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Agricultural wealth better predicts mental wellbeing than market wealth among highly vulnerable households in Haiti: Evidence for the benefits of a multidimensional approach to poverty

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Abstract

Objectives: Lack of wealth (poverty) impacts almost every aspect of human biology. Accordingly, many studies include its assessment. In almost all cases, approaches to assessing poverty are based on lack of success within cash economies (eg, lack of income, employment). However, this operationalization deflects attention from alternative forms of poverty that may have the most substantial influence on human wellbeing. We test how a multidimensional measure of poverty that considers agricultural assets expands the explanatory power of the construct of household poverty by associating it with one key aspect of wellbeing: symptoms of mental health.

Methods: We used the case of three highly vulnerable but distinctive communities in Haiti—urban, town with a rural hinterland, and rural. Based on survey responses from adults in 4055 geographically sampled households, linear regression models were used to predict depression and anxiety symptom levels controlling for a wide range of covariates related to detailed measures of material poverty, including cash-economy and agricultural assets, income, financial stress, and food insecurity.

Results: Household assets related to the cash economy were significantly associated with lower (ie, better) depression scores (−0.7, [95% CI: −1.2 to, −0.1]) but unrelated to anxiety scores (−0.3 [95% CI: −0.8 to 0.3]). Agricultural wealth was significantly—and more strongly—associated with both reductions in depression symptoms (−1.4 [95% CI: −2.2 to −0.7]) and anxiety symptoms (−1.8 [95% CI: −2.6 to −1.0]). These associations were consistent across the three sites, except in the fully urban site in Port-au-Prince where level of depression symptoms was not significantly associated with household agricultural wealth.

Conclusions: Standard measures of poverty based on success in the cash economy can mask important associations between poverty and wellbeing, in this case related to household-level subsistence capacity and crucial food-producing household assets.

1 | INTRODUCTION

1.1 | Human biology and the challenge of assessing poverty status

Poverty, often defined as very low socioeconomic status or lack of material wealth, negatively impacts almost every aspect of human biological functioning (Goodman & Leatherman, 2010). It undermines growth and development, compromises basic physiological functions like immunity, intensifies disease, and worsens mental health (eg, Evans & Kim, 2007; Lund et al., 2010; Martorell, 2017; Sapolsky, 2005). Lack of material wealth is a fundamental stressor in humans, both in terms of lack of access to basic needs, but also because of the low power and stigmatized social meanings attached (eg, Weaver, Tadess, Stevenson, & Hadley, 2019; Wutich & Brewis, 2014). In studies that treat poverty as a driver of biocultural variation, "poverty" is most often operationalized as lack of wealth within the cash economy (Hruschka, Hadley, & Hackman, 2017; Mulligan, Dixon, Joanna Sinn, & Elliott, 2015). Direct measures often focus on assessment of income or purchased material assets like housing materials or vehicles (Decaro, Manyama, & Wilson, 2016; Kaiser, Hruschka, & Hadley, 2017). Other often applied proxy measures are related to consumption or current or predicted participation in the cash economy, like occupation or education (McDade et al., 2019).

Recently, a study by Hadley, Maxfield, and Hruschka (2019), clarified that a dimension of agricultural wealth independent from cash economy wealth can show very different associations with human biological outcomes compared to those based on the cash economy. They found in a study of households in several sub-Saharan African countries that success in the cash economy was associated with increased risk of HIV infection, while success in agricultural activities often proved protective against that risk. Here we expand on the proposition that wealth measures giving primacy to success in the cash economy could overlook a crucial dimension of wealth that is important for understanding associations with wellbeing, specifically the potential buffering role of agricultural forms of household wealth. We expand on this prior work on infectious disease by testing whether this distinction might also hold true for common mental disorders—a fundamental aspect of health that has been extensively demonstrated to show significant associations with poverty.

