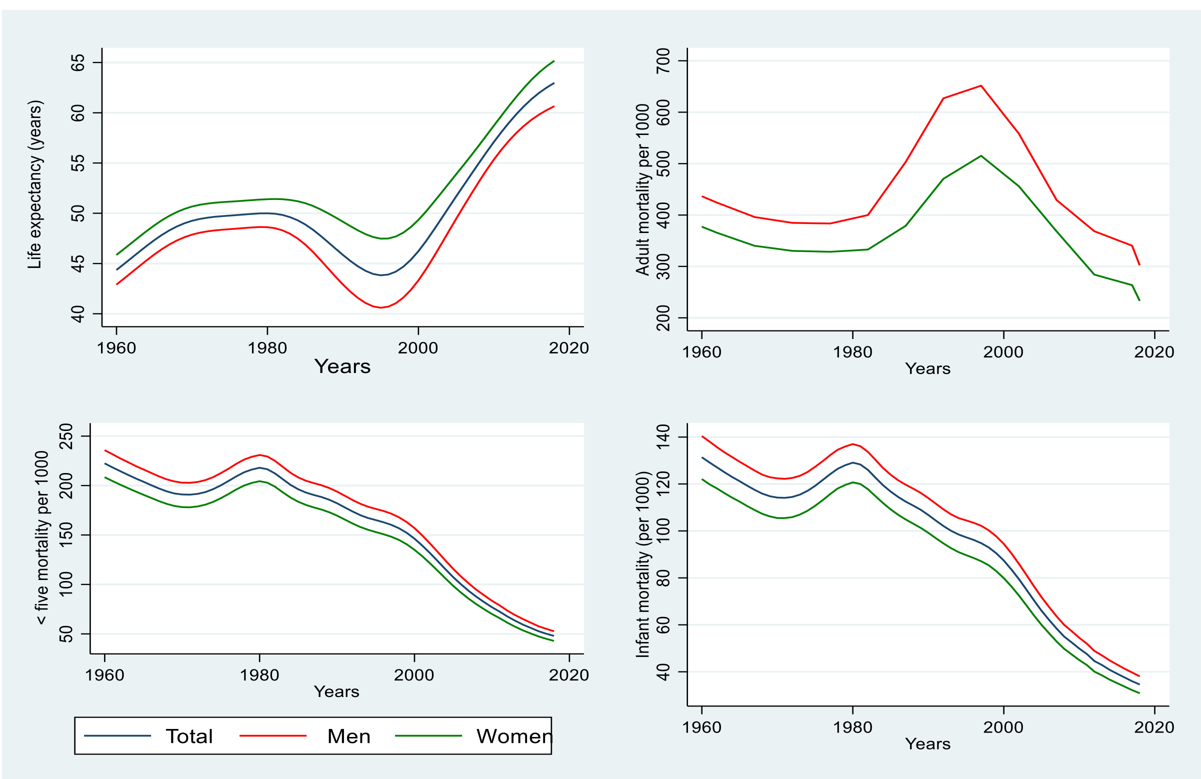

Figure 1: Life expectancy, infant and adult mortality rates in Uganda
Source, adapted from the World bank data

2.2 Data Sources

2.3 Living Standards Measurement Study (LSMS) data

The study uses individual level and household level data from the four waves (2009-2014) of a national representative dataset. Uganda National Panel Survey (UNPS) which is part of the World Bank Living Standards Measurement Studies - Integrated Surveys on Agriculture (LSMS –ISA) in collaboration with the Government of Uganda through Uganda Bureau of Statistics (UBOS).

Sampling was done at household level through the two-stage stratified cluster sampling, and the survey design in the different waves was maintained as the same (Uganda Bureau of Statistics, 2013). Samples were drawn from all regions and districts of Uganda, and household locations georeferenced. In total approximately 3000 households in 322 enumeration areas were interviewed in each wave (Uganda Bureau of Statistics, 2011, 2013) . Households and individuals in the respective households were followed and re-interviewed in the subsequent waves. The total cumulative sample of rural individuals interviewed in the four waves was approximately 49,644 with 22,469 individuals in the working age category (aged between 15-64 years). This study focused on this sub-sample only and not the other age-groups given that most of the variables to be controlled for in the empirical analysis were collected for this group. Furthermore, this is the age-group that is economically active and where gender aspects are dominant.

This study used the household level questionnaires and data from the following sections; household roster, general information on household members, education, health and labor force status capturing individual specific information (Uganda Bureau of Statistics, 2011, 2013). Housing conditions, water and sanitation, household assets sections were used, even though the data was captured at household level.

2.3.1 Weather data

The georeferenced data in the LSMS enabled us to match each household with temperature and rainfall data within a given enumeration area. Monthly rainfall data was extracted from the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) data version 2, (Funk et al., 2015) while the temperature data was from Moderate Resolution Imaging Spectroradiometer-MODIS (Hooker et al., 2018; Wan et al. 2015). These datasets are advantageous because of the high spatial resolution of 0.05° longitude/latitude climate modelling grid (Funk et al., 2015; Poméon et al., 2017). Additionally, they combine satellite and in-situ station data. The downloaded monthly temperature (2000-2014) and rainfall datasets (1981-2014) were processed in QGIS software, and used to construct weather indices in STATA.

2.3.2 Study variables

The main outcome variables were self-reported individual measures of health status, in terms of self-reported morbidity, number of sick days and work day lost (days of restricted activities) due to illnesses or injuries 30 days prior to the interview. The latter two questions were extracted in the health section where all regular and usual household were asked information on their health conditions. However, the two outcome variables were only for the household members whose response was "YES" to the following question; "*During the past 30 days, did [name] suffer from any illness or injury?*". We also treated the morbidity dummy variable (Yes/No) as an outcome variable in the decomposition analysis detailing the contribution of weather effects in explaining the gender gap observed in terms of the illness occurrence.

The mediator variable was time spent on water collection activities in hours, over the last seven days prior to the interview. This variable was captured in the labor force module (non-market labor activities) where all individuals over five years or respondents were asked this question "*In the last 7 days, how much time in hours did [Name] spend fetching water for the household, including travel time?*"

The main explanatory variables were the respective weather variables and the health care variables. Weather variables comprised of both long-term and short-term variable. Long-term variables include the annual rainfall deviation from the long-term mean (a dummy variable of a dummy variable of (1= yes) if the annual rainfall deviation from the long-term annual mean (since 1981) was less than 0mm. For temperature, positive temperature deviation was constructed with (1=yes) denoting annual average temperature deviation of greater than 0 from the long-term temperature. Figure 2 shows the distribution of rainfall and temperature deviations from the mean. Short term measures of weather variables include temperature and rainfall in the month before the interviews. These variables were included in respective regressions because the outcome variables were based on a 30-day recall period. Each individual was matched with weather information in the respective enumeration areas.

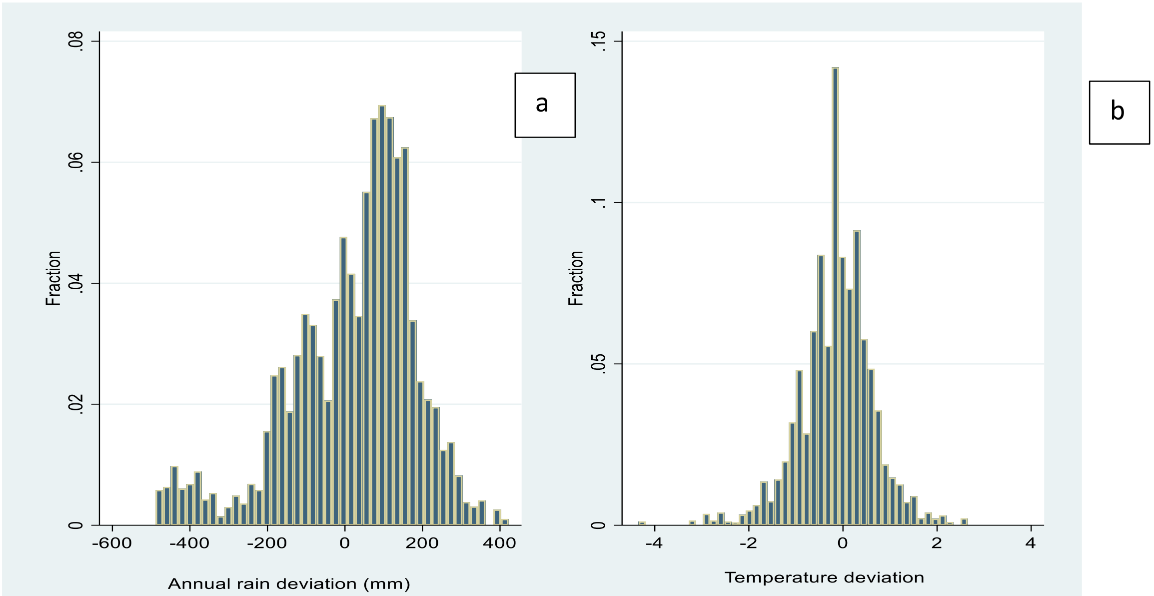

Figure 2: Distribution of annual rainfall from mean -*1981 to survey years* (a) and temperature deviations from the mean – *2000 to survey years*
Source: Author elaborations from CHIRPS and MODIS data

The health care variables were collected at an individual level given that the level of health consciousness varies among individuals. The specific health care variables used include; places where individuals consulted first (a dummy variable for pharmacy, private hospital or doctor, government hospital or center), distance to the health care center in kilometers, and usage of treated mosquito nets. These health care variables were only collected for individuals who reported illness except, usage of mosquito nets. While the latter is preventive, the former variables are curative health care services. We considered the above health care services because, health care and other health behaviors have a direct effect on health outcomes, and plays key roles in improving and explaining disparities in health status among individuals. Other independent variables included in the analysis such as age, marital status, occupation, education, wealth index (using principal component analysis - PCA) and individual income were guided by literature focusing on the main determinants of health. Given a range of covariates to be included in the models, we tested for multicollinearity using the variance of inflation factor (VIF).

2.4 **Empirical Strategy**

2.4.1 Two-part and hurdle count model

The two primary outcomes of the study (the number of days an individual was sick, and the number of work days lost due to the illness outcome variables) were only reported by a subsample of individuals (approximately a third of the total sample) who were sick in the 30 days prior to the interview. For the rest of the sampled individuals, a positive random variable was not observed given that there was no occurrence of illness, hence the outcome value was assumed to be zero, occurring in a substantial number of observations as shown in the left panel of Figure 3. Estimation strategies designed to address and deal with the problem of limited dependent variables were therefore adopted.

