HHS Public Access

Author manuscript

Afr J AIDS Res. Author manuscript; available in PMC 2018 May 22.

Published in final edited form as:

Afr J AIDS Res. 2017 July ; 16(2): 91–99. doi:10.2989/16085906.2017.1308386.

Barriers and facilitators of antiretroviral therapy adherence in rural Eastern province, Zambia: the role of household economic status

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Abstract

In Zambia, more people living with HIV now have access to lifesaving antiretroviral therapy than ever before. However, progress in HIV treatment and care has not always resulted in lower mortality. Adherence remains a critical barrier to treatment success. The objective of this study was to examine the barriers and facilitators of antiretroviral therapy adherence, particularly the role of household economic status. The study included a cross-sectional sample of 101 people living with HIV (PLHIV) in two rural communities in eastern Zambia. Adherence was measured using patient self-assessment and pharmacy information. Household economic status included components such as occupation, income, assets, food security, and debt. Multivariable logistic regression was conducted to examine the associations between household economic factors and adherence. Our findings suggest that the role of economic status on adherence appears to be a function of the economic component. Debt and non-farming-related occupation were consistently associated with non-adherence. The association between assets and adherence depends on the type of asset. Owning more transportation-related assets was consistently associated with non-adherence, whereas owning more livestock was associated with self-reported adherence. Additionally, living in a community with fewer economic opportunities was associated with non-adherence. The associations between place of residence and pharmacy refill adherence and between transportation assets and self-reported adherence were statistically significant. Improving adherence requires a multifaceted strategy that addresses the role of economic status as a potential barrier and facilitator. Programmes that provide economic opportunities and life-skills training may help PLHIV to overcome economic, social, and psychological barriers.

Keywords

asset ownership; debt; HIV treatment; medication; Southern Africa

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Introduction

In recent years, Zambia has achieved notable progress in expanding access to HIV treatment. In 2014 an estimated 55% (or 530 702) of adults living with HIV in Zambia were receiving antiretroviral therapy (ART), one of the highest coverage rates in sub-Saharan Africa (UNAIDS, 2014). Additionally, the number of Zambian adults living with HIV who have access to ART increased by more than 25 percentage points between 2010 and 2015 (UNAIDS, 2016). This substantial expansion of ART coverage has provided lifesaving drugs to hundreds of thousands of people living with HIV (PLHIV) in the country. However, expansion of and progress in HIV treatment and care have not always translated into a lower mortality rate (National AIDS Council [Zambia], 2014; Rathod et al., 2014; Stringer et al., 2006). In addition to delayed HIV testing and late diagnosis (Hensen, Baggaley, & Wong, 2015; Stringer et al., 2006; Thierman et al., 2006), non-adherence to ART remains a barrier to treatment success (Denison et al., 2015; Rathod et al., 2014; Vinikoor et al., 2014). Furthermore, as access to ART in Zambia increases and treatment duration extends, adherence rates decline over time (Jones, Cook, Spence, Weiss, & Chitalu, 2014; Okawa et al., 2015). In turn, non-adherence to ART elevates risk of adverse outcomes, including higher rates of morbidity and mortality (Bangsberg et al., 2001; Chi et al., 2009; Wood et al., 2003; Wood et al., 2006), and may undermine efforts to increase survival of PLHIV and eliminate HIV/AIDS.

Given the importance of adherence to treatment failure or success, a growing body of research has identified barriers and facilitators of ART adherence among treatment-experienced PLHIV in Zambia (Birbeck et al., 2011; Musheke, Bond, & Merten, 2012; Nozaki, Dube, Kakimoto, Yamada, & Simpungwe, 2011; Sanjobo, Frich, & Fretheim, 2008; Sasaki et al., 2012). Consistent with evidence in other parts of sub-Saharan Africa (Kagee et al., 2011; Mills et al., 2006; Reda & Biadgilign, 2012), factors affecting adherence in Zambia can be classified into five dimensions: patient-related, therapy-related, condition-related, institutional, and socio-economic (Birbeck et al., 2011; Denison et al., 2015; Grant, Logie, Masura, Gorman, & Murray, 2008; Nozaki et al., 2011; Sanjobo et al., 2008). However, few studies have focused on the role of household economic status in influencing adherence to ART, particularly in rural and low-resource communities in Zambia. Previous research in low- and middle-income countries has shown positive associations between household economic stability and adherence to ART (Lankowski, Siedner, Bangsberg, & Tsai, 2014; Peltzer & Pengpid, 2013; Reda & Biadgilign, 2012). At the very least, household economic insecurity, characterised by inadequate income and limited assets, deprives PLHIV of tangible resources that they can use to pay for treatment-related costs (such as transportation expenses to visit health facilities) and to access adequate and nutritious food necessary to optimise benefits of ART. At its worst, household economic insecurity may force PLHIV to skip doses, miss clinic appointments, or give up treatment, which in turn, heightens risks of morbidity and mortality (Chi et al., 2009; Stringer et al., 2006). In addition, our study, to the best of our knowledge, is one of the first empirical studies to examine correlates of ART adherence in Eastern province, Zambia. Previous research has been conducted primarily in urban and rural settings in Lusaka, Southern, and Copperbelt provinces (Birbeck et al., 2009; Grant et al., 2008; Jones et al., 2014; Murray et al., 2009;

Nozaki et al., 2011; Sanjobo et al., 2008). Given current gaps in knowledge, this study aims to investigate the role of various components of household economic status in influencing adherence to ART among treatment-experienced PLHIV in rural Eastern province, Zambia. Furthermore, we focus on examining alterable economic correlates of ART adherence to help identify factors that can be targeted by adherence interventions.

Methods

Study design and sample

This study used a cross-sectional design. We analysed baseline data that were collected from 101 treatment-experienced PLHIV who were participating in a livelihood intervention. The sample size was determined by the requirements of the main intervention outcome, treatment adherence. Thus, the aim was to recruit 100 treatment-experienced PLHIV. Furthermore, at the time of data collection, all participants were receiving outpatient HIV care either at Lundazi District Hospital (LDH) or Lumezi Mission Hospital (LMH). The study received institutional review board (IRB) approvals from the University of Zambia Biomedical Research Ethics Committee and the University of North Carolina at Chapel Hill Institutional Review Board. Permission to conduct research activities was obtained from the Zambian Ministry of Health and the Office of the District Community Medical Officer in Lundazi district. Informed consent was obtained from all study participants.

