Estimating Effects of Poverty on the Survival of HIV Patients on ART and Food Supplementation in Rural Haiti: A Comparative Evaluation of Socio-Economic Indicators

(Article begins on next page)

ESTIMATING EFFECTS OF POVERTY ON THE SURVIVAL OF HIV PATIENTS ON ART AND FOOD SUPPLEMENTATION IN RURAL HAITI: A COMPARATIVE EVALUATION OF SOCIO-ECONOMIC INDICATORS

by

Fernet Léandre, MD

Submitted in Partial Fulfillment of the Requirements for the Master of Medical Sciences in Global Health Delivery

Mentors: Joia Mukherjee, MD, MPH — Joia Mukherjee — 4/27/2014

Name | signature | date

Estimating Effects of Poverty on the Survival of HIV Patients on ART and Food Supplementation in Rural Haiti: A Comparative Evaluation of Socio-Economic Indicators.

Fernet Léandre, MMSc-GHD Candidate 2014

ABSTRACT

Background: Because economic conditions are both a risk factor for disease and may themselves be objectives for health delivery interventions, monitoring changes in economic outcomes has become a routine priority for health and development efforts. However, the lack of formal commerce in poor agrarian communities creates challenges for measuring economic status. Data on household finances, such as income, are ideal but are time-consuming, costly, and less reliable, whereas proxy measures of wealth such as indices of durable assets are easier to measure but relatively coarse and are less sensitive to rapid changes in underlying drivers.

Methods: We used data from a cohort of 528 people living with HIV/AIDS (PLHA) enrolled in a food intervention study on household demographics, agricultural production, cash income, in-kind income, household durable assets and health status, including CD4 count. We created a household economic index using principal components analysis (PCA) and compared it with three other economic indicators generated from the data (income, expenditures, poverty score). Through multivariate logistic regression analysis we evaluated the effect of the economic metric on probability of survival within the first year of study**.**

Results: Socioeconomic status determined by PCA of durable assets, weighted by the square root of the household size, was the only consistently significant economic predictor of probability of death. It remained significant even after controlling for direct health indicators such as CD4 count. There was no significant correlation between CD4 count and the economic indicators, which may be attributable to uniform access to ART among study participants.

Conclusion: Among people who have HIV and are all enrolled in ART and food programs, household socioeconomic status is an important predictor of mortality rates, even after controlling for direct health measurements such as CD4 count and other health-related covariates. The SES indicator from PCA is also a simple metric to estimate. The study underscores that poverty is a social determinant of mortality even in the context of equal access to health services, and is suggestive of the importance of poverty alleviation activities as an important supplement to clinical interventions.

Keywords: socio-economic metrics, indicator, economics, health predictors, ART, patient households, rural Haiti

INTRODUCTION

Given the critical role of economic conditions as a risk factor for disease and health care access, there is a growing focus among health organizations to include economic status as a key indicator. In Haiti, a country situated in the Caribbean basin known as the poorest in the northern hemisphere, there was a dramatic decline in the national prevalence of HIV from 5.5 % in adults aged 15 to 49 at the beginning of the HIV epidemic to 1.8% (MSPP, 2012). We also noticed a great improvement of life expectancy in thousands of patients on HIV care, some of whom have been treated for more than 15 years (PIH/ZL: HIV patients' cohort registers 2014). These improved outcomes do not tell the whole story because these survivors live in a social context that includes their families, colleagues, and communities. Patient survival impacts not just the individual, but also those around him/her.

Social medicine seeks to explain the social causes and consequences of disease and medical interventions. Among these social factors is economics. Many recent studies address the impact of disease on development in terms of human capital and income (Bleakley, 2010; Bloom and Canning, 2001; Malaney and Sachs, 2002; Armelagos, et al, 2005; Bonds, et al, 2012). One of the basic challenges of measuring relationships between poverty and disease is how best to quantify household economic status. Scholars have used expenditures and found other evidence supporting the impact of socioeconomic status on income. For instance, Cutler, et al (2010) provide an example of the effects of a health program in India on income. Lu et al. (2012) used household total expenditure to measure household economic status in the evaluation of the impact of the Rwanda *Mutuelles* program between 2000 and 2008.

Several studies provide alternative methods for measuring household production, which include a broader definition than cash income. These measures include production of goods (procuring water and firewood) for own use or sale by households (Kuznets, 1946). Rather than rely solely on a simple measure of money income, Edward Wolff and colleagues champion the incorporation of household production in a comprehensive measure of economic well-being (Wolff, et al, 2012) .