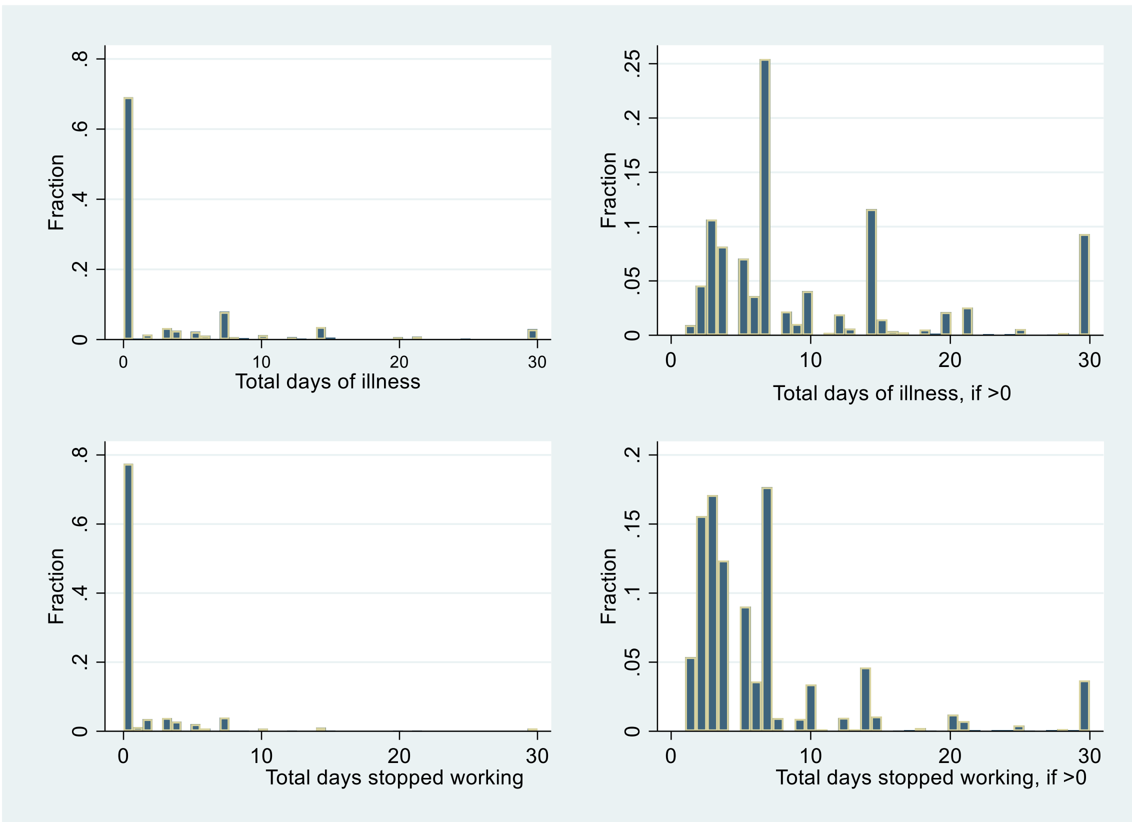

Figure 3: Proportion of individuals with different days of illness and work days lost due to illness.

In this study, I specifically use the two-parts model (TPM) because of the nature and distribution of the outcome variables (large number of zeros, skewness and counts). Conceptually, TPM is richer than a one-part model given that it allows decomposition of one random variable into two distinct observed random variables Y>0 and Y|Y>0, having different densities (Duan et al., 1984). Furthermore, the main goal is to investigate and distinguish the covariates that affect the propensity of being sick or stop working, from those factors affecting the number of days an individual was sick, and the number of work days lost, once the illness occurs. I rely on the assumption that there is no correlation of the error terms between the continuous and the binary equations (Belotti et al., 2015). Additionally, I assume that the zeros in the outcome variable are true zeros and not missing values as it is in Heckman and Tobit cases (Belotti et al., 2015; Duan et al., 1984).

TPM model that enables separate estimations of covariates effects on the outcome variable at both the extensive and intensive margins, and further establish the overall effect is ideal for this study (Belotti et al., 2015; Colchero et al., 2017; Deb & Norton, 2018). In the first part of TPM, the outcome is binary in nature, that is whether an individual suffered or recorded any day of illness /day of work lost in the month prior to the interview or not. Thus, a binary choice model, either logit or probit is used in predicting the probability that an individual has any illness or lost any work day due to illness, and in estimation of the factors that determine the probability of being ill, on the full sample. The general specification predicting the likelihood of a positive outcome in the first part is specified as follows;

$$\Pr(Y_{it} > 0) = \gamma_0 + \gamma_1 X_{1it} + \gamma_2 X_{2it} + \mu_{it} \quad (1)$$

where Y_{it} is the number of sick days or days of work lost due to illness for individual i in year t, x_{1it} is a vector of individual or household variables that are determinants of illness such as; age, income, marital status and education. Separate regressions models are estimated for men and women subsamples, however in the total sample estimation, a sex covariate is also added. x_{2it} is a vector of variables that represent the different weather variables such as, temperature and rainfall, assumed to be exogeneous and random. Coefficient of interest is γ_2 which measures the total effect of specific weather events on probability of illness. Subscript t is added on each covariate since year dummies of the different survey years are controlled for. The above estimation is fitted using logit model.

In the second part, a conditional equation is used to model the outcome variable on a subsample of individuals with positive outcomes (who suffered illness or had at least one day of illness or lost at least one work day). Maintaining the same independent variables used in the first part estimation, the general estimation of the second part is specified as;

$$E(Y_i|Y_i > 0) = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \varepsilon_1 \quad (2)$$

Main coefficient of interest is still (β_2) on the weather variables (X_{2i}) and ε_{it} is the error term. The choice of the model in the second stage is critical since this has implications on the estimated results (Deb & Norton, 2018). Assuming our outcome variable is a continuous variable, the generalized linear model (GLM) that can naturally accommodate skewness and is flexible in providing several functional forms and mixed distributions was used as opposed to the ordinary least squares OLS (Blough et al., 1999; Deb & Norton, 2018). I fit the GLM model in the second stage using the log link function and gamma as the distribution family, using robust standard errors for statistical corrections, in case of any consistencies arising from the choice of family and link. Given that the same set of covariates were used in both parts of the model, expected total days of illness for individual i is therefore equal to individual probability of having days of illness multiplied by the conditional number of days of illness. The general specification that applies also to expected total days of stopped working is specified as follows;

$$\begin{aligned} E\,(Y_{it}) &= \Pr(Y_{it} > 0) * E(\,Y_{it} | Y_{it} > 0) \\ &= (\gamma_0 + \gamma_1 X_{1it} + \gamma_2 X_{2it} + \mu_i) * (\,\beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \varepsilon_1) \end{aligned} \quad (3)$$

In the second part of the above estimation, I assumed continuous outcome variable and used GLM in the second stage. However, the main dependent variables are nonnegative counts (number of days). Therefore, I repeat these estimations using the two-part model for count data for robustness checks. Deb & Norton (2018) indicate that there are significant losses in statistical power in models that ignore the discrete nature of the data, and this can further result into inconsistent estimates of the parameters (Vistnes, 1997).

In particular, the hurdle negative binomial model (HNBM) is adopted, with logit in the first part to model the participation decision, and truncated negative binomial in the second part in estimating the participation extent to the individuals that cross the hurdle. HNBM is chosen because this combination has been recommended and used in many health applications previously (Deb & Norton, 2018; Farbmacher, 2011; Pohlmeier & Ulrich, 1995; Vistnes, 1997). Generally, the negative binomial (NBM) model results into more efficient and unbiased estimates in presence of high number of zeros and skewed data as opposed to Poisson (Cameron & Trivedi, 1986; Greene, 2008; Ver Hoef & Boveng, 2007). The specification for the first and second part of the hurdle negative binomial model uses the same covariates as earlier explained. The only difference is that the outcome variable is treated as discrete as opposed to continuous. The second part of the hurdle (truncated negative binomial model), using exponential conditional mean is specified as follows;

$$E(Y_i|Y_i > 0) = \exp(\alpha + x_{it}\beta + \varepsilon_{2it}) \quad (4)$$

For the overall effect, we estimate the negative binomial model.

One of the main determinants of individual health status is the health care, which was collected only on the sub-sample of individuals who reported illness and consulted illness. These curative health care variables were not included in the previous estimation because they were irrelevant for individuals whose outcome variable was zero, and those with positive values but did not consult or seek any medication. In order to assess, the association between health-seeking behaviors and the number of sick days or unproductive work days, the second part of the model is estimated separately, using a single index model controlling for health care variables, in addition to the earlier socio-economic as well as weather controls. The general specification of the model is as follows:

$$E(Y_i|Y_i > 0) = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \varepsilon_{3it} \quad (5)$$

Where X_{3it} is a vector denoting health care variables, including distance to the health facilities. X_{1it} and X_{2it} remains as earlier defined. Since the coefficients of the logit, GLM and NBM are not interpretable, the average marginal effects that estimates the predicated probabilities are reported for all estimations.

2.4.2 Direct and indirect effect analysis

This study hypothesizes that the total effect of climate or weather events on health operates both directly, and indirectly by influencing the time spent on water collection. In (Equation 1), the mediator variable was omitted in the respective regressions, enabling estimation of the total effects (sum of direct and indirect effect). Therefore, I present estimations that enables quantify the direct effect, and the degree to which water collection time mediates the relationship between weather events and health outcomes (indirect effect), using "difference in coefficients methods" while holding another factors constant. The key variables are weather events with statistically significant coefficients in (Equation 1), because they provide evidence for existence of the hypothesized relationship. To measure this mediation, KHB method proposed by Karlson, Holm and Breen that enables cross-model coefficients comparisons of two nested non-linear models, and also enables average partial effects estimations is adopted (Kohler et al., 2011). This estimation is only conducted at the extensive margin, on the binary response model. For clarity purposes the reduced model in the previous sub-section (Equation 6, similar to Equation 1) is presented, using the same set of covariates and further estimations of the full model after inclusion of the mediator variable (Z_{it}) in (Equation 7) as shown below;

$$\Pr(Y_{it} > 0) = \gamma_0 + \gamma_1 X_{1i} + \gamma_2 X_{2it} + \mu_i \tag{6}$$

$$\Pr(Y_{it} > 0) = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2it} + \alpha_3 Z_{it} + \mu_i \tag{7}$$

Weather variables denoted by X_{2it} are key variables in both the reduced model and full model, and the coefficients γ_2 and α_2 represent the total effect and direct effect of specific weather variables respectively. The difference between coefficients of same weather variables (γ_2- α_2) in the two regression equations is a measure of the indirect effect. For interpretation of coefficients on a probability scale, average partial effects are estimated using KHB command with ape option (Kohler et al., 2011). However, we rely on the logit coefficients for significance test for the effect differences (Kohler et al., 2011).