Study setting

The study was conducted in Lundazi district, Eastern province. Lundazi district was selected as the study site because it is a rural, low-resource district with a high prevalence of HIV. More than 90% of the population in Lundazi district live in rural areas (Central Statistical Office [Zambia], 2012). In 2010 Lundazi district had a population of 314 281 (Central Statistical Office [Zambia], 2011). In 2010 HIV prevalence was estimated at 15%, higher than the overall prevalence rates in the province and the country (National AIDS Council [Zambia], 2014). Agriculture is the most common occupation, and the district is one of the highest producers of maize, cotton, groundnuts, and tobacco. The two health facilities in the study, LDH and LMH, are located in Lundazi district and primarily serve the residents of Lundazi and Lumezi communities respectively. Both towns are more than 150 kilometres away from Chipata, the capital and economic centre of Eastern province.

Data collection methods

Data were collected using two methods: interviewer-administered survey questionnaire and abstraction of medical and pharmacy records. The survey, conducted between December 2014 and January 2015, gathered data on respondents' demographics, socio-economic status, and psychosocial functioning. Medical and pharmacy records were reviewed to obtain ART-related information (such as treatment start date, treatment duration, treatment regimen, and timing of pharmacy refill pick-up) and physical health and clinical data (e.g., weight, body mass index, and CD4 count). Medical and pharmacy data abstraction occurred between January and March 2015.

Variables and measures

Adherence—Adherence to ART was measured using two methods: patient self-assessment and pharmacy refill information. Patient self-assessment was collected using a visual analogue scale (VAS). The VAS assessed adherence during the past 30 days. Respondents were asked to place an "X" inside the box above the point showing the best guess about how much of their current antiretroviral (ARV) medications were taken in the past 30 days. Despite their limitations, patient self-assessments of ART adherence have been shown to perform well (i.e., no evidence of significant overestimation) in comparison with other more objective adherence measures such as pharmacy records (Kabore et al., 2015; Ross-Degnan et al., 2010; Simoni et al., 2014).

Pharmacy refill information referred to the timing of ARV prescription pick-up. In the event that refills are not obtained in a timely manner, it is assumed that ART patients are not taking their medications between refills or are missing doses in a way that allows medication to last longer than it should (Steiner & Prochazka, 1997). The pharmacy adherence measure in this study was based on a variation of the medication possession ratio (MPR), defined as the proportion of days an ART patient possessed his or her medications relative to the total amount of time between two ARV prescription pick-ups (McMahon et al., 2011). Consistent with prior studies (Hong et al., 2013; Musumari et al., 2014), MPR was calculated as 1–(number of days late for ARV pick-up/total number of days between the two most recent ARV pick-ups), expressed as a percentage. Pharmacy records from the first and second quarters of 2015 were analysed to calculate MPR. Pharmacy records have been shown to be highly associated with biological markers of adherence among ART patients in SSA (Henegar et al., 2015; Rougemont, Stoll, Elia, & Ngang, 2009) and to outperform self-reported methods in predicting ART-related outcomes (Grossberg, Zhang, & Gross, 2004; McMahon et al., 2011; Sangeda et al., 2014).

To examine the association between ART adherence and household economic variables, we created binary adherence variables using data from the VAS and MPR. We defined adherence primarily as ≥95% of scheduled doses taken (Ickovics & Meade, 2002; Musumari et al., 2014; Paterson et al., 2000). Respondents were adherent if they took ≥95% of prescribed doses, and non-adherent if they took <95% of prescribed doses.

Household economic variables—Components of household economic status were the key independent variables of interest. These variables included occupation (farming or non-farming), monthly income (measured in 4 categories: 0 to 20 Zambian kwacha [ZMW], ZMW21–50, ZMW 51–500, and ZMW ≥501), debt (owed money or did not owe money), asset ownership, and food security. Asset ownership included three different types of assets: land, transportation, and livestock. With the exception of landownership (owned or did not own), asset variables were measured using indices (Filmer & Scott, 2012; Moser & Felton, 2007). Transportation assets included bicycles, motorcycles, ox carts, and other motor vehicles (e.g., cars and trucks). Livestock consisted of chicken, pigs, goats, cattle, donkeys, and sheep. Food security, defined in this study as access to food, was measured using an adapted version of the Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale, & Bilinsky, 2007). HFIAS consists of nine items that ask respondents the frequency of

experiencing different conditions and degrees of food insecurity within the past four weeks. We obtained a continuous measure of food insecurity by summing the scores for all HFIAS items. For descriptive purposes, we also created a categorical measure of the different degrees of food insecurity. These categories classified households as food secure, and mild, moderately, and severely food insecure (Coates et al., 2007).

Other covariates—We included three additional covariates. These covariates were place of residence (Lundazi or Lumezi), gender (female or male), and self-perceived health (poor, fair, good, very good, or better). We used purposeful variable selection strategies to identify key additional covariates and to avoid model over parameterisation given the sample size. First, we performed backward elimination (Maldonado & Greenland, 1993; Sun, Shook, & Kay, 1996) after we identified an initial list of adherence correlates in the literature. The list included patient (age, gender, marital status, education level, body mass index, perceived stress, self-perceived health, place of residence), therapy-related (pill burden, treatment duration), and health facility (distance to care and travel time to health facility) characteristics. Second, we kept variables that changed the coefficient for household economic predictors by more than 20% when eliminated (Hosmer, Lemeshow, & Sturdivant, 2013). These variables may provide necessary adjustment of the relationships between economic factors and ART adherence. Additionally, to determine an optimal number of predictor variables, we used the recommendation of Vittinghoff and McCulloch (2007) to have at least five observed events per predictor variable included into a logistic regression model.

Analysis

Bivariable and multivariable analyses were conducted to examine the association between household economic factors and ART adherence. We used logistic regression because of the binary nature of our outcome variables. Results of diagnostic tests indicated absence of highly collinear and influential data. We estimated two main multivariable models, one for each type of adherence measure set at the ≥95% threshold. In addition, we estimated two sensitivity models using alternative adherence thresholds. These alternative thresholds were set at the ≥90% and ≥80% levels. However, alternative definitions were created only for MPR because there was insufficient variation in the VAS to create sensitivity models based on ≥80% or ≥90% thresholds. These alternative adherence levels were consistent with studies that have shown adherence level of ≥80% or ≥90% may be sufficient to achieve optimal treatment outcomes (Kobin & Sheth, 2011; Shuter, Sarlo, Kanmaz, Rode, & Zingman, 2007; Viswanathan et al., 2015). All multivariable logistic regression models estimated the association between ART adherence and household economic factors by controlling for place of residence, gender, and self-perceived health.