The objective of this paper is to systematically explore various methods of estimating household economic status, and validate them in terms of their ability to predict health outcomes. We rely on data from a longitudinal cohort study of rural Artibonite /Haiti among HIV patients on ART therapy (n=528 patients) (Ivers et al, 2014). We compare four different metrics of household economic status and their relationships with health and well-being: 1) “real income”; 2) household expenditures; 3) household socio-economic index from principle components analysis; and 4) poverty score. One of the challenges for statistical analysis of such studies is the problem of endogeneity: health and economics are hypothesized to simultaneously affect each other. For this reason, we focus on survival after the first year of the study as the key dependent variable. This is regressed on explanatory variables at baseline. Thus our statistical model is interpreted as revealing a structural relationship of initial health and economic conditions on future survival among HIV patients on ARVs with food supplementation.

METHODS

Design: We investigated relationships between socioeconomic factors and survival of a cohort of HIV-positive patients following antiretroviral therapy and receiving food supplementation in the lower Artibonite (provincial) region of Haiti. This quantitative research has been conducted through a de-identified database collected from an NIH-funded study, “Tailored Nutrition and Food Security Interventions in Comprehensive HIV Care” (ANLAP) (Ivers, 2014). Data from the study population of 528 HIV affected individuals and their household comprised men and women aged 17 to 75 years old. Women constitute more than 61% of the cohort, of whom 50.8% are in procreative age between 26 and 40 years old. A dwelling in which at least one member was known to have HIV and on ART receiving a food package at the start of the study constitutes the definition of affected households. The collection of data was done through interviewer-administered questionnaires of the HIV patient and other members of their household. These data were then collated with clinical data from an electronic medical records system. For more details on subjects, recruitment, the type of informed consent and the confidentiality regarding HIV status disclosure to other household members, see Ivers et al. (2014).

Computing economic metrics

Questions on the demographic, economic and health characteristics of a household and its individual members were included in the questionnaire of this study. Around 1320 items were collected from economic questions addressing income sources, various types of expenditures, and from socio-demographic questions regarding durable assets, housing characteristics, water and sanitation. With these data we computed four major economic indicators through the following methods.

Income

Data on "real income" is inclusive of pecuniary income (cash flow) from wages and in-kind income (food and other goods, gifts, from labor, child caring, etc.). We quantified the value of these multiple sources of income by ascribing prices (averaged from three sources) to a range of categories of agricultural products harvested by the study participants (two types of rice, cereals, root products, vegetables, fruits, beans, others agriculture products, eggs, milk and fish production). We additionally included values of "in-kind" compensation (such as "hot meal") for services such as child care and farm work, labor, housekeeping, and other activities.

Expenditures

Household expenditures is sometimes used by economists as a proxy for income in settings where income is difficult to measure. In this dataset, we computed household total expenditures by summing spending on health, food, education, agriculture, housing, personal care, leisure time, personal hobbies, and events including weddings and funerals. This information was based on recall of expenses in the previous month of study participants.

Wealth Index

PCA is a common statistical method used to create wealth indices in middle and lower developed countries (Falkingham & Namazie, 2002; FIlmer & Pritchett, 1998, 2001; Gwatkin, Rutstein, & Johnson, 2000; Gwatkin et al., 2007; Howe et al., 2012; Lindelow, 2006; Montgomery et al. 1999; Rutstein, 1999; Vyas & Kumaranayake, 2006; Wagstaff, Paci, & van Doorslaer, 1991). The first component of the PCA explains the greatest proportion of variance among household assets (Howe L et al., 2012 P 873). Such methods are now standard in Demographic and Health Surveys (DHS), which focus on possession of durable assets and equipment, dwelling types (kind of materials in and cooking combustibles) and on existing utilities and services access (Howe et al., 2012). Our household wealth index is based on PCA of the following economic indicators at baseline: radio, floor material, land ownership, roof material, latrine, electricity, water access, and livestock. Information on each household characteristic was ascribed a value of 0 or 1, where 1 represents "high" and 0 represents "low" economic value.

Poverty Score

The poverty score was determined by a "poverty scorecard", a socio-economic metric coined by Schreiner (2006) that encompasses 10 variables on living conditions which are each assigned a weight. The poverty scorecard is similar to many of the variables in SES index except that the "score factor' of each variable can be a number beyond simply the binary zero or one as in the PCA. It also explicitly includes socio-demographic information, such as number of children and school attendance. A Haiti poverty score card table of the variables of interest is presented in Appendix 1 in the supporting information.