2.4.3 Gender gap decomposition analysis on health outcomes

After assessing the determinants of sick days and work days lost, a decomposition analysis was conducted in order to estimate the gender differences in the health status, and explain the source of these differences based on the gender-specific factors that contribute to the observed health inequalities. O'Donnell asserts that the next natural step after measuring health inequalities is seeking to explain them, and Blinder–Oaxaca decomposition analysis enables this (O'Donnel et al., 2012). However, given the non-linear nature of our outcome variables (binary and counts) , Powers et al. (2011) multivariate decomposition method for non-linear models, which is an extension of Blinder–Oaxaca is adopted. Unlike other non-linear decomposition that are limited in their decomposition, the multivariate decomposition provides estimates for both the overall decomposition and detailed decomposition, thus allowing assessment of each covariate contribution to the different components of the gap (Powers et al., 2011). Furthermore, the method addresses problems of path dependency and identification problem due to the reference categories chosen for the dummy predictor variables (Powers et al., 2011). Path dependency and identification problems are solved by use of weights and normalization of the dummy variables such that decomposition is invariant on how the variables are entering the decomposition and, on the reference category chosen (Powers et al., 2011).

Using women subsample as the comparison group and men as the reference category. The overall decomposition of the women-men aggregate gap in health outcome is specified as;

$$\bar{Y}_w - \bar{Y}_m = [F(\bar{X}_w\hat{\beta}_w) - (\bar{X}_m\hat{\beta}_w)] - [F(\bar{X}_m\hat{\beta}_w) - (\bar{X}_m\hat{\beta}_m)] \quad (6)$$

Where $\bar{Y}_w - \bar{Y}_m$, is the mean differences in the health outcomes between women and men. The first part $[F(\bar{X}_w\hat{\beta}_w) - (\bar{X}_m\hat{\beta}_w)]$ is due to composition differential between men and women, also known as the explained component given that it is due to the differences in characteristics or endowments between the two groups (Jann, 2008; Powers et al., 2011). The explained component is the counterfactual comparison of health differences from the women perspective, interpreted as the difference expected in health outcomes if women are given men covariates. In our case such characteristics include; age, education, health seeking behaviors, marital status, as well as the weather variables. The second part $[F(\bar{X}_m\hat{\beta}_w) - (\bar{X}_m\hat{\beta}_m)]$ is known as the coefficient effect or unexplained component which is due to differences in coefficients, behavioral responses or returns. The unexplained aggregate contribution is interpreted as the expected difference in health outcomes if men experienced women behavioral responses.

After assigning the weights, the final decomposition of the raw aggregate gap is expressed as a summation of the weighted total of each factor unique contribution as shown below;

$$\bar{Y}_w - \bar{Y}_m = E + C = \sum_{k=1}^{K} W_{\Delta X_k} E + \sum_{k=1}^{K} W_{\Delta X_k} C = \sum_{k=1}^{K} E_k + \sum_{k=1}^{K} C_k \quad (7)$$

Where $W_{\Delta X_k}$ is the decomposition weights, E and C are the explained and unexplained components respectively. Based on our outcome variables (binary and counts), we use logit (for the gap differences on the probability of illness) and negative binomial decomposition approaches (for the gap differences on sick and restricted days).

3 Results

3.1 Descriptive Statistics

The socio-demographic, economic and weather characteristics of men and women in the working age group are presented in Table 1. On average, women constituted 51% of respondents, and were relatively older (32 years) than men, aged 31 years. The proportion of men and women in the different survey years was almost similar, with no significance differences. Educational attainment levels were significantly lower in women than men, with a difference of approximately 1.5 years. The small gap in education attainment reveal substantial progress made by women in catching up with male education levels in the recent years. With regards to occupational and income inequalities, a female disadvantage of about 13 percentage points in total for paid work and business activities, and 11 percentage points in income despite a small difference in education attainment provides evidence for gender occupational sorting, partly shaped by the societies (Schieder & Gould, 2016), especially in developing countries.

On health care usage, more women used treated mosquito nets than men at 42% and 37% respectively with significant differences at 1% level. The proportion of women who suffered illnesses and sought consultations was similar to that of men with no significant imbalances between the two groups. On the other hand, gender differences in health care seeking behaviors were noted for the sub-sample of individuals who sought consultations. While more women (37%) reported to have visited the government hospital or health care centers for first consultations, a significant proportion of men visited private hospitals, private doctors (38%) and pharmacy or drug shop (27%) than women at 34% and 23% respectively. Significant differences in the distance to the health facilities were also reported, where the health facilities consulted by women were far away (4.8kms) than those accessed by men (4.3kms).

Significant differences in temperature experienced in the month prior to the survey were noted with, women residing in hotter areas. For the rest of the weather variables there was no significance differences between men and women geographical areas. Over a third of men and women experienced annual rainfall amount lower than the long-term mean, and annual mean temperature above the medium-term average.

Focusing on the main intermediate variable, women spent more time collecting water as compared to men, with significant differences. On average, women spent 4.4 hours collecting water in the last 7 days before the interview while men spent 2 hours as shown in Table 1.

Table 1: Summary statistics of working age individuals, disaggregated by gender

Category	Variable	Total Sample) (N = 22,469)	Women (N= 11,568)	Men N= (10,901)	Difference
		1	2	3	4
Socio-economic Information	Age (years)	31.382	31.971	30.757	1.214***
	Education (years)	5.785	5.059	6.555	-1.495***
	Occupation				
	Salaried /wage (1 = yes)	0.218	0.161	0.279	-0.118***
	Business (1 = yes)	0.177	0.172	0.183	-0.010**
	Farming (1 = yes)	0.835	0.866	0.802	0.064***
	Income				
	No personal income (1 = yes)	0.833	0.886	0.777	0.109***
	Income (1-250000 UGX)	0.134	0.100	0.171	-0.070***
	Income (250001-750000)	0.027	0.012	0.043	-0.032***
	Income (>750000)	0.005	0.002	0.009	-0.007***
	Marital status				
	Married monogamous (1 = yes)	0.402	0.411	0.392	0.018***
	Married polygamous	0.131	0.151	0.109	0.043***
	Divorced / Separated	0.057	0.079	0.034	0.045***
	Widow/Widower	0.039	0.070	0.006	0.065***
	Never married	0.371	0.289	0.459	-0.170***
	Other factors				
	HH Asset Index	-0.472	-0.483	-0.460	-0.024
	Water harvesting (1=Yes)	0.014	0.014	0.014	0.000
	Dependency ratio	126.0	135.2	116.3	18.93***
Intermediate variables	Water time (hours)	3.174	4.386	1.887	2.499***
	Water quantity (litres)	64.326	63.784	64.902	-1.119
Weather variables	Negative rain deviation (1=yes)	0.382	0.378	0.385	-0.007
	Positive temperature deviation (1=Yes)	0.412	0.411	0.414	-0.003
	Rainfall (month mm)	107.6	106.9	108.3	-1.309
	Temperature (month mm)	29.18	29.23	29.12	0.112**
Health seeking behaviors & variables	Mosquito net use (1=Yes)	0.485	0.516	0.452	0.064***
	Treated mosquito nets (1=Yes)	0.396	0.423	0.367	0.056***
	Illness consulted[2] (1=Yes)	0.879	0.881	0.876	0.006
	Distance to health facility[3] (Km)	4.596	4.797	4.301	0.496**
	Government hospital (1=Yes)	0.339	0.369	0.295	0.074***
	Private hospital/doctor (1=Yes)	0.355	0.341	0.375	-0.035***
	Pharmacy or shop (1=Yes)	0.248	0.231	0.274	-0.043***
	Other healthcare[4] (1=Yes)	0.050	0.052	0.047	0.006
Year dummies	Year dummies (2009) 1=Yes	0.251	0.251	0.252	-0.002
	Year dummies (2010) 1=Yes	0.226	0.226	0.225	0.002
	Year dummies (2011) 1=Yes	0.252	0.253	0.251	0.001
	Year dummies (2013) 1=Yes	0.271	0.270	0.272	-0.002

*** p<0.01, ** p<0.05, * p<0.1

[2] The observations are only for those who incurred some illnesses and not the total sample (N= 6,965, women= 4,130, women = 2,835)

[3] The sample is only for those who incurred some illness and sought consultations (N= 6,127, women= 3,641, men= 2,486). The same applies healthcare usage.

[4] This includes traditional healer, friend and relative, religious institutions, NGO based community distributor, outreach, government community-based distributor,

Water collection time varied tremendously by region. Women in the northern region spent approximately 8 hours of water collection (more than twice the time spent by women in central and west), despite majority of households (80%) in the north accessing water from improved water sources as shown in Figure 3. Domestic rain water harvesting for household use was high in central and western part of Uganda. Men and women in central region spent almost the same number of hours in water collection activities, and overtime there was a slight improvement in men's time allocation to water collection activities, and a reduction in time women spent on water collection which partly signifies progress towards gender equality in division of household labour.

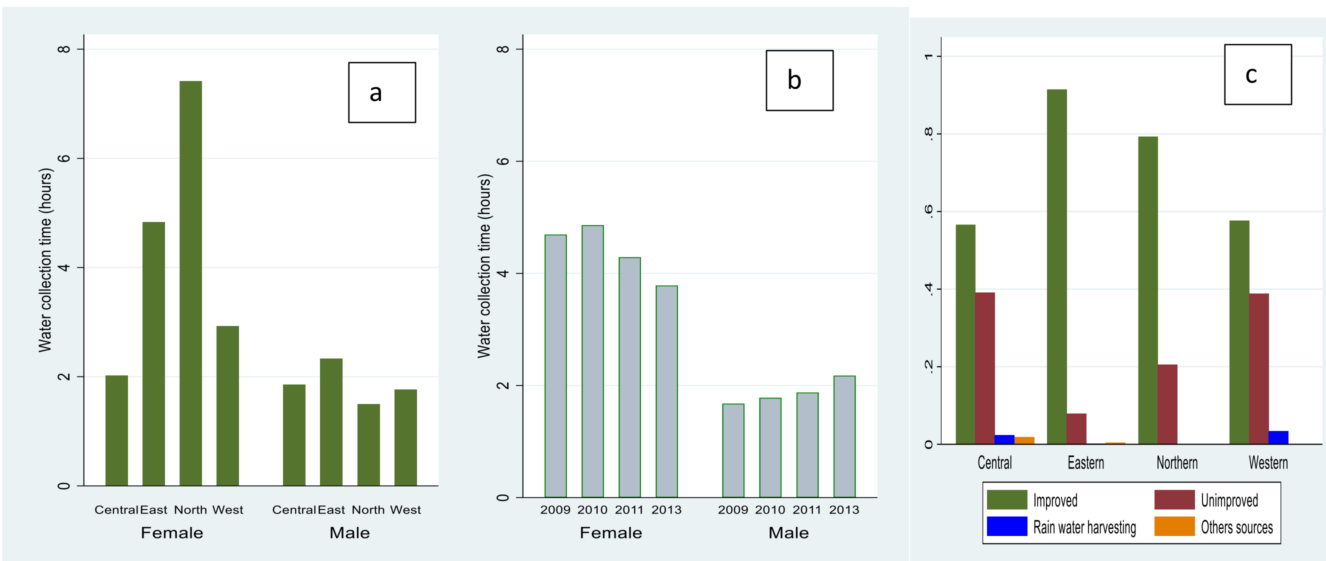

Figure 3: Time spent on water collection, among men and women disaggregated by region (*a*) and survey year (*b*), *and* proportion of households using different water sources (c)

The outcome variables descriptive statistics shown in Figure 4 and Table 2 reveal women health disadvantage in general, as compared to the men, over the four survey periods. On average, the proportion of women reporting occurrence of illness was significantly higher than men at 36% and 26% respectively. Similarly, approximately a third of the women (26%) were unable to continue with their usual activities due to the illness, while only 19% of men reported inability to continue with their work activities.