In addition, we treated two ordinal independent variables (household income and self-perceived health) as interval variables in our analyses. To determine whether the successive categories of these two independent variables were equally spaced, we performed a series of likelihood ratio (LR) tests. For each LR test, the results were not significant ($p > 0.05$), which indicated that treating the household income and self-perceived health as interval

variables did not lead to loss of information about the association between these two independent variables and adherence (Long & Freese, 2006).

Finally, we conducted multiple imputation (MI) to take into account missing data, particularly adherence. Proportions of missing values for VAS and MPR were 22% and 12% of the overall sample size, respectively. We conducted MI based on best practices suggested in the literature (Graham, 2009; Enders, 2010; Little & Rubin, 2014). MI data sets were created by imputation using the chained equations approach (White, Royston, & Wood, 2011; van Buuren, 2007). We also created our primary MI model with 50 imputed datasets (Enders, 2010; Graham, Olchowski, & Gilreath, 2007). Bivariable and multivariable tests were conducted using multiply imputed data sets. Sensitivity analyses were conducted to compare results using complete case analysis and multiple imputation. Results were consistent. In particular, the direction of the significant associations did not change when using either complete case analysis or multiple imputation method. Data were analysed using Stata 14 (StataCorp, 2015).

Results

Sample characteristics

Table 1 lists the characteristics of study participants. Average age of respondents was 38 (youngest was 18 and oldest was 50). Most respondents were married (75%), 56% were women, and 35% obtained some secondary education or higher. Mean treatment duration was 26 months, and the median was 19 months. Ninety-seven per cent of respondents were prescribed first-line ART and 22% were taking more than one pill a day. Of the 78% who were prescribed a medication regimen of one pill once a day, respondents were given the drug combination of tenofovir, emtricitabine, and efavirenz.

ART adherence differed by adherence levels and measures. For example, based on the 30-day VAS, 74% of the sample were adherent. Based on pharmacy information and MPR, 67% were adherent at the ≥95% threshold. When MPR adherence thresholds were decreased to ≥90% and ≥80% of all prescribed doses, 71% and 77% of the sample respectively were adherent. In other words, the proportion of adherent patients increased as the optimal adherence levels were lowered. In addition, comparison of VAS and MPR using the ≥95% optimal adherence threshold indicated that the proportion of adherent respondents was higher based on the 30-day VAS (74%) than MPR (67%). The differences may suggest sensitivity of self-report adherence measures to bias, including over reporting or problem recalling real adherence levels. However, consistent with prior studies (Kabore et al., 2015; Simoni et al., 2014), there was no evidence of significant differences or overestimation between the two adherence measures.

In terms of economic characteristics, most respondents (75%) were involved in farming or farming-related occupations. Most respondents were income poor, with 70% reporting a household monthly income of ZMW 50 or less (or less than $0.30 per day). Using the World Bank’s poverty line for low income countries of 1.25 USD per day, an estimated 83% of the sample earned ≤$1.25 USD a day, or roughly ZMW 250 or less. In terms of asset ownership, 89% reported owning a plot of land. Bicycle was the most commonly-owned type of

transportation-related asset, with 21% of respondents reported owning one or two bicycles. Livestock was more commonly owned than mode of transportation. Chicken was the most commonly-owned livestock, with 46% of respondents reported raising one or more chickens. In terms of financial liabilities, 24% of respondents reported owing money. Lastly, 93% of the respondents were food insecure. The most prevalent form of food insecurity was hunger, with 74% of respondents reported experiencing severe food insecurity.

Household economic status and adherence

Bivariable results indicated mixed associations between components of household economic security and ART adherence. Table 1 presents results of bivariable tests. The following factors were associated with ART adherence: having more income and having a non-farming related occupation (e.g., construction, trading, or service). Owning land, owning more assets (i.e., mode of transportation and livestock), and food insecurity were associated with ART non-adherence. The role of debt differed depending on the measure of adherence. Debt was a predictor of adherence based on VAS, whereas debt was a predictor of non-adherence based on MPR. However, none of these bivariable associations were statistically significant. Place of residence was the only variable that was significantly correlated with adherence. Using MPR, respondents from Lumezi were less likely to adhere to their treatment than respondents from Lundazi ($p = 0.03$).

Table 2 presents results of multivariable tests. Multivariable findings indicated mixed associations of household economic security factors and ART adherence. In general, the following variables predicted non-adherence: having a non-farming-related occupation, having more income (except MPR at ≥80% threshold), owning land, owning more transportation-related assets, owing money, and having inadequate access to food. The correlations between livestock ownership and ART adherence were mixed. Using the VAS, livestock ownership was associated with adherence. However, based on MPR of various thresholds, livestock ownership was marginally associated with non-adherence. Among household economic variables, the relationship between ownership of transportation-related assets and ART adherence based on VAS was statistically significant ($p = 0.01$). Respondents who owned more transportation-related assets were less likely to be adherent than respondents who owned none or fewer transportation-related assets. The associations between type of occupation ($p = 0.08$), livestock ownership ($p = 0.06$), and adherence based on VAS approached statistical significance. Similarly, the relationship between having monetary debts and adherence based on MPR with ≥95% threshold demonstrated statistical trend ($p = 0.09$).

Place of residence, self-perceived health, and adherence

Although none of the economic variables were consistently and significantly associated with ART adherence, geographic residence (i.e., whether respondents reside in Lumezi or in Lundazi) was a consistent, significant predictor of adherence ($p \leq 0.05$). In other words, Lumezi-based respondents were less likely to adhere to ART than Lundazi-based respondents. In addition, self-perceived health status was significantly associated with adherence when measured using VAS ($p = 0.05$), controlling for all other independent

variables. Respondents who rated their health as better were more likely to adhere to their treatment than respondents who rated their health poorly.