ANALYSIS

One of the challenges of estimating relationships between poverty and health is endogoneity: health and economics are hypothesized to influence each other, thus making statistical estimates of their causality potentially biased. We chose the dependent variable to be the probability of survival after the first year of the study because it is less likely to suffer from endogeneity bias; i.e., because death is a later event, explanatory variables (such as a poverty and other poor health conditions) at baseline can cause death, but a future death event cannot cause poverty at baseline. However, because it is possible that death is correlated with unobserved factors (such as poor health) that are correlated with baseline economic status, we also controlled for a range of baseline covariates to reduce potential omitted variable bias. We accordingly estimated the following logistic regression model:

$$L = \beta_0 + \beta_1 \ln(CD4) + \beta_2 Econ + \beta_3 GenHealth + \sum_{j=4} \beta_j X_j + \epsilon \quad (1)$$

where L represents probability of survival through the first year of the study; ln(*CD4)* is the natural log of the CD4 count, *Econ* is the economic indicator, *GenHealth* is a combined metric of health perception indicators and physical health indicators, *X* represents other control variables such as age, gender, literacy, household head, history of missing ARTs; these control variables are each systematically removed from the analysis in a stepwise manner (pr = 0.2) depending on their significance. The variable, ϵ, is an error term which is assumed to be normally distributed with mean of 0. We considered three variants of the socioeconomic index: 1) *SES*, 2) *SES*/household size, 3) *SES* /(household size)$^{1/2}$, where *SES* refers to the composite index of durable goods and living standards from the PCA analysis. Weighting the *SES* score by household size is due to the need to account for the relationship between the total value of wealth and the number of people in the household. The assumption is that the generation of income among individuals in a household translates to the accumulation of household assets. However, because these assets are shared among the entire household (i.e., they are “club goods”), as the number of income-earning individuals increases in the household, the accumulation of assets is not expected to respond linearly: thus if a household increases its size, it is expected to increase the assets but at a decreasing rate. More details of each variable are provided in Table 1 of the supporting information and in the Tables 2 to 6.

Table 1: Correlation Matrix

	Survived	Expen.	Income	SES	SES/ hhsize	SES/ $hhsize^{1/2}$	Poverty score	Ln CD4	GenPhys Health	ART History	Age	Female	Head	Literate
Survived	1.0													
Expenditure	0.049	1.000												
Income	-0.002	0.108	1.000											
SES	0.115	0.034	-0.043	1.000										
SES/size	0.117	0.049	-0.018	0.48	1.00									
SES/$size^{1/2}$	0.135	0.042	-0.034	0.77	0.92	1.00								
Poverty score	0.120	0.035	0.012	0.46	0.45	0.53	1.000							
Ln CD4	0.36	-0.008	0.024	0.02	0.04	0.037	0.007	1.00						
GenPhys Health	0.201	0.030	0.081	0.09	0.09	0.117	0.096	0.12	1.00					
ART always	0.089	0.038	-0.103	0.09	0.04	0.072	0.058	0.03	0.097	1.00				
Age	0.071	0.094	0.007	0.07	0.10	0.103	0.118	0.01	-0.048	0.12	1.00			
Female	0.000	-0.127	-0.129	- 0.015	-0.23	-0.16	-0.08	0.14	-0.067	0.055	-0.05	1.00		
Head	-0.054	0.008	-0.024	0.067	0.15	0.135	0.027	0.08	-0.002	0.08	0.23	-0.12	1.00	
Literate	0.051	0.118	0.017	0.226	0.14	0.191	0.143	-0.02	0.088	-0.02	-0.18	-0.186	-0.049	1.00

Results

The results of the PCA generate weights for each household characteristic such that the SES is given by the following equation:

$$SES = 0.35Radio + 0.5Floor + 0.10Land + 0.05Roof + 0.51Latrine + 0.43Electricity + 0.43Water + 0.01Livestock \quad (2)$$

A correlation matrix of the variables of interest at baseline is presented in Table 1. The three variables that are most strongly correlated with survival after the first year are CD4 count (0.36), Health Score (0.20), and SES/size$^{1/2}$ (0.14). Gender was least correlated with survival. The income variable (-0.002) was also among the least correlated with survival, presumably due to a lack of measurable income-generating activities and inaccuracy in reporting. Tables 2-6 present the results of the analysis, with different metrics for economics, excluding income (which Table 1 indicates to be uncorrelated with survival). Together, they paint a consistent picture. Not surprisingly, the variable that is the most consistent predictor of mortality is *ln(CD4), which* is significant at the 1% level in all analyses presented in all tables. The general health score was also highly significant at the 1% level in each of the analyses. Among economic indicators, the poverty score was the only indicator that was not significant at the 5% level for any of the analyses (Table 6), while the SES index weighted by the square root of the household size was the most significant (Table 4, column 5). The history of adherence to ARTs was not consistently significant (with the exception of the first set of analyses in Table 2).