1.2 | Poverty, human biology, and mental health

The picture from decades of research from high-income countries is clear: worse socioeconomic status consistently predicts worse mental health outcomes, especially common mental disorders (CMDs) like anxiety and depression (Fotso et al., 2012; Howell & Howell, 2008; Huppert et al., 2009; Kaplan, Shema, & Leite, 2008; Lazzarino, Yiengprugsawan, Seubsman, Steptoe, & Sleigh, 2014; Lever, 2004; Ryff & Singer, 2008; Tay & Diener, 2011). The associations do not solely mean that conditions of poverty drive CMDs, but that they may also feed each other syndemically (Mendenhall, Kohrt, Norris, Ndetei, & Prabhakaran, 2017) in a "vicious cycle" (Lund et al., 2010; Patel, Abas, Broadhead, Todd, & Reeler, 2001).

In higher income countries, the onset, deterioration, or relapse of mental illness in turn tends to increase economic risk and undermine wealth (such as through unemployment or sickness absence) (Harvey, Henderson, Lelliott, & Hotopf, 2009; Lelliott, Tulloch, Boardman, Henderson, & Knapp, 2008). The *uncertainty* of living with material poverty in itself is proposed to be stressful in ways that can trigger or heighten mental distress (Mani, Mullainathan, Shafir, & Zhao, 2013; Yoshikawa, Aber, & Beardslee, 2012). Women tend to have elevated risk for CMDs (such as depression and anxiety) compared to men (Whiteford et al., 2013). This is explained in part by both poverty and female gender intersecting with many other related vulnerabilities—like undernutrition, low education, poor access to health services, chronic physical illness, gender-based violence, and discrimination, stigma/discrimination, or other forms of low social capital—that can heighten risks further (Bhattacharya, Currie, & Haider, 2004; Calixto & Anaya, 2014; Dohrenwend et al., 1992; Fotso et al., 2012; Pampel, Krueger, & Denney, 2010; Patel, Araya, De Lima, Ludermir, & Todd, 1999; Peters et al., 2008; Tomalski et al., 2013; Tsai, 2013; Winkelmann, 2009).

In contrast, emerging research in low- and middle-income countries (LMICs) paints a more complex picture. Specifically, measures of material poverty, such as financial stress, food insecurity, income, and consumption expenditures, have shown surprisingly mixed associations with mental health in LMIC contexts (Das, Do, Friedman, McKenzie, & Scott, 2007; Lund, 2014; Lund et al., 2010). Of these, food insecurity tends to demonstrate the more robust associations (Patel, Kirkwood, Pednekar, Weiss, & Mabey, 2006; Seligman, Laraia, & Kushel, 2010); income and expenditure less so (Seplaki, Goldman, Weinstein, & Lin, 2006). A number of reasons have been proposed for these inconsistent findings, including measurement issues and the argument that the everyday contexts and stressors of poverty are fundamentally different between higher and lower income countries in ways that matter for mental health (Cooper, Lund, & Kakuma, 2012; Lund, 2014).

1.3 | Assessing poverty as predictive of mental health

A commonly applied measure of wealth/poverty in research in LMICs is the Demographic and Health Survey (DHS) wealth index. This indicator is mainly based on household assets that can be purchased in the cash economy (Cooper et al., 2012; Filmer & Pritchett, 1999, 2001; Kaiser et al., 2017; Vyas & Kumaranayake, 2006). Using a statistical reduction technique, household items (eg, TV, bicycle), quality of housing construction (eg, concrete floor), and access to services (eg, electricity) are scaled into a single one-dimensional index. This asset-based indicator has become the key variable used in LMICs to assess economic gradients in education (Filmer & Pritchett, 1999; Lachaud, LeGrand, & Kobiané, 2017), nutrition (Balarajan, Ramakrishnan, Özaltin, Shankar, & Subramanian, 2011; Gwatkin et al., 2007; Mayén, Marques-Vidal, Paccaud, Bovet, & Stringhini, 2014), physical health (Hosseinpoor, Parker, Tursan d'Espaignet, & Chatterji, 2012; Hruschka, Gerkey, & Hadley, 2015; Phaswana-Mafuya, Peltzer, Chirinda, Musekiwa, & Kose, 2013), mortality (Ezeh, Agho, Dibley, Hall, & Page, 2015; Mustafa, 2008), and mental health (Ismayilova, Gaveras, Blum, T -Camier, & Nanema, 2016). However, this uni-dimensional index really only captures household poverty through livelihoods associated with the *cash* economy (Filmer & Pritchett, 1999). Importantly, too, these cash-economic goods or services are more easily accessible in urban areas; thus, they often depict rural settings as largely poor or deprived (Bingenheimer, 2007; Howe, Hargreaves, Gabrysch, & Huttly, 2009; Hruschka et al., 2017).