Discussion

This study examined the role of various components of household economic status on ART adherence among treatment-experienced PLHIV in two rural health facilities in Lundazi district, Eastern province, Zambia. To the best of our knowledge, our study findings are among the first evidence reported on the role of household economic variables on ART adherence in Eastern province, Zambia. Although prior research in other parts of Zambia and sub-Saharan Africa has found positive and significant associations between household economic factors and adherence (Birbeck et al., 2011; Nachega et al., 2015; Reda & Biadgilign, 2012; Peltzer & Pengpid, 2013; Young, Wheeler, McCoy, & Weiser, 2014), our findings indicated a more complex role of household economic status on ART adherence. Overall, we did not find a conclusive pattern of positive relationships between components of household economic security and adherence. Based on our findings, the association between household economic security and ART adherence is less straightforward. In particular, the role of economic security on ART adherence appears to be a function of the household-level economic variable.

Additionally, our findings suggest that there are indicators of household economic security that have a negative association with adherence. Although these negative associations seem counter-intuitive, a closer examination may reveal underlying mechanisms that may explain the observed relationship. An example is asset ownership. Typically, more assets correspond with more tangible resources, which in turn, may increase an individual's ability to afford and pay for treatment. However, our findings suggest that the association between asset ownership and adherence depends on the type of asset. Respondents with more transportation-related assets were less likely to be adherent than their peers with fewer transportation-related assets. On the contrary, respondents with more livestock were more likely to be adherent than their peers with fewer livestock. This conflicting relationship may be explained by the distinct characteristics associated with each asset type. For example, livestock provides a direct and immediate source of food through eggs, milk, meat, or other food products. However, transportation-related assets may provide indirect access to food through income generation, which is used to purchase or obtain food. Respondents and their households may rely on some of their livestock (particularly smaller animals such as chickens which were the most commonly owned livestock in the sample) to feed and nourish them. In turn, better access to food increases the ability to take ARV drugs as prescribed (Cantrell et al., 2008; Musumari et al., 2014; Young et al., 2014).

In addition, ownership of transportation-related assets may indicate two things: a) these assets are used for income-generation; and b) people who own more transportation-related assets have higher social status. The first point implies that when transportation assets are used to generate income, ART patients may become so preoccupied transporting people or goods that they forget to take their medications as prescribed. Also, if using transportation assets requires spending some time away from home, ART patients may forget to bring their medications with them, or if they bring their medications, they may not want to take ARV

drugs in front of people who do not know about their health condition. Similarly, if ART patients are away from home, they may not be able to go to the pharmacy and pick up their medications on time. In turn, these situations constrain PLHIV from taking their medications as prescribed. The second point suggests that ownership of more transportation-related assets may signify higher socio-economic status. For ART patients who have higher socio-economic status, taking their ARV medications or going to the pharmacy and health clinics to get medications may be challenging, especially if they have not disclosed their HIV-positive status to people around them. They may feel that they have much to lose if people find out about their HIV-positive status and because of fear and stigma, they may avoid taking their medications in public or at their workplace. Similarly, they may avoid going to the pharmacy and miss refilling their prescription on time. These circumstances, in turn, reduce the ability of PLHIV to adhere to ART.

Although the immediate indicators of household-level economic security did not have a consistent positive association with adherence, place of residence was consistently and significantly associated with adherence. In our study, place of residence might be a potential surrogate measure of economic security at the community level. Respondents from Lumezi were less likely to be adherent to ART than respondents from Lundazi. One plausible explanation for this finding is the different levels of economic activities and opportunities in each town. Lundazi is the economic centre of Lundazi district, which means most trading activities and job opportunities beyond subsistence farming are located in this town. Lundazi is also the district capital and the location for most government agencies with offices in Lundazi district. In contrast, Lumezi is a secondary town with fewer trading activities and job opportunities.

In addition to economic differences at the community level, there may be differences in social and healthcare-related conditions that the place of residence might represent. For example, social assistance or other ancillary services, which enable or motivate poor ART patients to adhere to their treatment, may be more accessible or regularly available in Lundazi, being the centre of Lundazi district, than in Lumezi. Compared with Lumezi, Lundazi has more community-based organisations that provide assistance to poor households or PLHIV. Furthermore, better health care and treatment-related services (e.g., nutrition and peer support) may be more accessible and available in Lundazi, given its proximity to district medical facilities, than in Lumezi. In turn, accessibility and availability of health services and support might influence Lundazi residents to adhere to ART more than Lumezi residents. In other words, the consistent significant association of place of residence with adherence suggests that there may be economic, social, and healthcare-related opportunities and conditions that are easier to access or more frequently available in Lundazi than Lumezi.

Implications

Findings have relevant implications for development of adherence programmes. Although we did not find conclusive associations between various indicators of economic security and adherence, our findings do not suggest that household economic security is an inconsequential predictor of ART adherence. Overall, household economic security remains

essential to provide ART patients with tangible resources that they can use to pay for treatment-related expenses and other treatment-related needs (such as food). Absence of these resources has been shown to negatively affect adherence behaviours (Peltzer & Pengpid, 2013; Weiser et al., 2010), which in turn, may undermine the efficacy of ART to increase survival and eliminate HIV/AIDS.

Furthermore, our findings highlight the different roles of various components of household economic security (e.g., type of occupation and asset ownership) in predicting ART adherence. In particular, study results indicate the value of focusing on individual and discrete indicators of household economic status because not all components of economic security universally and positively influence ART adherence. Equally important to promoting economic security is tackling potential unintended consequences. For example, fear of unplanned disclosure of HIV status due to stigma and discrimination may motivate ART patients with higher socio-economic status to skip taking their pills and miss their visits to the pharmacy. Programmatically, including life-skills training to adherence interventions may be helpful. The training should focus on increasing life skills, such as how to deal with stigma, how to form social support, how to ensure personal safety, and how to disclose HIV status, which may help ART patients adhere to treatment. Finally, our findings indicate the importance of targeting low-resource rural communities, including areas outside of main economic centres. Rural communities such as Lumezi may not have adequate opportunities for residents to start a livelihood and generate income. Livelihood programmes that promote locally appropriate income-generating activities may offer a feasible and potentially effective strategy that targets underlying economic predictors of ART non-adherence. These livelihood programmes can also be integrated with HIV treatment and care to further motivate ART patients to adhere to their treatment.