Table 2. Dependent Variable: Probability of Living					
	Coefficient (Standard error)				
Const	**9.270*** (1.906)**	**9.264*** (1.864)**	**9.273*** (1.862)**	**8.656*** (1.703)**	**8.413*** (1.671)**
Ln(CD4)	**1.240*** (0.215)**	**1.240*** (0.212)**	**1.238*** (0.212)**	**1.258*** (0.211)**	**1.246*** (0.210)**
Expenditure[a]	0.24* (0.13)	0.24* (0.13)	0.24* (0.13)	0.25* (0.13)	0.25* (0.13)
General/physical Health scores	**0.220*** (0.069)**	**0.219*** (0.067)**	**0.219*** (0.067)**	**0.218*** (0.067)**	**0.220*** (0.067)**
Never Miss ART	0.929 (0.475)	0.913* (0.469)	0.901* (0.463)	**0.962** (0.458)**	**0.954 ** (0.457)**
Literate	0.470 (0.449)	0.462 (0.445)	0.464 (0.445)	0.386 (0.434)	
Age	0.019 (0.023)	0.020 (0.230)	0.020 (0.023)		
Head	-0.077 (0.496)	-0.0712 (0.494)			
Female	0.010 (0.473)				
N	442	443	443	442	443
R square	0.29	0.29	0.29	0.28	0.28
*** significant at 1 % level ** significant at 5% level * significant at 10% level [a] x 10^{-4}					

In Table 2, the economic metric, *expenditure*, was weakly significant (p=0.054 in final set) predictor of probability of survival. The significance of ART adherence was significant at the 5% level for the most parsimonious of models (columns 4 and 5).

Table 3. Dependent Variable: Probability of Living					
	Coefficient (Standard error)				
Const	**8.849*** (1.828)**	**8.863*** (1.822)**	**8.930*** (1.781)**	**8.661*** (1.738)**	**8.160*** (1.615)**
Ln(CD4)	**1.143*** (0.202)**	**1.141*** (0.201)**	**1.138*** (0.199)**	**1.128*** (0.198)**	**1.146*** (0.198)**
SES	0.553 (0.357)	0.553 (0.357)	0.558 (0.354)	0.627* (0.342)	0.658* (0.340)
General/physical Health scores	**0.221*** (0.069)**	**0.221*** (0.069)**	**0.222*** (0.068)**	**0.224*** (0.068)**	**0.226*** (0.068)**
Never miss ART	0.705 (0.469)	0.696 (0.462)	0.679 (0.460)	0.675 (0.459)	0.714 (0.456)
Age	0.021 (0.023)	0.020 (0.023)	0.021 (0.023)	0.018 (0.022)	
Literate	0.370 (0.461)	0.372 (0.461)	0.377 (0.453)		
Female	-0.072 (0.470)	-0.069 (0.470)			
Head	-0.053 (0.484)				
N	442	442	443	443	443
R square	0.28	0.28	0.28	0.27	0.27
***Significant at 1% level ** significant at 5% level * significant at 10% level					

In Table 3, *SES* was a weakly significant predictor of the probability of survival (p=0.053), when other explanatory variables (i.e., cd4, general health, and ARTs) were controlled for. The ART adherence was not statistically significant for any variations of the statistical model.

Table 4. Dependent Variable: Probability of Living					
	Coefficient (Standard error)				
Constant	**8.694*** (1.825)**	**8.668*** (1.770)**	**8.691*** (1.767)**	**8.388*** (1.711)**	**7.902*** (1.575)**
Ln(CD4)	**1.117*** (0.203)**	**1.119*** (0.201)**	**1.114*** (0.200)**	**1.100*** (0.198)**	**1.116*** (0.198)**
SES/(household size)$^{1/2}$	1.265* (0.681)	1.280* (0.677)	1.275* (0.678)	**1.379** (0.666)**	**1.426** (0.661)**
General/Physical health scores	**0.214*** (0.069)**	**0.213*** (0.068)**	**0.214*** (0.068)**	**0.214*** (0.068)**	**0.215*** (0.068)**
Never miss ART	0.707 (0.470)	0.706 (0.467)	0.685 (0.461)	0.685 (0.460)	0.725 (0.456)
Age	0.021 (0.023)	0.021 (0.023)	0.020 (0.023)	0.017 (0.022)	
Literate	0.369 (0.457)	0.362 (0.451)	0.368 (0.450)		
Head	-0.129 (0.486)	-0.129 (0.485)			
Female	0.032 (0.470)				
N	442	443	443	443	443
R square	0.28	0.28	0.28	0.28	0.28
*** significant at 1 % level ** significant at 5% level * significant at 10% level					

The economic indicator in Table 4 is *SES/(household size)*$^{1/2}$. It was a statistically significant predictor of survival in the final two (parsimonious) statistical models, and was weakly significant for a subset of the other models. ART adherence was not a statistically significant independent predictor of survival for any of the variations.