In countries or regions where agriculture plays a dominant role in many household economies, agricultural assets (and the lack of these assets) should fundamentally shape experiences of poverty. Most notably, availability of crops and animals for household consumption provides food security and healthy food options (Hoke, 2017). Agricultural assets are also means of production (such as eggs, milk, livestock, vegetables) and can contribute to the household income (Berinyuy & Fontem, 2011; Hruschka et al., 2017). Importantly, too, agricultural assets need not be held solely by, or provide benefit to, rural households. Peri-urban and even urban households owning even just a few animals or small plots of cultivatable land can produce small but valuable amounts of consumable or sellable food (Ayenew, Wurzinger, Tegegne, & Zollitsch, 2011). For these reasons, agricultural assets could provide a straightforward buffer against nutrition-related disease at the very least (Ali, Bowen, Deininger, & Duponchel, 2016; Dangour et al., 2012; Ferguson, 1992; Hadley et al., 2019; Hruschka et al., 2017; Lawson et al., 2014; Little, Mcpeak, Barrett, & Kristjanson, 2008; Popkin, 2014).

Beyond such effects on nutrition and wealth, agricultural assets might also enhance social capital and status to provide further buffering effects for mental health. For example, in a Tanzanian community in which cattle ownership is prestigious, lack of ownership was found to predict mental distress: being without cattle meant one really could not belong in a society where individuals viewed themselves as defined by their pastoralism and relationship to cows (Pike & Patil, 2006). In a study of livestock and animal assets in Democratic Republic of Congo, Glass, Perrin, Kohli, and Remy (2014) computed a total livestock asset score for rural women, finding that animal ownership had a moderating effect on depression symptoms. They proposed that ownership provided a means to produce cash that could pay school fees, purchase land, and get materials to build/repair homes, but it was also potentially buffering via the social indexing of women's productivity and status (see also Nanama & Frongillo, 2012). Similarly, cultivatable land ownership does not just reflect material wealth but also in some contexts lends the owner considerable power, status, and prestige (eg, Grabe, Grose, & Dutt, 2015; Rao, 2006).

In spite of the potential for agricultural assets to buffer health risks, few empirical studies have considered these alternative dimensions of wealth in assessing the relationship between poverty and wellbeing in low-income countries (Hadley et al., 2019; Hruschka et al., 2017). Based on these multiple proposed mechanisms by which agricultural wealth might buffer vulnerabilities, we should also expect that greater household agricultural wealth could have a protective effect in relation to mental wellbeing (Weaver & Hadley, 2009).

1.4 | Study aim

In this study we consider how lack of agricultural assets—as a specific dimension of poverty—is associated with common mental disorder symptoms in Haiti. Our basic proposition was that *household agricultural wealth will promote mental wellbeing*—or buffer against depression and anxiety symptoms—with an effect evident beyond other commonly measured forms of material wealth, such as cash-economy wealth and food security. We analyzed novel data from Haiti, considering how these relate within geographically randomly selected samples from three very different, but all highly vulnerable, communities. These contrasted with each other in degree of rurality and direct access to and dependence on agricultural assets—a fully urban neighborhood, a fully rural zone, and a mid-sized town with a rural hinterland.