Limitations

Although our study found significant associations, our study has limitations and results should be interpreted in the context of these. First, we used cross-sectional data that provide weak evidence of causal relationship. Additionally, lack of temporal order in cross-sectional data does not eliminate reverse causality and may alter the true direction of the observed relationship. Second, the small sample size might affect statistical power, which in turn, may result in overestimation of coefficient sizes and inability to detect true relationships. However, multiple imputation could have helped increase statistical power (Enders, 2010). Third, our findings may not be generalisable to other treatment-experienced PLHIV in other rural communities in Zambia because the characteristics of our small sample may not be representative of all rural ART patients in the country. Fourth, our list of household economic indicators is not exhaustive. For example, we likely did not measure other key variables, such as employment status and savings, which may determine households' access to resources. Fifth, the weak correlation ($r^2 < 0.15$) between VAS and MPR may indicate that the adherence measures were classifying different participants as adherent. The distinct correlates of VAS and MPR may also suggest inconsistent categorisation of adherent patients, even though the proportion of adherent participants was not significantly different between the two measures. Future research should address these limitations to improve our understanding of the role of household economic status on ART adherence among PLHIV in

low-resource, rural communities in Zambia and elsewhere in sub-Saharan Africa. For example, latent factor analysis can be used to address measurement limitations of adherence, if at least three observed adherence measures are used in a study.

Conclusions

Although adherence is not the only predictor of treatment failure or success, adherence to ART remains one of a few potentially alterable factors that strongly influence survival of PLHIV. Given the adverse effects of non-adherence, identifying alterable barriers to adherence is vital to the development of effective adherence interventions. Our study sought to address gaps in knowledge by examining the role of household economic status on ART adherence of treatment-experienced PLHIV in rural Zambia. Our findings suggest that the association between household economic security and adherence appears to be a function of the economic indicator and adherence measure. Our study also provides empirical findings of alterable household economic characteristics that are associated with adherence and that can be targeted by carefully designed interventions. Improving adherence may require a multifaceted strategy that provides tangible economic opportunities and life-skills training that, in combination, may allow PLHIV to overcome economic, social, and psychological barriers to ART adherence.

References

Bangsberg DR, Perry S, Charlebois ED, Clark RA, Roberston M, Zolopa AR, Moss A. Non-adherence to highly active antiretroviral therapy predicts progression to AIDS. AIDS (London, England). 2001; 15(9):1181–1183. https://doi.org/10.1097/00002030-200106150-00015.

Birbeck GL, Chomba E, Kvalsund M, Bradbury R, Mang'ombe C, Malama K, the RAAZ Study Team. Antiretroviral adherence in rural Zambia: The first year of treatment availability. The American web of Tropical Medicine and Hygiene. 2009; 80(4):669–674. https://doi.org/10.4269/ajtmh.2009.80.669.

Birbeck GL, Kvalsund MP, Byers PA, Bradbury R, Mang'ombe C, Organek N, Malama C. Neuropsychiatric and socioeconomic status impact antiretroviral adherence and mortality in rural Zambia. The American web of Tropical Medicine and Hygiene. 2011; 85(4):782–789. https://doi.org/10.4269/ajtmh.2011.11-0187.

Cantrell RA, Sinkala M, Megazinni K, Lawson-Marriott S, Washington S, Chi BH, Stringer JS. A pilot study of food supplementation to improve adherence to antiretroviral therapy among food-insecure adults in Lusaka, Zambia. web of Acquired Immune Deficiency Syndromes. 2008; 49(2):190–195. https://doi.org/10.1097/QAI.0b013e31818455d2.

Central Statistical Office. Zambia 2010 census of population and housing: Preliminary population figures. Lusaka. Zambia: Central Statistical Office; 2011.

Central Statistical Office. 2010 Census of population and housing. Population summary report. Lusaka. Zambia: Central Statistical Office; 2012.

Chi BH, Cantrell RA, Zulu I, Mulenga LB, Levy JW, Tambatamba BC, Stringer JS. Adherence to first-line antiretroviral therapy affects non-virologic outcomes among patients on treatment for more than 12 months in Lusaka, Zambia. International web of Epidemiology. 2009; 38(3):746–756. https://doi.org/10.1093/ije/dyp004.

Coates, J., Swindale, A., Bilinsky, P. Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.

Denison JA, Koole O, Tsui S, Menten J, Torpey K, van Praag E, Bangsberg DR. Incomplete adherence among treatment-experienced adults on antiretroviral therapy in Tanzania, Uganda and Zambia. AIDS (London, England). 2015; 29(3):361–371. https://doi.org/10.1097/QAD.0000000000000543.

Enders, CK. Applied missing data analysis. New York: Guilford Press; 2010.

Filmer D, Scott K. Assessing asset indices. Demography. 2012; 49(1):359–392. https://doi.org/10.1007/s13524-011-0077-5. [PubMed: 22135117]

Graham JW. Missing data analysis: Making it work in the real world. Annual Review of Psychology. 2009; 60(1):549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530.

Graham JW, Olchowski AE, Gilreath TD. How many imputations are really needed? Some practical clarifications of multiple imputation theory. Prevention Science. 2007; 8(3):206–213. https://doi.org/10.1007/s11121-007-0070-9. [PubMed: 17549635]

Grant E, Logie D, Masura M, Gorman D, Murray SA. Factors facilitating and challenging access and adherence to antiretroviral therapy in a township in the Zambian Copperbelt: A qualitative study. AIDS Care. 2008; 20(10):1155–1160. https://doi.org/10.1080/09540120701854634. [PubMed: 19012078]

Grossberg R, Zhang Y, Gross R. A time-to-prescription-refill measure of antiretroviral adherence predicted changes in viral load in HIV. web of Clinical Epidemiology. 2004; 57(10):1107–1110. https://doi.org/10.1016/j.jclinepi.2004.04.002.