Table 5. Dependent Variable: Probability of Living					
	Coefficient (Standard error)				
Constant	**8.562*** (1.828)**	**8.445*** (1.763)**	**8.474*** (1.761)**	**8.082*** (1.688)**	**7.553*** (1.544)**
Ln(CD4)	**1.102 *** (0.204)**	**1.108*** (0.202)**	**1.101*** (0.200)**	**1.085*** (0.199)**	**1.101*** (0.198)**
SES/household size	1.888* (1.120)	1.887* (1.120)	1.859* (1.120)	2.000* (1.135)	2.069* (1.138)
General/Physical health scores	**0.211*** (0.069)**	**0.208*** (0.068)**	**0.208*** (0.068)**	**0.209*** (0.068)**	**0.210*** (0.068)**
Never miss ART	0.731 (0.469)	0.741 (0.466)	0.711 (0.459)	0.715 (0.458)	0.761 (0.454)
Age	0.023 (0.023)	0.023 (0.023)	0.022 (0.023)	0.018 (0.022)	
Literate	0.435 (0.453)	0.418 (0.448)	0.429 (0.448)		
Head	-0.183 (0.488)	-0.186 (0.487)			
Female	0.120 (0.471)				
N	442	443	443	443	443
R square	0.28	0.28	0.28	0.28	0.28
*** significant at 1% level ** significant at 5% level * significant at 10% level					

The economic indicator in Table 5 was the *SES/household size*. It was not a statistically significant predictor at the 5% level of probability of survival for any variations of the analysis, but is significant at the 10% level for all analyses. ART adherence was not significant.

Table 6. Dependent Variable: Probability of Living					
	Coefficient (Standard error)				
Constant	**8.779*** (1.843)**	**8.791*** (1.790)**	**8.807*** (1.789)**	**8.214*** (1.645)**	**7.978*** (1.603)**
Ln(CD4)	**1.135 *** (0.205)**	**1.135*** (0.203)**	**1.130*** (0.202)**	**1.149*** (0.202)**	**1.132*** (0.200)**
Poverty score	0.0298 (0.023)	0.030 (0.023)	0.030 (0.023)	0.034 (0.022)	0.036* (0.022)
General/Physical health scores	**0.211*** (0.069)**	**0.210*** (0.068)**	**0.210*** (0.068)**	**0.210*** (0.068)**	**0.211*** (0.067)**
Never miss ART	0.756 (0.465)	0.740 (0.461)	0.726 (0.456)	0.778* (0.452)	0.769* (0.450)
Literate	0.455 (0.453)	0.449 (0.448)	0.455 (0.447)	0.378 (0.437)	
Age	0.021 (0.024)	0.021 (0.024)	0.021 (0.023)		
Head	-0.103 (0.489)	-0.097 (0.488)			
Female	-0.006 (0.469)				
N	438	439	439	439	439
R square	0.27	0.27	0.27	0.27	0.26
*** significant at 5% level ** significant at 5% level * significant at 10% level					

The economic indicator in Table 6 is *poverty score*, which was not statistically significant at the 5% level for any analyses, but was significant at the 10% level in the most parsimonious model (controlling for CD4 count, general health, and ART adherence). ART adherence was not found to be statistically significant at the 5% level for any of the models, though it is significant at the 10% level for the two final estimations. Cd4 count and General health status remain strong predictor of probability of living (significant at 1 % level).

DISCUSSION

This study aims to make two contributions. First, we aim to explore various methods of measuring household economic status. In the process of validating these metrics, we aim to simultaneously contribute to a basic understanding of the socioeconomic determinants of mortality of HIV patients. Through an existing data set of 528 HIV-affected households, the probability of mortality was predicted most consistently and significantly from CD4 count and general health scores. These conclusions are not surprising, as the CD4 count and general health scores are direct indicators of the health of the patients. The prospect of economic indicators independently predicting mortality rates was less obvious *a priori* because all patients are on ARTs and food packages. After controlling for direct health indicators, such as CD4 count and health scores, we found that the *SES*, generated by PCA, and weighted by the square root of the household size was a statistically significant predictor of mortality in the most parsimonious models (i.e., after other independent variables with less than 0.20 p values were removed via a stepwise process). This result has two implications. First, it provides a guide for which economic indicator is most able to predict a health outcome, and second it presents evidence that economic factors remain relevant for HIV patients even when there is universal access to treatment. The other economic indicators were less statistically significant. The lack of a consistent effect of ARTs on mortality is presumably due to two effects: 1) there was not substantial variation between patients who never missed ARTs and those who had some record of missing ARTs, given that all patients adhered to their regiment most of the time, and 2) the mechanism through which ARTs reduce mortality is through boosting the CD4 count, which was controlled for separately.