Table 2: Outcome variable statistics

N	Variable	All individuals		Women		Men		Difference
		Mean	SD	Mean	SD	Mean	SD	
22,469	Suffered illness (1=Yes)	0.310	(0.462)	0.357	(0.479)	0.260	(0.439)	0.097***
22,469	Days illness	3.173	(6.522)	3.734	(6.925)	2.578	(6.008)	1.156***
6,971	Days of illness if >0	10.227	(8.060)	10.446	(8.003)	9.908	(8.133)	0.538***
22,469	Stopped working (1=Yes)	0.226	(0.418)	0.262	(0.440)	0.189	(0.391)	0.073***
22,469	Days stopped working	1.484	(4.084)	1.674	(4.148)	1.283	(4.006)	0.390***
5,084	Days stopped working if >0	6.560	(6.359)	6.394	(5.962)	6.804	(6.896)	-0.410**

Standard deviations in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Concerning the number of days of illness and working days lost due to the illness in the 30 days prior to the interview, women reported 3.7 and 1.7 days on average for the total sampled women, while, men reported 2.6 and 1.3 days respectively. More number of days were reported for the subsample of individuals who had experienced at least one illness, that is, 10.4 days of illness and 6.4 days of restricted work for women. The corresponding figures for men were 9.9 and 6.8 respectively. The differences in health outcomes between women and men were positive and statistically significant. The pattern of health outcomes in women and men was consistent over the survey years – women reporting significantly poorer health on all health measures than men, even though poor health follows a declining trend for both groups over the four survey years as shown in Figure 4.

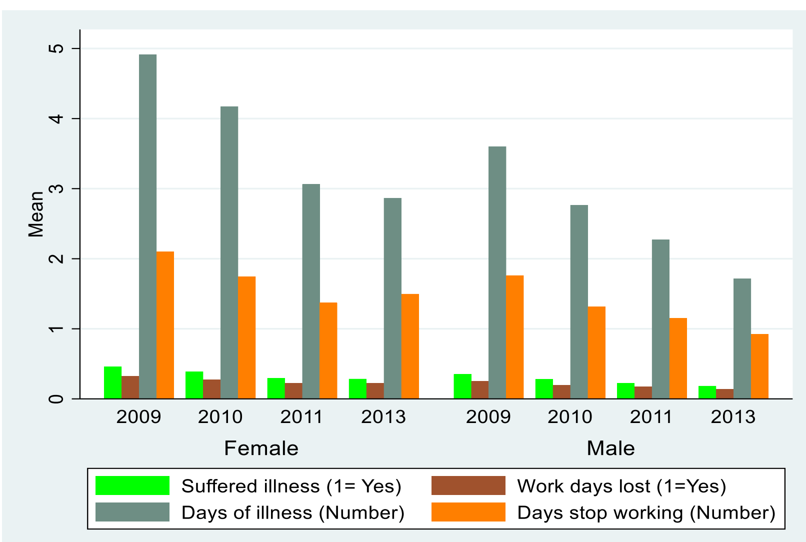

Figure 4: Trends in men and women health over the survey years

3.2 **Empirical Results**

3.2.1 Effects of weather variables on days of illness (total effect)

The two-part models average marginal effects estimates for the combined effects of weather variables are shown in Table 3. In general, the logit models indicate that individuals experiencing low rainfall below the long-term mean were more likely to report at least a day of illness as compared to their counterparts, holding other factors constant. Significant differences were reported in both men and women sub-samples, even though the magnitude was higher in women at – 8.3 percentage points, than in men – 6.7 percentage points. On the contrary, the GLM model showed insignificant effects of low rainfall among women who experienced some illnesses. Nevertheless, the coefficients of the overall effect of both parts of the two-parts model for the whole sample were consistently positive and significant, indicating that low rainfall significantly increased days of illness in both men and women, with high effects in women.

Correspondingly, individuals exposed to high annual temperature above the mean reported increased probability of suffering from illnesses, as compared to those not experiencing high temperature. The magnitude of effect was roughly 2 percentage points for both men and women. The temperature effect at the intensive margin for those who experienced illness was consistently insignificant, even though the overall effect was positive and highly significant in men.

Concerning the short-term weather measures, differences in rainfall and temperature experienced in the month before the interview were noted on the coefficient's signs and significance. For instance, an increase in rainfall was negatively associated with likelihood of illness in men and not in women, while temperature was positively associated with illness in both men and women. Specifically, rainfall reduced the probability of illness in men by 6.4 percentage points. A possible explanation to the significant reduction effect of rain on illness is men is as follows; men are responsible for provision of household needs in many societies including Uganda (Morgan et al., 2017), and many rural households depend on agriculture and livestock for food and income. Therefore, increased rainfall leads to improved food production and increased income, which reduces the burden, stress and other health outcomes related to provision of household needs. However, the positive and significant coefficients of the quadratic term of rainfall in men imply that too much rain maybe detrimental to men health. The effect size of temperature on the probability of illness was higher in men at 5 percentage points as compared to the women at 4 percentage points. The overall effect was significant in both groups, with high magnitude in women.

Other socio-economic determinants of illnesses among men and women include age, years of schooling, wealth index, use of treated mosquito net, occupation, marital status and income as shown in Table 3. A one-year increase in age was associated with an increase in probability of illness of about 0.4 and 0.3 percentage points in women and men respectively. The coefficients magnitude and significance levels of years of education and wealth index in the logit model were negative, and same for both genders at 1% significant level. This implied that education and wealth reduced the probability of illness.

Table 3: Marginal effects of the two-part model on the effect of weather and other determinants on days of illness

Variables	**All sample**			Women			Men		
	Logit	GLM	Overall	Logit	GLM	Overall	Logit	GLM	Overall
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Negative rain deviation	0.0748***	-0.203	0.685***	0.0827***	0.542	1.036***	0.0671***	-1.224***	0.337*
	(0.0096)	(0.318)	(0.137)	(0.0136)	(0.417)	(0.203)	(0.0134)	(0.473)	(0.178)
Log monthly rain	-0.0439*	-0.124	-0.477	-0.0223	-0.326	-0.344	-0.0615*	0.346	-0.510
	(0.0245)	(0.776)	(0.344)	(0.0354)	(0.993)	(0.499)	(0.0336)	(1.208)	(0.460)
Log rainfall squared	0.0070***	0.013	0.074*	0.0050	0.039	0.065	0.0085**	-0.049	0.069
	(0.0031)	(0.099)	(0.044)	(0.0045)	(0.129)	(0.064)	(0.0043)	(0.155)	(0.059)
Positive temp deviation	0.0224***	0.012	0.228**	0.0203**	-0.049	0.189	0.0230**	0.149	0.263**
	(0.0068)	(0.216)	(0.095)	(0.0098)	(0.282)	(0.142)	(0.0093)	(0.332)	(0.125)
Monthly temperature	0.0434***	-0.039	0.422***	0.0399***	0.245	0.494***	0.0480***	-0.376	0.371**
	(0.0088)	(0.297)	(0.128)	(0.0124)	(0.359)	(0.182)	(0.0127)	(0.499)	(0.179)
Temperature squared	-0.0006***	0.000	-0.006***	-0.0006***	-0.004	-0.007**	-0.0007***	0.006	-0.006*
	(0.0001)	(0.005)	(0.002)	(0.0002)	(0.006)	(0.003)	(0.0002)	(0.008)	(0.003)
Age	0.004***	0.096***	0.065***	0.004***	0.100***	0.080***	0.003***	0.094***	0.054***
	(0.000)	(0.009)	(0.004)	(0.000)	(0.012)	(0.006)	(0.000)	(0.015)	(0.006)
Education	-0.006***	-0.051*	-0.080***	-0.006***	0.008	-0.057***	-0.006***	-0.114***	-0.089***
	(0.001)	(0.030)	(0.013)	(0.001)	(0.042)	(0.021)	(0.001)	(0.043)	(0.016)
Asset index	-0.009***	-0.105*	-0.122***	-0.009***	-0.022	-0.102***	-0.009***	-0.220***	-0.147***
	(0.002)	(0.054)	(0.024)	(0.003)	(0.073)	(0.036)	(0.002)	(0.082)	(0.031)
Water harvesting	-0.033	0.301	-0.241	0.015	0.280	0.254	-0.101**	-0.173	-1.026*
	(0.027)	(0.845)	(0.371)	(0.036)	(1.026)	(0.523)	(0.042)	(1.492)	(0.558)
Treated mosquito net	-0.040***	-0.484	-0.547***	-0.054***	-0.370	-0.679***	-0.023	-0.700	-0.407**
	(0.011)	(0.323)	(0.145)	(0.015)	(0.413)	(0.213)	(0.015	(0.508)	(0.195)
Salaried /wage	0.067***	-0.772***	0.431***	0.064***	0.004	0.648***	0.071***	-1.523***	0.301*
	(0.009)	(0.276)	(0.128)	(0.014)	(0.372)	(0.197)	(0.012)	(0.414)	(0.163)
Business	0.048***	-0.868***	0.210**	0.053***	-0.811	0.245	0.048***	-0.937**	0.222
	(0.008)	(0.233)	(0.106)	(0.011)	(0.300)	(0.156)	(0.011)	(0.384)	(0.146)
Farming	-0.002	-2.607***	-0.825***	-0.029**	-2.203***	-1.085***	0.015	-2.922***	-0.610***
	(0.009)	(0.280)	(0.124)	(0.014)	(0.390)	(0.198)	(0.011)	(0.395)	(0.150)
Polygamous	-0.009	0.243	-0.014	0.002	0.199	0.089	-0.024*	0.310	-0.151
	(0.009)	(0.275)	(0.123)	(0.012)	(0.347)	(0.177)	(0.013)	(0.453)	(0.174)
Divorced	0.029**	0.486	0.444***	0.018	0.368	0.314	0.049**	0.638	0.640**
	(0.012)	(0.366)	(0.166)	(0.016)	(0.450)	(0.227)	(0.021)	(0.653)	(0.262)
Separated	0.050***	0.653*	0.701***	0.042**	0.596	0.639***	0.063	1.522	1.009*
	(0.015)	(0.389)	(0.192)	(0.017)	(0.423)	(0.233)	(0.048)	(1.515)	(0.604)
Never married	-0.068***	-0.086	-0.707***	-0.089***	-0.273	-1.001***	-0.052***	-0.015	-0.511***
	(0.009)	(0.317)	(0.137)	(0.014)	(0.416)	(0.204)	(0.014)	(0.508)	(0.189)
Income (1- 250000 UGX)	-0.017	-0.024	-0.182	-0.008	-0.122	-0.123	-0.025*	0.143	-0.207
	(0.011)	(0.323)	(0.148)	(0.017)	(0.449)	(0.235)	(0.014)	(0.463)	(0.182)
Income (250,001 – 750,000)	-0.081***	-0.548	-0.982***	-0.092**	-1.484	-1.463**	-0.071***	0.458	-0.577*