Henegar CE, Westreich D, Maskew M, Brookhart MA, Miller WC, Majuba P, Van Rie A. Comparison of pharmacy-based measures of adherence to antiretroviral therapy as predictors of virological failure. AIDS and Behavior. 2015; 19(4):612–618. https://doi.org/10.1007/s10461-014-0953-2. [PubMed: 25433652]

Hensen B, Lewis JJ, Schaap A, Tembo M, Mutale W, Weiss HA, Ayles H. Factors associated with HIV testing and acceptance of an offer of home based testing by men in rural Zambia. AIDS and Behavior. 2015; 19(3):492–504. https://doi.org/10.1007/s10461-014-0866-0. [PubMed: 25096893]

Hong SY, Jerger L, Jonas A, Badi A, Cohen S, Nachega JB, Jordan MR. Medication possession ratio associated with short-term virologic response in individuals initiating antiretroviral therapy in Namibia. PLoS One. 2013; 8(2):e56307. https://doi.org/10.1371/web.pone.0056307. [PubMed: 23509605]

Hosmer, DW., Lemeshow, S., Sturdivant, RX. Applied logistic regression. 3rd. New York, NY, USA: John Wiley & Sons; 2013. https://doi.org/10.1002/9781118548387

Ickovics JR, Meade CS. Adherence to antiretroviral therapy among patients with HIV: A critical link between behavioral and biomedical sciences. web of Acquired Immune Deficiency Syndromes. 2002; 31(Suppl 3):S98–S102. https://doi.org/10.1097/00126334-200212153-00002.

Joint United Nations Programme on HIV/AIDS. The gap report. Geneva: UNAIDS; 2014.

Joint United Nations Programme on HIV/AIDS. Global AIDS update 2016. Geneva: UNAIDS; 2016.

Jones D, Cook R, Spence A, Weiss SM, Chitalu N. Antiretroviral therapy in Zambia: Do partners on ART enhance adherence? web of the International Association of Providers of AIDS Care. 2014; 13(6):497–500. https://doi.org/10.1177/2325957414553843.

Kabore L, Muntner P, Chamot E, Zinski A, Burkholder G, Mugavero MJ. Self-report measures in the assessment of antiretroviral medication adherence: Comparison with medication possession ratio and HIV viral load. web of the International Association of Providers of AIDS Care. 2015; 14(2): 156–162. https://doi.org/10.1177/2325957414557263.

Kagee A, Remien RH, Berkman A, Hoffman S, Campos L, Swartz L. Structural barriers to ART adherence in Southern Africa: Challenges and potential ways forward. Global Public Health: An International web for Research, Policy and Practice. 2011; 6(1):83–97. https://doi.org/10.1080/17441691003796387.

Kobin AB, Sheth NU. Levels of adherence required for virologic suppression among newer antiretroviral medications. The Annals of Pharmacotherapy. 2011; 45(3):372–379. https://doi.org/10.1345/aph.1P587. [PubMed: 21386024]

Lankowski AJ, Siedner MJ, Bangsberg DR, Tsai AC. Impact of geographic and transportation-related barriers on HIV outcomes in sub-Saharan Africa: A systematic review. AIDS and Behavior. 2014; 18(7):1199–1223. https://doi.org/10.1007/s10461-014-0729-8. [PubMed: 24563115]

Little, RJA., Rubin, DB. Statistical analysis with missing data. 2nd. Somerset, NJ, USA: Wiley; 2014.

Long, JS., Freese, J. Regression models for categorical dependent variables using Stata. College Station TX: Stata Press; 2006.

Maldonado G, Greenland S. Simulation study of confounder-selection strategies. American web of Epidemiology. 1993; 138(11):923–936. https://doi.org/10.1093/oxfordjournals.aje.a116813.

McMahon JH, Jordan MR, Kelley K, Bertagnolio S, Hong SY, Wanke CA, Elliott JH. Pharmacy adherence measures to assess adherence to antiretroviral therapy: Review of the literature and implications for treatment monitoring. Clinical Infectious Diseases. 2011; 52(4):493–506. https://doi.org/10.1093/cid/ciq167. [PubMed: 21245156]

Mills EJ, Nachega JB, Bangsberg DR, Singh S, Rachlis B, Wu P, Cooper C. Adherence to HAART: A systematic review of developed and developing nation patient-reported barriers and facilitators. PLoS Medicine. 2006; 3(11):e438. https://doi.org/10.1371/journal.pmed.0030438. [PubMed: 17121449]

Moser, C., Felton, A. The construction of an asset index measuring asset accumulation in Ecuador. Manchester, UK: University of Manchester, Chronic Poverty Research Centre; 2007. Chronic Poverty Research Centre Working Paper No. 87

Murray LK, Semrau K, McCurley E, Thea DM, Scott N, Mwiya M, Bolton P. Barriers to acceptance and adherence of antiretroviral therapy in urban Zambian women: A qualitative study. AIDS Care. 2009; 21(1):78–86. https://doi.org/10.1080/09540120802032643. [PubMed: 19085223]

Musheke M, Bond V, Merten S. Individual and contextual factors influencing patient attrition from antiretroviral therapy care in an urban community of Lusaka, Zambia. web of the International AIDS Society. 2012; 15(S1):1–9. https://doi.org/10.7448/IAS.15.3.17366.

Musumari PM, Wouters E, Kayembe PK, Kiumbu Nzita M, Mbikayi SM, Suguimoto SP, Kihara M. Food insecurity is associated with increased risk of non-adherence to antiretroviral therapy among HIV-infected adults in the Democratic Republic of Congo: A cross-sectional study. PLoS One. 2014; 9(1):e85327. https://doi.org/10.1371/journal.pone.0085327. [PubMed: 24454841]

Nachega JB, Uthman OA, Peltzer K, Richardson LA, Mills EJ, Amekudzi K, Ouedraogo A. Association between antiretroviral therapy adherence and employment status: Systematic review and meta-analysis. Bulletin of the World Health Organization. 2015; 93(1):29–41. https://doi.org/10.2471/BLT.14.138149. [PubMed: 25558105]

National AIDS Council [Zambia]. Zambia country report: Monitoring the declaration of commitment on HIV and AIDS and the universal access. Lusaka: Ministry of Health, National AIDS Council; 2014.