2 | METHODS

2.1 | Study sites and sample

Due largely to a complex history of foreign intervention, Haiti is the poorest nation in the Western hemisphere and one of the most economically unequal in the world, with high national dependence on the agricultural sector (World Bank, 2018). Much of the rural farming is done on small plots by smallholder farmers, but making a living with small-scale farming is increasingly difficult given poor quality and lack of land, complex legal issues around proving land ownership, and vulnerabilities to natural hazards (Cohn et al., 2017; Tittonell & Giller, 2013). These *peyizan* (lit. "peasants," ie, rural farmers) often balance multiple informal occupations; moreover, they can inhabit peri-urban and suburban zones, though most live in rural areas (Grabner, 2017).

The study communities reflect three particularly vulnerable sites within Haiti, all with high levels of food insecurity and significant material poverty (Diagnostic & Develpment Group, 2017). However, they differ substantially in agricultural wealth. Martissant is a fully urban, densely-populated district of the City of Port-au-Prince where a minority of households surveyed own cultivatable land (4.2%) or animals (11%). Ouanaminthe is a market border-town with rural hinterland located across the Massacre River from the Dominican Republic, exhibiting a mix of subsistence and cash economy households (34.9% own land and 19% own animals). Cornillon is a fully rural community in the West department with much higher rates of household cultivatable land (60.4%) and animal ownership (48.8%). Additionally, both Ouanaminthe and Cornillon are municipalities, called *Communes* in Haiti, and have their own local administrative authority, an elected three-member mayoral council; while Martissant is a municipal district administrated by the City of Port-au-Prince (Diagnostic & Develpment Group, 2017).

We surveyed 4055 households (1678 from Martissant, 1586 from Ouanaminthe, and 791 from Cornillon). Household sampling was powered so that each site would be able to detect an effect size of $0.15(\alpha = 0.05, \beta = 0.2)$. The survey used a two-stage cluster sampling approach to select households. In the first stage, using the smallest census territorial entity, called Dissemination Areas (DAs), all three sites under study were divided into clusters determined by the level of access to core services and central markets located in the main town or village. The level of access was measured based on two criteria: having an all-season road and the distance from each DA to reach those core services. Four clusters were generated: *accessibility very difficult*, *accessibility difficult*, *accessible*, and *very accessible*. On the basis of probability proportional to size, a random sample of DAs was selected in each cluster for a total sample of 157 of 389 DAs in all three sites. Then, 25-26 households within each selected DA were selected in randomly generated sequence, while also allowing for over-selection of female household heads if needed to meet a 45% goal (oversampling proved unnecessary). The questionnaire was administered in-person to the head of the selected households. More details have been published (Diagnostic & Develpment Group, 2017).

2.2 | Key variables

Table 1 summarizes variables included in our analyses. We assessed mental well-being with locally adapted and/or validated depression and anxiety inventories. The Zanmi Lasante Depression Symptom Inventory (ZLDSI) assesses a combination of culturally adapted items from standard depression screeners and local idioms of distress (Rasmussen et al., 2015). The ZLDSI was previously completed among a sample of 105 patients who also underwent diagnostic assessment by Haitian psychologists and social workers. Results were used to clinically validate the tool and identify cut-off scores for depression. The ZLDSI contains 13 symptom items, which respondents rated using a Likert scale from not at all (0) to almost every day (3), based on the frequency they occurred within the last 15 days. These were summed to provide total scores ranging from 0 to 39. The Beck anxiety inventory (BAI) was culturally adapted in a previous study in rural Haiti (Kaiser et al., 2013). Bilingual (English/Kreyòl) individuals provided initial translations of items, which were then discussed in focus groups. Participants commented on comprehensibility, acceptability, and relevance of each item, as well as recommending alternate wording. The Kreyòl BAI assesses experience of 20 anxiety symptoms over the previous 2 weeks (the original BAI contains 21 items, but one was dropped due to being considered irrelevant by focus group discussion participants). Each question is scored from not at all (0) to severe (3), yielding a possible range from 0 to 60.