Per these results, *SES* (weighted by the square root of the household size) stands with the CD4 and the general health status as a powerful predictor of whether someone will survive or die. The best explanation for the economic effect is that it influences non-HIV-related mortality. A number of other authors have found that low SES leads to poorer individual health outcomes and lower health services utilization (Deaton, 2003; Schellenberg et al., 2003; Vyas & Kumaranayake, 2006). A study done by Radoslaw et al (2012) found that people with lower SES conditions had a statistically significant higher probability of mortality from all causes when compared to people living in the highest socioeconomic positions. Those living in the lowest socio-economic conditions also had the highest disease burden ranging from suicide to cancer including cardiac pathologies. Islami et al. (2009) showed a higher risk of esophageal cancer among low SES people with no education. Our study did not find a relationship between income/expenditure and health status. The reason we did not find this relationship may be due to issues highlighted by Falkingham and Namazie (2002) such as: low-reporting and recall bias; or the proxy used to impute values on household production of foods and on goods and utilities. A number of studies have shown a close relationship between SES and consumption (income/expenditure) (FIlmer & Pritchett, 1998; Montgomery et al., 1999; Rutstein, 1999; Wagstaff et al., 1991). In agreement with Gwatkin et al. (2000), we suggest that an asset-based index can be used as a satisfactory proxy for economics status where accurate income data is not available. In particular we suggest that weighting the SES by household size, such that the household size effect has "diminishing returns" (i.e., through the square root), may be ideal.

Gwatkin et al, (2000) suggests that the survival-poverty relationship shown may be driven primarily by a few assets. This points to other potential limitations of these analyses. For example, SES does not capture the quality of the assets (some may be more or less valuable such as fertile versus arid land, while others may be obsolete such as a non-working radio). Our dataset did not specify whether assets such as wells, access to electricity and latrines were shared or owned by one household. Our study population is people living in rural areas with quasi-similar socio-economic conditions; however, some people might have lived closer to urban settings and had more access to services. The study may suffer from "clumping," as the population size is small and from "truncation" due to an even distribution of SES that may engender the difficulty to distinguish the poor from the very poor (Mackenzie 2003, Vyas, 2006). We may not be able to generalize our findings to a wider population because our sample was from rural areas and may not be representative of suburban and urban areas. These findings may be generalizable to other regions or countries with similar limited infrastructure and social conditions. Lastly, these findings did not cover all the multidimensional aspects of subjective well-being and happiness measures developed in other studies (Conceição & Bandura, 2008; Vázquez, Hervás, Rahona, & Gómez, 2009).

CONCLUSION

Socio-economic status encompasses many dimensions that define and categorize wealth and poverty. Grounded in a literature review of analyses into the social dimensions, we chose to examine a number of socioeconomic and health related variables collected for an HIV- affected household cohort in rural Haiti. Income is the gold standard of household economic status in economics. In many low-resource countries like Haiti the source of cash income is inconsistent for much of the population. For those who do have income, it is rarely or inaccurately documented.

The main goal of this paper was neither to review the socio-economic metrics nor to suggest that one method is better. Rather, the main goals were to deepen the understanding of the relationship between SES and health outcomes, and to determine which socio-economic indicator may be the most convenient measurement to depict the trend of this relationship. Among a cohort of HIV-affected households in rural Haiti we have found that there is a strong relationship between survival and socioeconomic status, as measured by PCA of household assets (weighted by the square root of household size), even in areas where there is little to no formal source of income, and after controlling for other health-related covariates. Given the simplicity for data collection of PCA, we conclude that it is a cheaper and more feasible method to assess socio-economic status in order to develop sustainable health interventions that emphasize social determinants of the disease. We acknowledge that the general properties of those indicators should be tailored to the relevant research questions and the local and social context (Gwatkin et al., 2000). Future studies could identify these context-specific factors in order to design better health interventions. The further implications for policy reside in the design and the application of a framework of social determinants to be addressed in establishing the sustainability of social change brought about by a heath intervention. This may contribute to what could be called a social theory of sustainability.

REFERENCES

Armelagos, G. J., Brown, P. J. & Turner, B. (2005). Evolutionary, historical and political economic perspectives on health and disease. *Social Science & Medicine, 61*(4), 755-765.

Bartholomew, D. J., Steele, F., Moustaki, I., & Galbraith, J. I. (2002). Principal components analysis. In C. Chatfield, J. Lindsey, M. Tanner & J. Zidek (Eds.), *The Analysis and Interpretation of Multivariate Data for Social Scientists* (pp. 115-142). Washington, DC: Chapman & Hall/CRC.