Nozaki I, Dube C, Kakimoto K, Yamada N, Simpungwe JB. Social factors affecting ART adherence in rural settings in Zambia. AIDS Care. 2011; 23(7):831–838. https://doi.org/10.1080/09540121.2010.542121. [PubMed: 21400314]

Okawa S, Chirwa M, Ishikawa N, Kapyata H, Msiska CY, Syakantu G, Yasuoka J. Longitudinal adherence to antiretroviral drugs for preventing mother-to-child transmission of HIV in Zambia. BMC Pregnancy and Childbirth. 2015; 15(1):258. https://doi.org/10.1186/s12884-015-0697-7. [PubMed: 26459335]

Paterson DL, Swindells S, Mohr J, Brester M, Vergis EN, Squier C, Singh N. Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. Annals of Internal Medicine. 2000; 133(1):21–30. https://doi.org/10.7326/0003-4819-133-1-200007040-00004. [PubMed: 10877736]

Peltzer K, Pengpid S. Socioeconomic factors in adherence to HIV therapy in low- and middle-income countries. web of Health, Population and Nutrition. 2013; 31(2):150–170. https://doi.org/10.3329/jhpn.v31i2.16379.

Rathod SD, Chi BH, Kusanthan T, Chilopa B, Levy J, Sikazwe I, Stringer JS. Trends in all-cause mortality during the scale-up of an antiretroviral therapy programme: A cross-sectional study in Lusaka, Zambia. Bulletin of the World Health Organization. 2014; 92(10):734–741. https://doi.org/10.2471/BLT.13.134239. [PubMed: 25378727]

Reda AA, Biadgilign S. Determinants of adherence to antiretroviral therapy among HIV-infected patients in Africa. AIDS Research and Treatment. 2012; 2012:574656. https://doi.org/10.1155/2012/574656. [PubMed: 22461980]

Ross-Degnan D, Pierre-Jacques M, Zhang F, Tadeg H, Gitau L, Ntaganira J, Wagner AK. Measuring adherence to antiretroviral treatment in resource-poor settings: The clinical validity of key indicators. BMC Health Services Research. 2010; 10(1):42. https://doi.org/10.1186/1472-6963-10-42. [PubMed: 20170478]

Rougemont M, Stoll BE, Elia N, Ngang P. Antiretroviral treatment adherence and its determinants in sub-Saharan Africa: A prospective study at Yaounde Central Hospital, Cameroon. AIDS Research and Therapy. 2009; 6(1):21. https://doi.org/10.1186/1742-6405-6-21. [PubMed: 19821997]

Sangeda RZ, Mosha F, Prosperi M, Aboud S, Vercauteren J, Camacho RJ, Vandamme AM. Pharmacy refill adherence outperforms self-reported methods in predicting HIV therapy outcome in resource-limited settings. BMC Public Health. 2014; 14(1):1035. https://doi.org/10.1186/1471-2458-14-1035. [PubMed: 25280535]

Sanjobo N, Frich JC, Fretheim A. Barriers and facilitators to patients' adherence to antiretroviral treatment in Zambia: A qualitative study. web of Social Aspects of HIV/AIDS Research Alliance. 2008; 5(3):136–143. https://doi.org/10.1080/17290376.2008.9724912.

Sasaki Y, Kakimoto K, Dube C, Sikazwe I, Moyo C, Syakantu G, Kai I. Adherence to antiretroviral therapy (ART) during the early months of treatment in rural Zambia: Influence of demographic characteristics and social surroundings of patients. Annals of Clinical Microbiology and Antimicrobials. 2012; 11(1):34. https://doi.org/10.1186/1476-0711-11-34. [PubMed: 23270312]

Shuter J, Sarlo JA, Kanmaz TJ, Rode RA, Zingman BS. HIV-infected patients receiving lopinavir/ritonavir-based antiretroviral therapy achieve high rates of virologic suppression despite adherence rates less than 95%. web of Acquired Immune Deficiency Syndromes. 2007; 45(1):4–8. https://doi.org/10.1097/QAI.0b013e318050d8c2.

Simoni JM, Huh D, Wang Y, Wilson IB, Reynolds NR, Remien RH, Liu H. The validity of self-reported medication adherence as an outcome in clinical trials of adherence-promotion interventions: Findings from the MACH14 study. AIDS and Behavior. 2014; 18(12):2285–2290. https://doi.org/10.1007/s10461-014-0905-x. [PubMed: 25280447]

StataCorp. Stata statistical software: Release 14. College Station TX: Stata Corp LP; 2015.

Steiner JF, Prochazka AV. The assessment of refill compliance using pharmacy records: Methods, validity, and applications. web of Clinical Epidemiology. 1997; 50(1):105–116. https://doi.org/10.1016/S0895-4356(96)00268-5.

Stringer JS, Zulu I, Levy J, Stringer EM, Mwango A, Chi BH, Sinkala M. Rapid scale-up of antiretroviral therapy at primary care sites in Zambia: Feasibility and early outcomes. web of the American Medical Association. 2006; 296(7):782–793. https://doi.org/10.1001/jama.296.7.782.

Sun GW, Shook TL, Kay GL. Inappropriate use of bivariable analysis to screen risk factors for use in multivariable analysis. web of Clinical Epidemiology. 1996; 49(8):907–916. https://doi.org/10.1016/0895-4356(96)00025-X.

Thierman S, Chi BH, Levy JW, Goldenberg RL, Stringer JS, Sinkala M. Individual-level predictors for HIV testing among antenatal attendees in Lusaka, Zambia. The American web of the Medical Sciences. 2006; 332(1):13–17. https://doi.org/10.1097/00000441-200607000-00003.

van Buuren S. Multiple imputation of discrete and continuous data by fully conditional specification. Statistical Methods in Medical Research. 2007; 16(3):219–242. https://doi.org/10.1177/0962280206074463. [PubMed: 17621469]

Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and cox regression. American web of Epidemiology. 2007; 165(6):710–718. https://doi.org/10.1093/aje/kwk052.