Our assessments of household wealth used a multidimensional approach (Hruschka et al., 2017; Kolenikov & Angeles, 2009). We included a wide range of household assets, household construction materials, access to basic services, and agricultural assets. Questions included vehicles and consumer goods; wall, roof and floor material; electrical access, sources of drinking water, toilet type, and ownership of livestock and land. All wealth-related items were dummy coded (0-1). Those with more than two categories were recoded as a series of dummy variables. Count variables such as number of livestock were ranged into categorical brackets before coding as dummy series (See Appendix S1).

To derive wealth dimensions that are comparable with nationally representative surveys, we matched asset

TABLE 1 Characteristics of participants included in the analyses by site and key variables

Variables	Martissant (urban) n = 1678 Percentage or mean (SD)	Ouanaminthe (town + rural) n = 1586 Percentage or mean (SD)	Cornillon (rural) n = 791 Percentage or mean (SD)	Total N = 4055 Percentage or mean (SD)
Wellbeing				
Depression symptom level	13.1 (9.2)	11.6 (8.7)	9.5 (11.5)	11.8 (9.6)
Anxiety symptom level	13.8 (11.2)	11.6 (9.4)	7.3 (8.8)	11.7 (10.3)
Poverty/wealth				
Cash economy wealth	0.7 (0.6)	−0.2 (0.9)	−1.1 (0.6)	0.0 (1.0)
Agricultural economy wealth	0.2 (0.7)	−0.2 (1.1)	0.1 (1.1)	0.0 (1.0)
Food insecurity	2.4 (2.8)	2.1 (2.8)	2.6 (2.9)	2.3 (2.8)
Water insecurity	38.7	33.5	51.9	39.3
Sociodemographics				
Age	38.2 (11.7)	40.6 (14.4)	42.7 (13.4)	40 (13.3)
French literacy (0-10 scale)	2.6 (2.3)	1.8 (1.9)	0.5 (1.9)	1.9 (2.2)
Gender (Female)	49.3	56.7	49.3	52.2
Education				
No education	16.8	36.1	71.8	35.1
Primary	19.1	22.4	19.3	20.4
Secondary	42.5	35.2	8.6	33.0
University or vocational	20.3	6.1	0.1	10.8
Remoteness from services				
Less than 30 min	60.0	57.5	2.4	47.8
30 min-1 h	28.4	20.2	24.1	24.4
1-2 h	7.1	14.1	46.3	17.5
2-4 h	0.8	5.3	24.3	7.1
Over 4 h	0.1	0.4	1.5	0.5
Missing value	3.6	2.5	1.4	2.7
Rural	0.0	33.5	100.0	32.6
Income			90.8	69.2
< 18 000 HTG	59.2	69.2		
18 000-20 000 HTG	19.8	14.6	7.7	15.4
> 20 000 HTG	21.0	16.3	1.5	15.3
Financial stress				
Can save	3.5	8.6	0.6	0.6
No major problems	10.4	9.5	3.2	3.2
Stretched	35.6	48.0	42.6	42.6
Hard time	48.0	29.2	51.7	51.7
Missing value	2.6	4.8	1.9	1.9

variables from the current survey to the Haiti Demographic and Health Survey (DHS 2012) and applied multiple correspondence analysis (MCA) to the Haiti DHS household-by-variable matrix (Greenacre, 2010; Hruschka et al., 2017). These analyses identified two reliable dimensions of wealth/poverty, which accounted for 77.1% of the total data set inertia. The first one, with 63.9% of the explained total, was strongly associated with variables such as having at least a TV, a radio, electricity, a cooker, internet services, or a bank account. We refer to this as our "cash economy