Bleakley, H. (2010). Health, Human Capital, and Development. *Annual Review of Economics, 2*, 283-310.

Bloom, D. E., Canning, D. & Sevilla, J. (2004). The Effect of Health on Economic Growth: A Production Function Approach. *World Development 32*, (1), 1–13.

Bonds, M. H., Dobson, A.P. & Keenan, D.C. (2012). Disease ecology, biodiversity, and the latitudinal gradient in income. *PLoS Biology 10*, (12), 1-12: e1001456.

Bonds, M. H., Keenan, D. C., Pejman, R., & Sachs, J. D. (2009). Poverty trap formed by the ecology of infectious diseases. *Proceedings of the Royal Society B: Biological Sciences, 277*(1685).

Conceição, P., & Bandura, R. (2008). Measuring Subjective Wellbeing: A Summary Review of the Literature. *Development Studies Working Papers*.

Cutler, D., Fung, W., Kremer, M., Sighal, M., & Vogl, T. (2010). Early-life Malaria Exposure and Adult Outcomes: Evidence from Malaria Eradication in India. *American Economic Journal: Applied Economics, 2*, 72-94.

Deaton, A. (2003). Health, Inequality, and Economic Development. *Journal of Economic Literature, 41*, 113-158.

European Communities, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, & World Bank. (2009). System of National Accounts 2008. New York, NY.

Falkingham, J., & Namazie, C. (2002). Measuring health and poverty: a review of approaches to identifying the poor *Issues Papers*. London, UK: DFID Health Systems Resource Center.

Filmer, D., & Pritchett, L. H. (1998). Estimating Wealth Effects Without Expenditure Data--Or Tears: With an Application to Educational Enrollments in States of India. *World Bank Policy Research Working Paper 1994*.

Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. *Demography, 38*(1), 115-132.

Gwatkin, D. R., Rutstein, S., & Johnson, K. (2000). Socio-economic differences in Brazil *HNP/Poverty Thematic Group of the World Bank*. Washington, DC: The World Bank.

Gwatkin, D. R., Rutstein, S., Johnson, K., Suliman, E., Wagstaff, A., & Amouzou, A. (2007). Socio-Economic Differences in Health, Nutrition, and Population Within Developing Countries. Washington, DC: The World Bank.

Helliwell, J. F., & Putnam, R. D. (2004). The social context of well-being. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*(1449), 1435-1446.

Howe, L. D., Galobardes, B., Matijasevich, A., Gordon, D., Johnston, D., Onwujekwe, O., . . . Hargreaves, J. R. (2012). Measuring socio-economic position for epidemiological studies in low- and middle- income countries: a methods of measurement in epidemiology paper. *International Journal of Epidemiology, 41*(3), 871-886.

Howe, L. D., Hargreaves, J. R., & Huttly, S. R. A. (2008). Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerging Themes in Epidemiology, 5*(Special section), 1-14.

Islami, F., Kamangar, F., Nasrollahzadeh, D., Achcheli, K., Sotoudeh, M., Abedi-Ardekani, B., . . . Malekzadeh, R. (2009). Socio-economic status and oesophageal cancer: results from a population-based case-control study in a high-risk area. *International Journal of Epidemiology, 38*(4), 978-988.

Ivers, L. C., Teng, J. E., Jerome, J. G., Bonds, M., Freedberg, K. A., & Franke, M. F. (2014). A Randomized Trial of Ready-to-Use Supplementary Food Versus Corn-Soy Blend Plus as Food Rations for HIV-Infected Adults on Antiretroviral Therapy in Rural Haiti. *Clinical Infectious Diseases, 58*(8), 1176-1184.

Kuznets, S. (1946). *National Income: A Summary of Findings*. Cambridge, MA: National Bureau of Economic Research, Inc.

Lanjouw, P., & Ravallion, M. (1995). Poverty and Household Size. *The Economic Journal, 105*(433), 1415-1434.

Lindelow, M. (2006). Sometimes more equal than others: how health inequalities depend on the choice of welfare indicator. *Health Economics, 15*(3), 263-279.

Lu, C., Chin, B., Lewandowski, J. L., Basinga, P., Hirschhorn, L. R., Hill, K., . . . Binagwaho, A. (2012). Towards Universal Health Coverage: An Evaluation of Rwanda Mutuelles in Its First Eight Years. *PLoS ONE, 7*(6), e39282.

Montgomery, M. R., Gragnolati, M., Burke, K. A., & Paredes, E. (1999). Measuring Living Standards with Proxy Variables. *Policy Research Division Working Paper 129*.

MSPP. (2012). Déclaration d'Engagement sur le VIH/SIDA, UNGASS. In Programme National de Lutte contre le Sida (Ed.), *Rapport de Situation Nationale*. Haiti: Republique d'Haiti Ministere de la Sante Publique et de la Population.