Vinikoor MJ, Joseph J, Mwale J, Marx MA, Goma FM, Mulenga LB, Chi BH. Age at antiretroviral therapy initiation predicts immune recovery, death, and loss to follow-up among HIV-infected adults in urban Zambia. AIDS Research and Human Retroviruses. 2014; 30(10):949–955. https://doi.org/10.1089/aid.2014.0046. [PubMed: 24998881]

Viswanathan S, Detels R, Mehta SH, Macatangay BJ, Kirk GD, Jacobson LP. Level of adherence and HIV RNA suppression in the current era of highly active antiretroviral therapy (HAART). AIDS and Behavior. 2015; 19(4):601–611. https://doi.org/10.1007/s10461-014-0927-4. [PubMed: 25342151]

Weiser SD, Tuller DM, Frongillo EA, Senkungu J, Mukiibi N, Bangsberg DR. Food insecurity as a barrier to sustained antiretroviral therapy adherence in Uganda. PLoS One. 2010; 5(4):e10340. https://doi.org/10.1371/journal.pone.0010340. [PubMed: 20442769]

White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. Statistics in Medicine. 2011; 30(4):377–399. https://doi.org/10.1002/sim.4067. [PubMed: 21225900]

Wood E, Hogg RS, Yip B, Harrigan PR, O'Shaughnessy MV, Montaner JS. Effect of medication adherence on survival of HIV-infected adults who start highly active antiretroviral therapy when the CD4 cell count is 0.200 to 0.350 × 10(9) cells/L. Annals of Internal Medicine. 2003; 139(10): 810–816. https://doi.org/10.7326/0003-4819-139-10-200311180-00008. [PubMed: 14623618]

Wood E, Hogg RS, Yip B, Moore D, Harrigan PR, Montaner JS. Impact of baseline viral load and adherence on survival of HIV-infected adults with baseline CD4 cell counts 200 cells/l. AIDS (London, England). 2006; 20(8):1117–1123. https://doi.org/10.1097/01.aids.0000226951.49353.ed.

Young S, Wheeler AC, McCoy SI, Weiser SD. A review of the role of food insecurity in adherence to care and treatment among adult and pediatric populations living with HIV and AIDS. AIDS and Behavior. 2014; 18(Suppl 5):505–515. https://doi.org/10.1007/s10461-013-0547-4. [PubMed: 24469223]

Table 1

Sample characteristics and results of bivariable tests

Variables	% or *M* (SD)	ART adherence			
		VAS		MPR ≥ 95%	
		OR	*p*	OR	*p*
Household economic characteristics					
Occupation					
Non-farming	25%	1.03	0.95	2.35	0.12
Farming (reference group)	75%	1.00			
Household income[1]					
K0–20 (<$0.15 per day)	45%	1.01	0.97	1.17	0.44
K21–50 ($0.15–0.30 per day)	25%				
K51–500	15%				
≥K501	15%				
Landownership					
Owned	89%	0.26	0.21	0.18	0.11
Did not own (reference group)	11%	1.00			
Transportation asset index	0.19 (0.38)	0.40	0.16	0.74	0.59
Livestock ownership index	1.40 (2.99)	0.98	0.81	0.95	0.45
Debt					
Owed money	24%	1.24	0.71	0.60	0.29
Did not owe money (reference group)	76%	1.00			
Food insecurity, continuous	14.43 (7.86)	0.99	0.80	0.98	0.37
Food insecurity, categorical[2]					
Severely food insecure	74%	0.33	0.31	0.22	0.17
Moderately food insecure	17%	0.35	0.39	0.27	0.28
Mildly food insecure	2%	1.00			
Food secure	7%	1.00			
Other covariates					
Gender					
Male	44%	0.68	0.45	0.94	0.89

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Variables	% or *M* (SD)	ART adherence			
		VAS		MPR ≥ 95%	
		OR	*p*	OR	*p*
Female (reference group)	56%	1.00			
Place of residence					
Lumezi	50%	0.65	0.38	0.37	0.03
Lundazi (reference group)	50%	1.00			
Health perception[1]		1.56	0.11	1.07	0.78
Poor	3%				
Fair	16%				
Good	36%				
Very good	41%				
Excellent	4%				

% = percentage distribution for categorical variables; *M* (*SD*) = mean (standard deviation) for continuous variables; OR (SE) = odds ratio (standard error), two tailed-tests

[1]For these analyses, we treated income and health perception as interval variables. Please refer to the Analysis section for more details

[2]Because of the distribution of the categorical food insecurity variable, the reference group was food secure and mildly food insecure

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Table 2

Multivariable logistic regression results of the association between household economic status and adherence

Variables	ART adherence											
	Patient assessment						Pharmacy information					
	VAS			MPR ≥ 95%			MPR ≥ 90%			MPR ≥ 80%		
	OR	*p*	95% CI	OR	*p*	95% CI	OR	*p*	95% CI	OR	*P*	95% CI
Indicators of household economic status												
Occupation (reference = farming)	0.20	0.08	0.03, 1.20	0.65	0.61	0.12, 3.39	0.75	0.77	0.10, 5.32	0.96	0.97	0.10, 9.10
Household income[1]	0.95	0.89	0.46, 1.95	0.90	0.76	0.48, 1.70	0.94	0.86	0.48, 1.85	1.04	0.92	0.50, 2.13
Landownership (reference = did not own)	0.18	0.19	0.01, 2.30	0.15	0.13	0.01, 1.73	0.26	0.31	0.02, 3.54	0.65	0.75	0.04, 9.72
Transportation asset index	0.12	0.02	0.02, 0.75	0.53	0.46	0.10, 2.78	0.53	0.49	0.09, 3.26	0.32	0.24	0.04, 2.18
Livestock ownership index	1.24	0.08	0.97, 1.59	0.99	0.95	0.81, 1.22	0.95	0.62	0.76, 1.18	0.97	0.82	0.77, 1.23
Debt (reference = did not owe money)	0.80	0.76	0.20, 3.26	0.33	0.09	0.10, 1.17	0.43	0.23	0.11, 1.69	0.60	0.48	0.14, 2.58
Food insecurity	1.00	0.95	0.92, 1.08	0.97	0.45	0.90, 1.04	0.97	0.40	0.90, 1.04	0.98	0.69	0.91, 1.07
Other covariates												
Gender (reference = female)	0.78	0.67	0.24, 2.46	1.12	0.82	0.42, 3.00	2.09	0.18	0.72, 6.11	2.20	0.18	0.70, 6.93
Health perception[1]	2.03	0.05	0.99, 4.18	1.06	0.83	0.60, 1.90	1.14	0.68	0.61, 2.13	1.43	0.28	0.74, 2.76
Place of residence (reference = Lundazi)	0.18	0.05	0.03, 0.99	0.21	0.03	0.05, 0.87	0.11	0.01	0.02, 0.56	0.09	0.01	0.02, 0.54

VAS = visual analogue scale; MPR = medication possession ration; OR (SE) = odds ratio (standard error), two-tailed tests

[1]For these analyses, we treated income and health perception as interval variables. Please refer to the Analysis section for more details

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