	(0.021)	(0.722)	(0.306)	(0.042)	(1.371)	(0.647)	(0.023)	(0.845)	(0.316)
Income (> 750,000)	-0.015	-1.055	-0.481	0.019	0.490	0.369	-0.018	-1.242	-0.494
	(0.040)	(1.276)	(0.570)	(0.090)	(2.422)	(1.273)	(0.042)	(1.477)	(0.572)
Dependency ratio	0.000	-0.001	0.000	0.000	-0.002**	-0.001	0.000	0.001	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)
Net usage	0.061***	-0.022	0.604***	0.069***	0.055	0.723***	0.051***	-0.198	0.445**
	(0.010)	(0.317)	(0.143)	(0.015)	(0.409)	(0.211)	(0.014)	(0.495)	(0.190)
Year 2010	0.004	-0.355	-0.070	0.006	0.425	0.212	0.002	-1.419***	-0.349*
	(0.011)	(0.362)	(0.160)	(0.016)	(0.472)	(0.237)	(0.016)	(0.543)	(0.209)
Year 2011	-0.057***	-0.555	-0.739***	-0.068***	-0.087	-0.724***	-0.043***	-1.024*	-0.689***
	(0.012)	(0.381)	(0.167)	(0.017)	(0.501)	(0.248)	(0.016)	(0.573)	(0.218)
Year 2013	-0.120***	-0.955***	-1.490***	-0.115***	-0.590	-1.381***	-0.125***	-1.346***	-1.563***
	(0.009)	(0.295)	(0.132)	(0.014)	(0.390)	(0.197)	(0.013)	(0.447)	(0.175)
Sex	-0.070***	-0.378*	-0.814***						
	(0.006)	(0.212)	(0.092)						
N	22,468	6,970	22,468	11,567	4,134	11,567	10,901	2,836	10,901

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

While the usage of treated mosquito net significantly reduced the likelihood of illness in women by 5.4 percentage points, the effect was rather insignificant in men. Heterogeneous effects of the different marriage arrangements on probability of illness across the genders were observed. For instance, men who were polygamous were less likely to report illnesses than those in the monogamous marriage arrangement. However, the coefficient was insignificant in women who were polygamously married. Similarly, men and women who were never married were less likely to report illness compared to those married monogamously. In contrast, divorce and separation was associated with significant increase in probability of illnesses in men and women respectively.

With respect to the relationship between occupation and personal income on illnesses, there was minimal differences in coefficients and significance by gender. Men and women engaged in paid work and business reported more likelihood of illness by at-least 4 percentage points, while women engaged in household farming activities were less likely to suffer from illnesses. This could be possibly because of consumption of fresh and healthy foods from their farms, and the fact that farming requires physical effort, thus a form of exercise. However, the coefficient of farming occupation was positive and insignificant in men. In general, an increase in income level had negative effects on illnesses, especially for individuals earning income of about 250,000 to 750,000 UGX. The effect size of reduction for women in this income range was higher (-9.2 percentage points) than for men in the same income category (-7.1 percentage points), compared to men and women receiving no income at all.

The second part (GLM estimations) results indicate that most of the covariates did not have significant effect on the number of days of illness especially in the women sub-sample. Coefficients of age, years of schooling and wealth index on days of illness were significant in men, and the sign was consistent with the logit estimates. However, in women, only age was significant, with an additional year increasing the number of days of illness by 0.1 days, for the women who experienced any illness. Farming was associated with reduced number of days of illness – at least 2 days in both men and women engaged in farming as compared to the base category. Even though men who were salaried and in business reported increased likelihood of illness, once sick, they reported a smaller number of days of illness. Similar results were observed for women in business, given that they spent significantly a smaller number of days of illness, conditional on being sick. These results imply that those salaried or in business had financial resources, therefore able to afford and access good health care services, once sick.

The overall effect sizes of age and salaried occupation were positive and significantly higher in women than in men. Reduction effects of an additional year of education and asset on illness in both parts of the model were higher in men, while use of treated mosquito nets, farming, income and never married significantly reduced illnesses in women, with higher magnitudes than in men.

3.2.2 Decomposition of total effect of weather events into direct and indirect effects

Table 4 shows the summary of KHB estimates of total, direct and indirect effect of key weather variables (negative rainfall deviation and temperature prior to the interview) through water collection pathway, holding all other covariates constant. The coefficients on the weather variables in the reduced model and full models indicate total and direct effects respectively, while the difference between these two coefficients is the indirect effect, mediated by water collection time. In general, there were reduction in our key weather coefficients, after introduction of water collection time variable in the full model.

For women subsample, water collection time mediated the relationship between low rainfall below the long-term mean and probability of illness as well as the relationship between temperature in the month before the interview and likelihood of illness. Exposure to low rainfall led to more time burdens in water collection, which translated into a higher probability of illness in women of 0.2 percentage points. However, the mediation effect of water collection was only significant on relationship between low rainfall and illness, and not on temperature – illness relationship as shown in column 5. The KHB ape estimates do not indicate the standard error and significance levels, therefore we rely on KHB logit estimates.

Table 4:KHB decomposition results of direct, indirect and total effects of negative rain and temperature on illness, through water collection time pathway

	All Sample				**Women**				**Men**			
	Logit estimates		Average partial effects		Logit estimates		Average partial effects		Logit estimates		Average partial effects	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Negative rainfall deviation												
Reduced model[5]	0.3861***	(0.0495)	0.0748***	(0.0096)	0.3985***	(0.0660)	0.0828***	(0.0136)	0.3774***	(0.0755)	0.0672***	(0.0134)
Full model	0.3808***	(0.0495)	0.0738***	(0.0096)	0.3894***	(0.0661)	0.0809***	(0.0136)	0.3753***	(0.0755)	0.0669***	(0.0134)
Difference	0.0052**	(0.0021)	**0.0010**	.	0.0091**	(0.0038)	**0.0019**	.	0.0020	(0.0024)	**0.0004**	.
Confounding ratio	1.0138		1.0138		1.0233		1.0233		1.0054		1.0054	
Mediation percentage	1.36		1.36		2.28		2.28		0.54		0.54	
Month temperature												
Reduced model	0.2233***	(0.0456)	0.0433***	(0.0088)	0.1911***	(0.0596)	0.0397***	(0.0123)	0.2693***	(0.0716)	0.0480***	(0.0127)
Full model	0.2205***	(0.0456)	0.0427***	(0.0088)	0.1862***	(0.0596)	0.0387***	(0.0124)	0.2669***	(0.0716)	0.0475***	(0.0127)
Difference	0.0028	(0.0018)	**0.0005**	.	0.0049	(0.0032)	**0.0010**	.	0.0024	(0.0024)	**0.0004**	.
Confounding ratio	1.0127		1.0127		1.0265		1.0265		1.0092		1.0092	
Mediation percentage	1.26		1.26		2.58		2.58		0.91		0.91	
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22468						11567		10901		10901	

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

[5] *The reduced model measures the total effect, the full model measures direct effect and the difference is the indirect effect.*

The confounding ratio in women indicate that the total effect of low rainfall and temperature was 1.02 and 1.03 larger than the direct effect of these key variables respectively while mediation percentages reveal that 2.28% and 2.58% of the total effect was due to water time burdens.

For men, water collection time mediated the relationship between low rainfall and probability of illness (0.54 percent of the total effect) and relationship between high temperature and illness (0.91 percent of the total effect). In probability terms, occurrence of dry events, and increase in temperature led to more time allocation on water collection, which increased the likelihood of illness by 0.04 percentage points. However, the mediation effect for water collection time in the relationship between weather events and illness was insignificant in men.

Further results on the coefficient estimates of water collection time on illness in the full model and coefficients of weather variables on water collection time are presented in Table A1 and Table A2 of the appendix. The results suggest that key weather events increased water collection time significantly in women and not in men, while domestic rain water harvesting reduced water collection time in both men and with, with higher magnitude in women. Similarly, increase in water collection time significantly increased illness in both men and women. In conclusion, our results support fully the complete mediation process of water collection time in the relationship between low rainfall and illness in women, while mediation process in men was partially supported.

3.2.3 Effect of weather variables on work days lost due to the illness

Table 5 present two-part estimation results on the gender differentiated effects of weather variables on days an individual stopped working due to the illness. Just like in the case of days of illnesses earlier reported, holding other factors constant, women and men experiencing low rainfall below the long-term mean were more likely to report illness related work absences by at least 5 percentage points, than women and men who did not experience low rainfall, as shown in columns 1, 4 and 7. However, the magnitude of effect of long-term low rainfall was higher in women than in men, with a difference of about 3 percentage points. The overall effects of low rainfall on both parts of the model for the whole sample was positive and significant in both groups, with higher effects in women.

Conditional on experiencing at least a day of restricted work, gender differences on coefficient signs of rainfall in the month before the interview on work absences were noted. For instance, women lost an additional 1.3 work days on average in response to the high rainfall experienced as shown in column 5. While the coefficients were insignificant for GLM estimates, the overall effect of high rainfall in women was positive and significant at 10% significance level.

Exposure to high positive temperature variation increased the probability of work days lost significantly by about 1.6 percentage points for women sub-sample, while in men it was insignificant. On the contrary, the effect size of the short-term temperature on likelihood of absence from work was lower and insignificant in women, whereas in men it was positive and significant. These results indicate that women health respond more to long-term temperature changes while men to short-term temperature changes.