Rutstein, S. (1999). *Wealth versus Expenditure: Comparison Between the DHS Wealth Index and Household Expenditures in Four Departments of Guatemala*.

Rutstein, S., & Johnson, K. (2004). The DHS Wealth Index *DHS Comparative Reports 6*. Calverton, MD: ORC Macro.

Sachs, J., and Malaney, P. (2002) The economic and social burden of malaria. *Nature*, *415* (6872): 680-685.

Sánchez-Zamorano, L. M., Flores-Luna, L., Ángeles-Llerenas, A., Romieu, I., Lazcano-Ponce, E., Miranda-Hernández, H., . . . Torres-Mejía, G. (2011). Healthy Lifestyle on the Risk of Breast Cancer. *Cancer Epidemiology, Biomarkers & Prevention, 20*(5), 912-922.

Schellenberg, J. A., Victora, C. G., Mushi, A., de Savigny, D., Schellenberg, D., Mshinda, H., . . . Tanzania Integrated Management of Childhood Illness MCE Baseline Household Survey Study Group. (2003). Inequities among the very poor: health care for children in rural southern Tanzania. *Lancet, 361*(9357), 561-566.

Schreiner, M. (2006). A Simple Poverty Scorecard for India. *Report to Grameen Foundation, U.S.A.* http://www.microfinance.com/English/Papers/Scoring_Poverty_India.pdf

Semnani, S., Sadjadi, A., Fahimi, S., Nouraie, M., Naeimi,M, Kabir,J., Fakheri, H. Saadatnia, H., Ghavamnasiri , M. R., Malekzadeh, R. (2006). Declining incidence of esophageal cancer in the Turkmen Plain, eastern part of the Caspian Littoral of Iran: A retrospective cancer surveillance, *Cancer Detection and Prevention*, 30(1), 14-19.

Stenberg, Karin, et al. (2013). Advancing social and economic development by investing in women's and children's health: a new Global Investment Framework. *The Lancet*.

Vázquez, C., Hervás, G., Rahona, & Gómez. (2009). Psychological well-being and health: contributions of positive psychology. *Annuary of Clinical and Health Psychology, 5*(1), 15-27.

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning, 21*(6), 459-468.

Wagstaff, A., Paci, P., & van Doorslaer, E. (1991). On the measurement of inequalities in health. *Social Science and Medicine, 33*(5), 545-557.

Wolff, E. N., Zacharias, A., & Caner, A. (2004). How Much Does Wealth Matter for Well-Being? Alternative Measures of Income from Wealth. *LIMEW Reports*.

Wolff, E. N., Zacharias, A., & Masterson, T. (2012). Trends in American Living Standards and Inequality, 1959-2007. *Review of Income and Wealth, 58*(2), 197-232.

Zacharias, A., Antonopoulos, R., & Masterson, T. (2012). Why Time Deficits Matter: Implications for the Measurement of Poverty. *Research Project Reports*.

Appendix 1

Table of Haiti Poverty Scorecard.

Indicator	**Value**	**Points**	**Total**
1. How many people in the household are 14 years old or younger?	Four or more Three Two One None	0 3 8 11 19	
2. Do all children of ages 6-14 attend school?	No Yes No children ages 6-14	0 3 3	
3. Where does the household reside?	Not Port-au-Prince Port-au-Prince	0 15	
4. Does the household own a radio/cassette player?	No Yes	0 7	
5. What are the dwelling's floors made of?	Earth Concrete or other Ceramic or wood planks	0 4 12	
6. In the past 12 months, did the household receive any money or gifts remitted from abroad?	No Yes	0 7	
7. Does any household member have salaried employment?	No Yes	0 12	
8. How many plots of agricultural land, forest land, pasture land, or gardens does the household use?	None One Two or three Four or more	2 0 5 11	
9. What is the dwelling's roof made of?	Straw, palm leaves, other Iron Concrete	0 4 9	
10. Does the household own any pigs?	No Yes	0 5	
		Total:	

Source: Schreiner (2006)

Acknowledgements
Matthew Bonds, PhD, Research Associate, Harvard Medical School Department of Global Health and Social Medicine

Louise Ivers, MD, MPH, DTM&H, Associate Professor of Medicine at Harvard Medical School; Senior Health and Policy Advisor for Partners In Health (PIH); Associate Physician in the Division of Global Health Equity at Brigham and Women's Hospital (BWH)

Christina Lively, EdM, Education Coordinator Harvard Medical School Department of Global Health and Social Medicine

Joia Mukherjee MD, MPH, Associate Professor, Harvard Medical School Department of Global Health and Social Medicine; Chief Medical Officer, Partners In Health