Results in columns 6 and 9 reveal gender differentiated overall effect of the weather variables on the work days lost due to illness, considering both the effects in the first part and second part. For instance, all the rainfall variables were positively and significantly associated with work days lost in women, while in men the significance differences were only observed on the negative rain deviation variable with less magnitudes as compared to women. The overall effect of positive temperature deviation was insignificant in both groups, while temperature in the month prior to the interview was significant and positive in men only.

With regards to the determinants of the work days lost, results are similar to those reported for days of illness in Table 3 with minimal differences on effect sizes[6]. Age, years of schooling, assets, salaried, polygamous, never married, domestic rain water harvesting and income were significantly associated with probability of work days lost in men. The same factors were significant in women except polygamous marriage and water harvesting.

[6] These results are not reported in Table 4, but available on request.

Table 5: Effect of weather events on days stopped working – average marginal effects of the two-part model

Variables	Total sample			Women			Men		
	Logit	GLM	Overall	Logit	GLM	Overall	Logit	GLM	Overall
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Negative rain deviation	0.068***	-0.816***	0.258***	0.080***	-0.823**	0.292**	0.056***	-0.762*	0.230**
	(0.009)	(0.281)	(0.084)	(0.013)	(0.365)	(0.123)	(0.012)	(0.422)	(0.112)
Log monthly rain	0.020	0.364	0.213	0.036	1.282	0.564*	0.005	-1.293	-0.211
	(0.023)	(0.659)	(0.214)	(0.034)	(0.797)	(0.303)	(0.032)	(1.132)	(0.303)
Log rain squared	-0.002	-0.039	-0.020	-0.003	-0.156	-0.063	0.000	0.162	0.030
	(0.003)	(0.085)	(0.027)	(0.004)	(0.104)	(0.039)	(0.004)	(0.145)	(0.039)
Positive temperature deviation	0.013**	0.007	0.085	0.016*	-0.031	0.093	0.009	0.094	0.074
	(0.006)	(0.191)	(0.059)	(0.009)	(0.238)	(0.085)	(0.008)	(0.307)	(0.080)
Monthly temperature	0.027***	-0.108	0.149*	0.019	-0.148	0.080	0.038***	0.041	0.259**
	(0.008)	(0.249)	(0.077)	(0.012)	(0.289)	(0.106)	(0.012)	(0.444)	(0.116)
Temperature squared	0.000***	0.002	-0.002*	0.000	0.003	-0.001	-0.001***	-0.001	-0.004**
	(0.000)	(0.004)	(0.001)	(0.000)	(0.005)	(0.002)	(0.000)	(0.007)	(0.002)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediator variable	No	No	No	No	No	No	No	No	No
Observations	22,468	5,083	22,468	11,567	3,027	11,567	10,901	2,056	10,901

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

3.2.4 Robustness checks – negative binomial hurdle count model

Since the outcome variable was a count, we repeated the two-part estimation using the hurdle count model as shown in the Table A3 in the appendix. Results of the effect of weather events on days of illness in the first part of the model in panel A of Table A3 were similar to those reported in Table 3, while results in the second part differed by effect size only, the effect sign and significance levels were similar in most cases. Similarly, logit parameter marginal effects estimate for the hurdle negative binomial model in Table A3, Panel B, for the missed work days were similar to those in the two parts model in Table 5. The coefficients for the truncated negative binomial, conditional on reporting any work days lost were however larger than figures reported in the GLM. The other weather variables remained insignificant in the truncated part of the model, except the monthly rainfall variable in women. An increase in rainfall in the month before interview increased the number of days women were unable to conduct their usual activities by 1.4. The negative binomial estimates of the overall effect were slightly higher than coefficients of overall effect in the two parts model, however the coefficients sign and significance levels were almost similar.

3.2.5 Health care services on number of days of illness and days of work days lost due to illness

Results in Table 6 shows the coefficients of different health care services, controlling for weather and other socio-economic covariates on the subsample of individuals who were sick and sought consultation. Gender based differences on the effect of health care services were noted. Most of the health care variables were significant showing evidence of the importance of health care services on health outcomes at the intensive margin (number of days of illness, conditional on being sick), especially in men. Distance to the health facility was positively associated with increased number of days of illness in both men and women. Specifically, an additional increase in distance by 1 km increased the number of days of illness in men by 0.14 and in women by 0.11 at 1% significance level. The results were consistent across the different regression models. Men who sought treatment in the government hospitals or health centers recorded significantly less number of days of illness than those who sought from base category (other healthcare centers). The coefficient sizes were higher for private hospitals (-2 days) than government health centers (-1.8 days) in men. In women, the coefficients of government hospitals were insignificant, even though the sign was negative as expected. Similar results were observed on private hospital in women. Pharmacy access had significant and negative effects on the number of days of illness in both men and women, with higher effect sizes than the other health care arrangements. All the other weather variables were not significant as earlier reported in the second parts of the respective two-parts models, except the negative rainfall variable whose coefficients were statistically negative in men only[7].

Table 6: Association between health care services and days of illness

	All			**Women**			**Men**		
Variables	GLM	Truncated NB (TNB)	Negative Binomial (NB)	GLM	TNB	NB	GLM	TNB	NB
Distance to health facility	0.125***	0.123***	0.122***	0.114***	0.112***	0.111***	0.141***	0.138***	0.136***
	(0.010)	(0.011)	(0.010)	(0.012)	(0.013)	(0.013)	(0.018)	(0.018)	(0.017)
Government hospital	-1.137**	-1.153***	-1.136***	-0.673	-0.692	-0.686	-1.841***	-1.870***	-1.839***
	(0.440)	(0.412)	(0.396)	(0.555)	(0.527)	(0.508)	(0.707)	(0.660)	(0.631)
Private hospital/doctor	-1.128**	-1.161***	-1.147***	-0.602	-0.636	-0.633	-1.982***	-2.026***	-1.993***
	(0.440)	(0.412)	(0.395)	(0.560)	(0.532)	(0.513)	(0.697)	(0.649)	(0.621)
Pharmacy or drug shop	-3.216***	-3.292***	-3.213***	-2.881***	-2.952***	-2.883***	-3.768***	-3.863***	-3.768***
	(0.453)	(0.430)	(0.413)	(0.579)	(0.559)	(0.538)	(0.713)	(0.675)	(0.644)
Weather variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediator variable	No	No	No	No	No	No	No	No	No
N	6,122	6,122	6,122	3,639	3,639	3,639	2,483	2,483	2,483

[7] Results not shown in the table

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

With reference to the association between health care services and number of days absent from work, results in Table 7 indicate significant coefficients in both men and men. As reported earlier, distance to the health facility, government hospital, private hospital and pharmacy had significant effects in men with expected signs, even though the effect sizes of these variables were a bit lower than the earlier reported for days of illness. Moreover, unlike for the number of sick days where there were no significant differences of private and government hospital in women, the number of work days missed by women who sought consultations from the specified health care services were significantly lower. Women who sought health care services from the pharmacies missed significantly less days of work- a reduction of about 3 days, as compared to those who sought health assistance from the other health care (base category). The coefficients in men was greater– a reduction in work days loss of nearly 4 days for pharmacy which is double to coefficients of private and government arrangements in women.

Table 7: Association between health care services and days individuals were unable to do activities

Variables	**All sample**			**Women**			**Men**		
	GLM	TNB	NB	GLM	TNB	NB	GLM	TNB	NB
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance to health facility	0.092***	0.090***	0.082***	0.091***	0.089***	0.078***	0.092***	0.090***	0.086***
	(0.009)	(0.009)	(0.009)	(0.011)	(0.010)	(0.011)	(0.015)	(0.015)	(0.015)
Government hospital	-1.203***	-1.234***	-1.199***	-0.918**	-0.933**	-0.997**	-1.696***	-1.748***	-1.519***
	(0.358)	(0.327)	(0.322)	(0.455)	(0.399)	(0.397)	(0.581)	(0.562)	(0.544)
Private hospital/doctor	-1.172***	-1.215***	-1.128***	-0.846*	-0.874**	-0.829**	-1.793***	-1.859***	-1.650***
	(0.357)	(0.326)	(0.320)	(0.456)	(0.402)	(0.399)	(0.569)	(0.554)	(0.535)
Pharmacy or drug shop	-3.038***	-3.217***	-3.261***	-2.729***	-2.891***	-2.984***	-3.541***	-3.746***	-3.709***
	(0.380)	(0.353)	(0.342)	(0.486)	(0.437)	(0.428)	(0.604)	(0.593)	(0.568)
Weather variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediator variable	No	No	No	No	No	No	No	No	No
N	4,632	4,632	6,122	2,776	2,776	3,639	1,856	1,856	2,483

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

3.2.6 Multivariate decomposition results

Table 8 presents multivariate results for logistic and negative binomial gender health gap decomposition estimates. Generally, the overall decomposition reveals that most of the differences in the health status in terms of prevalence of illness and work days lost between women and men were due to coefficients or differences in effects, thus unexplained. Differences in observed endowments or characteristics between men and women only explained 27% and 34% of the gender health gap at the extensive margin (suffering illness and stop working) as illustrated in columns 2 and 4 respectively.

Focusing on the explained component part of the detailed decomposition, results show women-men health differences in terms of likelihood of suffering from illness would have decreased by at least 4% if women and men were exposed to the same temperatures' distribution regimes. With regards to contribution of the other individual and household socioeconomic characteristics to gender health inequality, most of the gender health differences on suffering illness were explained by age which significantly accounted for 5.7% of the total explained gap, years of schooling (9.6%) and marital status-never married, which contributed to the highest proportion of the gap (16.5%). These results imply that the inequalities in health status between women and men would be eliminated or narrowed if all individuals of both gender groups were of the same age, similar marital status arrangements and similar education levels. Differences in the occupation status were also significant in reducing the gap at the extensive margin, especially the gender differences in the paid work, accounting for -8% of the gap.

Only differences in long-term weather measures contributed significantly to the gender health gap, at the extensive margin in terms of probability of work days lost. However, the magnitude of contribution was less than 1%. Differences in age, years of schooling and marital status also contributed significantly to the gap in terms of work days lost with positive coefficients and higher percent contributions than those reported earlier. For instance, the women-men gap in terms of the likelihood of missed work days is expected to reduce by 5%, 13% and 18% if age, years of education and marital status (never married) are equalized for the both groups.

For differences in number of days of illness or workdays lost for whole subsamples, the proportion of the overall health gap attributable to differences in characteristics was relatively higher to that reported at the extensive margin, more so on the number of work days lost. However, approximately 60% of the gap was largely due to the coefficient's effects and could not be explained. The proportion of health gap explained by the weather variables was however minimal, with temperature contributing the highest at around 5% on number of days of illness. Just like at the extensive margin, over half of women-men health inequalities (for both the number of days of illness and days stopped working) due to differences in characteristics were explained by never married category of marital status.

Controlling for health seeking behaviors in the decomposition analysis, results in Table 9 indicate that the proportion of gender health inequalities explained by the endowment component increased significantly. In particular, the explained health gap in the number of days of illness doubled to 57% as compared to 27% without health care variables. This reveals the importance of health care services[8] at the intensive margin. Gender differentials in terms of distance to the health explained a considerable magnitude of about 14% of the health gap, access to pharmacy or drug shop accounts for 21% while government hospital and private hospital explains 7% and -4% respectively. However, government and private hospital variables were insignificant. Other factors that greatly and significantly explained the gender gap in terms of days of illness include; age, farming, business, dependency ratio, treated mosquito net and year dummies[9].

Table 8: Multivariate decomposition of women-men gap on days illnesses and days stopped working

VARIABLES	Logistic				Negative binomial			
	Suffered illness (dummy)		Stopped working (dummy)		Days illness (number)		Days stopped working	
	Coefficients	Percent	Coefficients	Percent	Coefficients	Percent	Coefficients	Percent
Overall decomposition	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Characteristics (E) – Explained	0.025***	27.08	0.024***	34.24	0.329***	29.25	0.164***	42.59
	(0.003)		(0.003)		(0.076)		(0.039)	
Coefficients (C) – Unexplained	0.067***	72.92	0.046***	65.76	0.798***	70.75	0.221**	57.40
	(0.009)		(0.008)		(0.176)		(0.094)	
Raw difference	0.092***		0.069***		1.128***		0.384***	
	(0.0084)		(0.0073)		(0.1710)		(0.091)	
Detailed decomposition (E)								
Negative rainfall deviation	-0.0006***	-0.662	-0.0006***	-0.842	-0.0088***	-0.781	-0.0030***	-0.788
	(0.0001)		(0.0001)		(0.0022)		(0.0010)	
Log month rain	0.0003	0.352	-0.0005	-0.749	0.0036	0.318	-0.0069	-1.786
	(0.0005)		(0.0005)		(0.0094)		(0.0046)	
Log rain squared	-0.0006	-0.697	0.0004	0.628	-0.0075	-0.666	0.0065	1.685
	(0.0006)		(0.0005)		(0.0107)		(0.0052)	
Positive temperature deviation	-0.0001**	-0.076	-0.0001*	-0.079	-0.0005	-0.043	-0.0002	-0.041
	(0.0000)		(0.0000)		(0.0006)		(0.0003)	
Month temperature	0.0045***	4.884	0.0021	3.003	0.0548**	4.862	0.0121	3.152
	(0.0014)		(0.0013)		(0.0260)		(0.0128)	
Temperature squared	-0.0042***	-4.566	-0.0020	-2.916	-0.0535*	-4.739	-0.0110	-2.858
	(0.0015)		(0.0014)		(0.0278)		(0.0136)	
Age	0.0053***	5.743	0.0036***	5.189	0.0879***	7.794	0.0352***	9.168
	(0.0005)		(0.0005)		(0.0123)		(0.0055)	
Education	0.0089***	9.663	0.0090***	12.97	0.1017**	9.014	0.0479**	12.45
	(0.0022)		(0.0021)		(0.0455)		(0.0224)	
Asset index	0.0002***	0.241	0.0001**	0.164	0.0024**	0.208	0.0010*	0.258
	(0.0001)		(0.0001)		(0.0011)		(0.0006)	
Water harvesting	0.0000	0.005	0.0000	0.012	0.0001	0.010	0.0001	0.026
	(0.0000)		(0.0000)		(0.0002)		(0.0001)	
Treated mosquito net	-0.0031***	-3.310	-0.0007	-1.03	-0.0318*	-2.819	-0.0142*	-3.695

[8] This estimate was only relevant for subsample of individuals who were ill (Table 9) while estimates in Table 8 were for the full sample

[9] These results are not shown.

	(0.0009)		(0.0008)		(0.0167)		(0.0083)	
Salaried /wage	-0.0076***	-8.194	-0.0044***	-6.437	-0.0768**	-6.808	-0.0401**	-10.426
	(0.0017)		(0.0015)		(0.0328)		(0.0156)	
Business	-0.0006***	-0.596	-0.0001	-0.209	-0.0026	-0.228	0.0011	0.292
	(0.0001)		(0.0001)		(0.0023)		(0.0011)	
Farming	-0.0019**	-2.052	-0.0015*	-2.160	-0.0571***	-5.06	-0.0374***	-9.738
	(0.0009)		(0.0008)		(0.0156)		(0.0076)	
Monogamous	-0.0003*	-0.307	-0.0001	-0.196	-0.0039	-0.343	-0.0013	-0.332
	(0.0001)		(0.0001)		(0.0031)		(0.0015)	
Polygamous	-0.0006	-0.641	-0.0004	-0.632	-0.0060	-0.534	-0.0034	-0.884
	(0.0004)		(0.0004)		(0.0082)		(0.0041)	
Divorced	0.0001	0.126	0.0000	0.044	0.0049	0.431	0.0046	1.205
	(0.0005)		(0.0005)		(0.0104)		(0.0052)	
Separated	0.0017**	1.872	0.0011	1.582	0.0158	1.399	0.0029	0.767
	(0.0008)		(0.0008)		(0.0173)		(0.0082)	
Never married	0.0153***	16.54	0.0126***	18.24	0.2100***	18.62	0.1021***	26.55
	(0.0022)		(0.0021)		(0.0406)		(0.0207)	
No income	0.0022	2.390	0.0029	4.153	0.0370	3.283	0.0494*	12.86
	(0.0029)		(0.0027)		(0.0552)		(0.0273)	
Income (1- 250000 UGX)	-0.0009	-0.945	-0.0005	-0.785	-0.0111	-0.988	-0.0087	-2.272
	(0.0019)		(0.0017)		(0.0359)		(0.0178)	
Income (250,001 – 750,000)	0.0023*	2.471	0.0015	2.113	0.0313	2.772	0.0053	1.367
	(0.0012)		(0.0011)		(0.0217)		(0.0111)	
Income (> 750,000)	-0.0003	-0.293	-0.0001	-0.119	-0.0034	-0.297	0.0028	0.733
	(0.0005)		(0.0004)		(0.0089)		(0.0045)	
Dependency ratio	0.0001	0.137	-0.0003	-0.377	-0.0071	-0.626	0.0015	0.384
	(0.0008)		(0.0007)		(0.0150)		(0.0075)	
Net usage	0.0045***	4.869	0.0017*	2.481	0.0481**	4.262	0.0171*	4.460
	(0.0010)		(0.0009)		(0.0195)		(0.0094)	
Year 2009	-0.0001***	-0.079	-0.0000	-0.015	-0.0006*	-0.051	-0.0002	-0.054
	(0.0000)		(0.0000)		(0.0003)		(0.0002)	
Year 2010	0.0001***	0.106	0.0001***	0.101	0.0015***	0.131	0.0004**	0.094
	(0.0000)		(0.0000)		(0.0004)		(0.0002)	
Year 2011	-0.0000***	-0.038	-0.0000	-0.005	-0.0002	-0.020	-0.0002*	-0.059
	(0.0000)		(0.0000)		(0.0002)		(0.0001)	
Year 2013	0.0001***	0.135	0.0001***	0.100	0.0017***	0.147	0.0003**	0.071
	(0.0000)		(0.0000)		(0.0003)		(0.0001)	
Observations	22,469	22,469	22,469	22,469	22,469	22,469	22,469	22,469

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

Table 9: Multivariate decomposition results for days of illness at the intensive margin

VARIABLES	Days illness (number)	
Overall decomposition	Coefficients	Percentage
Characteristics (E) – Explained	0.196**	56.83
	(0.091)	
Coefficients (C) – Unexplained	0.149	43.17
	(0.2200	
Raw difference	0.345*	
	(0.205)	
Detailed decomposition (E)	E	
Distance to the health facilities	0.0495***	14.35
	(0.0070)	
Other health care	0.0055***	1.593
	(0.0019)	
Government hospital/center	0.0243*	7.057
	(0.0136)	
Private hospital/doctor	-0.0131**	-3.785
	(0.0065)	
Pharmacy or drug/local shop	0.0715***	20.737
	(0.0096)	
Weather variables	Yes	
Other variables	Yes	
Year variables	Yes	
Mediator variable	Yes	
Observations	6,971	6,971

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

4 Discussion and Conclusion

4.1 Discussions

This study analyzed the effects of weather anomalies on days of illness and days of work lost due to illness among men and women groups, established the indirect effect through water collection labor burdens and further established the gender differentials in factors that explain the observed gender gap in health status. Most studies on the effect of weather or climate anomalies focuses on specific diseases, we however took an alternative approach by considering all illnesses captured within the last 30 days prior to the interview. This is because information was only collected on symptoms rather than particular diseases. Furthermore, the most common symptoms are related to climate sensitive illnesses.

Empirical results showed that low rainfall significantly increased the likelihood of illness of the total sample by 7.5 percentage points. These results are consistent Lohmann & Lechtenfeld (2015) who found out that drought increased the probability of general diseases by about 10 percentage points among individuals. Even though the magnitude of effect in our study was almost similar to Lohmann & Lechtenfeld (2015) study, they did not find any significance differences by gender (interaction of gender and drought), and furthermore they considered all individuals as opposed to our study which focused on only individuals in the working age. They however revealed that younger people were less sickly than adults, and males suffered less from a health shock as compared to women. Other studies on effects of droughts and mental health found out that prolonged drought was associated with increased likelihood of psychological distress, especially in the rural areas (OBrien et al., 2014), and drought related worries especially among the working individuals (Stain et al., 2011). However, these studies did not establish the effects of drought on distress on the different gender categories. Apart from the highlighted mental health, Yusa et al. (2015) indicate the importance of drought on other illnesses such as infectious disease, respiratory diseases, injuries and food/water insecurity related illness.

Further results indicate that water collection time fully mediated the relationship between negative rainfall events and illness in women and partially mediated the relationship in men. Full mediation means that occurrence of low rainfall increased water collection time in women, and in turn, both low rainfall and water collection time burden directly affected health outcomes. Indeed, we found that women allocated more time to water collection activities as compared to men. Similar studies on water scarcity reported that in Kasalu subcounty of southern part of Uganda, a high proportion of households (85%) spent significantly more time collecting water during drier periods (at least one hour a day) as compared to wet seasons (Mukasa et al., 2021). More time spent at water source and on hilly roads, especially when carrying a heavy container of water has severe health consequences on women and girls. Asaba et al. (2013) study in Uganda revealed that women and children suffered more from health complications associated with water collection such as headaches.

High temperature in the long run and short run significantly increased probability of suffering from illness and absenteeism in both men and women, and further contributed to a significant proportion of the observed gender health gap. The coefficient of the positive temperature deviation was almost similar for both groups, while the coefficient of the temperature prior to the month before interview was higher in men. These results are consistent with Gifford (2019) meta-analysis that reported a high risk of heat related illness in men, after correction for occupation. Other studies that found positive correlation between temperature and specific illnesses without gender dimensions include; (Chowdhury et al., 2018; Sewe et al., 2016; Texier et al., 2013; Tompkins et al., 2019).

One of the major results from the decomposition analysis is that 27 - 57% of the gender gap in health status was explained by the different risk factors, including weather factors, differences in socio-economic and demographic characteristics of men and women. This proportion of gender health inequality is almost similar to (54%) that was reported by Murendo & Murenje (2018), Zhang et al. (2015) where the explained component of the gender health gap ranged between 31-69% and 66% reported by (Madden, 2010). However, the proportion attributable to endowments in this study was lower to what was reported by Sia et al. (2014), especially in Lesotho and Tanzania where the gap attributable to gender differences in characteristics was over three quarters.

With regards to contributions of the individual factors to the explained gap, age, years of schooling, marital status (single), income, wealth and occupation were significant and explained a significant proportion of the gender health gap. These results are consistent with Felder (2006) and Madden (2010) for marital status, Zhang et al. (2015) for education and Murendo & Murenje (2018) for wealth. While our findings reveal a reduction in women-men illness gap if men and women income is equalized, Leung et al. (2004) reported that longevity advantage of women in terms of life expectancy will reduce if gender gap in wages or income is narrowed.

Differences in health seeking behaviors indeed explained a significant proportion of the health gap (over half of the total explained component) at the intensive margin of days of illness. From the descriptive statistics, heterogeneity was observed in the places where they visited for health care services. These results are consistent with Gyasi et al. (2019) and Ssewanyana et al. (2004) who found no significance differences in health care usage among men and women. The former study also reported that adult males sought formal health care than young men and women. However, Stefan (2015) argued that women were more active in health information seeking, from both formal and informal sources, more attentive on healthy life styles and pandemics. Schünemann et al. (2017) found out that gender specific health investment and preferences explained 70% of the gender health gap, and up to 89% with inclusion of preferences in unhealthy consumption. Thereby reducing life expectancy from 4.6 to 1.4 when women were endowed with men health behaviors preferences (Schünemann et al., 2017).

4.2 Conclusions

We examined the effects of weather anomalies on illness in men and women of the working age using the datasets from 2009-2014. The study goes beyond establishing total and direct effects of weather variability on illness, and evaluates the extent to which rainfall and temperature affect health, through water scarcity pathway. Furthermore, the study provides new insights on gender differential factors that explain the observed gender health gap at both extensive and intensive margins of illness, including weather events as well as healthcare seeking behaviors.

Generally, both men and women health were negatively affected by weather anomalies at the extensive margins, in terms of likelihood of illness and work days lost due to the illness. Heterogenous insignificant effects were observed at the intensive margin conditional on being sick, where weather anomalies increased the number of days of illness in women, and reduced the number of sick days in men. The overall effect of weather variables was however significant, positive and of higher magnitude in women than in men. Mediation analysis revealed that water collection time fully mediated the relationship between negative rainfall anomaly and probability of illness in women while a partial mediation process was observed in men. Domestic rain water harvesting played important roles in reducing the time burdens in water collection in both women and women, and improved health in men.

Further estimates provided evidence that indeed health care services matter in reduction of the number of illness and number of work day lost. Decompositions analysis demonstrated that differences in characteristics accounted for about 27-57% of the gender gap in health status, with over half of the explained gap at the intensive margin explained by health-seeking behaviors. Differences in temperature age, years of schooling, wealth and never married accounted for significant proportions of the explained gender health gap.

Given that women had poorer health than men and were less economically endowed, investment in education, job creation and other income-based investments, water sanitation and hygiene conditions as well as investment in health adaptation such as early warning systems, will aid in reducing the propensity for illness, and the subsequent days of illness or unproductive days and improve household welfare in Uganda. Limitations of the study include data deficiency, especially on health behaviors and health adaptation measures. Weather variables were for the enumeration areas as opposed to where the specific individuals spent time. Furthermore, illness was captured for a short period of time.

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Table A1: Average marginal effects results of logit model on the effect of weather and other determinants on probability of illness (Full model), with mediator variable

	All sample		Women		Men	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Negative rain deviation	**0.0738*****	0.0096	**0.0809*****	0.0136	**0.0669*****	0.0134
Log monthly rain	-0.0417*	0.0246	-0.0170	0.0354	-0.0630*	0.0336
Log rain squared	0.0067**	0.0031	0.0043	0.0045	0.0087**	0.0043
Positive temperature deviation	0.0230***	0.0068	0.0212**	0.0098	0.0233**	0.0093
Monthly temperature	**0.0427*****	0.0088	**0.0387*****	0.0124	**0.0475*****	0.0127
Temperature squared	-0.0006***	0.0001	-0.0005***	0.0002	-0.0007***	0.0002
Water collection time	**0.0023*****	0.0006	**0.0027*****	0.0007	**0.0027****	0.0011
Water harvesting	-0.030	0.027	0.020	0.036	-0.098**	0.042
Other covariates	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Observations	22,468		11,567		10,901	

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

Table A2: Marginal effects results of effect of weather variables on time spent on water collection

	All sample		Women		Male	
Variables	Coefficient	Std. Err.	Coefficient	Std. Err.	coefficient	Std. Err.
	(1)	(2)	(3)	(4)	(5)	(6)
Negative rain deviation	**0.3503*****	(0.1260)	**0.7030*****	(0.1879)	**0.1584**	(0.1322)
Log monthly rain	-0.2781	(0.2975)	-1.4906***	(0.4288)	1.1295***	(0.3568)
Log rain squared	0.0450	(0.0386)	0.2169***	(0.0555)	-0.1462***	(0.0463)
Positive temperature deviation	-0.2892***	(0.0966)	-0.5497***	(0.1415)	-0.1124	(0.1037)
Monthly temperature	**0.2391****	(0.1049)	**0.3691****	(0.1500)	**0.1810**	(0.1318)
Temperature squared	-0.0029*	(0.0017)	-0.0040*	(0.0024)	-0.0028	(0.0021)
Water harvesting	-2.951***	(0.513)	-4.490***	(0.885)	-2.014***	(0.537)
Other variables	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
N	22,468		11,567		10,901	

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

Table A3: Effect of weather variables on days of illness and days stopped doing the usual activities - Negative binomial hurdle model - marginal effects

Variables	All sample			Women			Men		
	Logit	Truncated NB	Negbin	Logit	Truncated NB	Negbin	Logit	Truncated NB	Negbin
	(1)	(2)		(3)	(4)		(5)	(6)	
Panel A				Days illness					
Negative rainfall deviation	0.075***	-0.198	0.932***	0.083***	0.552	1.364***	0.067***	-1.251**	0.562**
	(0.009)	(0.313)	(0.202)	(0.014)	(0.403)	(0.303)	(0.013)	(0.494)	(0.264)
Log month rainfall	-0.044*	-0.106	-0.576	-0.022	-0.330	-0.282	-0.062*	0.384	-0.742
	(0.025)	(0.744)	(0.503)	(0.035)	(0.962)	(0.739)	(0.034)	(1.168)	(0.674)
Log rain squared	0.007***	0.011	0.089	0.005	0.041	0.067	0.009**	-0.054	0.097
	(0.003)	(0.096)	(0.065)	(0.005)	(0.124)	(0.095)	(0.004)	(0.151)	(0.086)
Positive temperature deviation	0.022***	0.010	0.272*	0.020**	-0.044	0.159	0.023**	0.137	0.337*
	(0.007)	(0.212)	(0.140)	(0.009)	(0.277)	(0.209)	(0.009)	(0.329)	(0.186)
Month temperature	0.043***	-0.025	0.518***	0.039***	0.254	0.556**	0.048***	-0.366	0.489*
	(0.009)	(0.279)	(0.180)	(0.012)	(0.349)	(0.258)	(0.013)	(0.462)	(0.251)
Temperature squared	-0.001***	0.000	-0.008***	-0.001***	-0.004	-0.008**	-0.001***	0.005	-0.007*
	(0.000)	(0.004)	(0.003)	(0.000)	(0.006)	(0.004)	(0.000)	(0.007)	(0.004)
Sex	-0.070***	-0.376*	-0.846***						
	(0.006)	(0.201)	(0.134)						
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,468	6,970	22,468	11,567	4134	11,567	10,901	2386	10,901
Panel B				**Work days lost due to illness**					
Negative rainfall deviation	0.068***	-0.850***	0.400***	0.080***	-0.861***	0.488***	0.056***	-0.798*	0.310**
	(0.009)	(0.270)	(0.110)	(0.013)	(0.331)	(0.159)	(0.012)	(0.460)	(0.153)
Log month rainfall	0.020	0.381	0.093	0.036	1.348*	0.562	0.005	-1.298	-0.279
	(0.023)	(0.650)	(0.265)	(0.034)	(0.797)	(0.374)	(0.032)	(1.120)	(0.378)
Log rain squared	-0.002	-0.041	-0.007	-0.003	-0.164	-0.060	0.000	0.164	0.033
	(0.003)	(0.083)	(0.034)	(0.004)	(0.102)	(0.048)	(0.004)	(0.144)	(0.049)
Positive temperature deviation	0.013**	0.007	0.084	0.016*	-0.025	0.053	0.009	0.089	0.106
	(0.006)	(0.180)	(0.075)	(0.009)	(0.224)	(0.108)	(0.008)	(0.302)	(0.105)
Month temperature	0.027***	-0.113	0.180*	0.019	-0.159	0.128	0.038***	0.045	0.226
	(0.008)	(0.235)	(0.096)	(0.012)	(0.280)	(0.134)	(0.012)	(0.423)	(0.138)
Temperature squared	0.000***	0.002	-0.003*	0.000	0.003	-0.002	-0.001***	-0.001	-0.004*
	(0.000)	(0.004)	(0.002)	(0.000)	(0.004)	(0.002)	(0.000)	(0.007)	(0.002)
Sex	-0.049***	0.437**	-0.275***						
	(0.006)	(0.172)	(0.071)						
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mediator variables	No	No	No	No	No	No	No	No	No
N	22,468	5,083	22,468	11,567	3,027	11,567	10,901	2,056	10,901

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