wealth" measure. The second dimension (13.2% of the total inertia) was positively associated with agricultural and subsistence assets, such as owning livestock and agricultural land. We refer to this as our "agricultural wealth" measure. A third dimension (with 4% of the total inertia) solely related to latrine ownership and was discarded. Cronbach's alpha showed good internal consistency for the two wealth dimensions: cash economy ($\alpha = 0.86$) and agricultural ($\alpha = 0.87$). The first dimension was also highly correlated with the standard DHS wealth factor score produced using Principal Components Analysis (Pearson $r = 0.93$), but the second dimension was not (Pearson $r = 0.11$). This observed difference suggests that the agricultural dimension of wealth provided a distinctive means to characterize households in relation to each other. MCA tables related to the two dimensions are reported in Appendix S2.

Then, using the DHS data, we estimated linear regressions predicting each of the two wealth dimensions from all asset variables in the DHS data that were also available in the current survey. This was facilitated by initial survey design aimed at maximizing overlap with DHS wealth index items, alongside additional wealth questions. Finally, we used those regression coefficients from the DHS data to estimate the two wealth dimensions for the current dataset based on each household's assets.

2.3 | Covariates

We also included food insecurity, water insecurity, income, financial stress, and household socio-economic status (SES) as key covariates likely highly correlated with (lack of) household assets. A global analysis of over 145 countries shows household food insecurity is consistently associated with poor mental health in a dose-response pattern (Jones, 2017) (also see Weaver & Hadley, 2009 and Whitaker, Phillips, & Orzol, 2006 for review). While there is less direct evidence, household water scarcity also shows an association with anxiety and depression symptoms, with women most affected (Cooper-Vince et al., 2018; Stevenson et al., 2012; Wutich & Ragsdale, 2008). To take this into account in our modeling, we applied the Household Food Insecurity Access Scale (HFIAS) to assess household food insecurity (Coates, Bilinsky, & Coates, Bilinsky, & Coates, 2007). The HFIAS asks how often during the past 2 weeks was there: (a) no food to eat of any kind in your house because of lack of resources to get food, (b) any household member went to sleep at night hungry because there was not enough food, and (c) if any household member spent a whole day and night without eating anything at all because there was not enough food. The possible answers to each question were never (0), once or twice (1), three to 10 times (2), and more than 10 times (3). These were summed, with a range of 0 to 9, where higher values reflect greater household food insecurity. We also included a simple measure to assess water insecurity, based on whether households reported they had (1) or had not (0) been short of water any time within the last 3 months.

Respondents were asked about the household monthly income. Due to sparse responses in the income categories above 20 000 HTG (≈USD 308), we consolidated income into three main income brackets: (1) less than 18 000 HTG (≈ USD 277), (2) from 18 000 to 20 000 HTG (≈USD 277 to 308), and (3) 20 000 HGT or more (≈USD 308 or more). The survey also asked about financial stress, a subjective question regarding sufficiency of income taken from the protocol of the Latin American Public Opinion Project (LAPOP, 2016) previously used in Haiti and other Latin American and Caribbean Countries, with four response options: (a) "is the income good enough for you and you can save from it," (b) "is it good enough for you, so you do not have major problems," (c) "is it not enough for you and you are stretched," or (d), "is not enough for you and you are having a hard time?"

We used two indicators of socioeconomic status that are especially relevant in the context of Haiti: education level and self-assessment of French literacy of the head-of-household. Haiti has two official languages: Haitian Creole (Kreyòl) and French. However, French remains the main language used in higher education, business, and administrative documents and interactions. This is a major linguistic barrier to public services and social advancement in Haiti since the vast majority of the population speaks only Kreyòl (Hebblethwaite, 2012). Education level was measured as the highest educational attainment, classified into four levels: No education, Primary, Secondary, and University or Vocational school.

Our additional covariates included gender, age (as a continuous variable), and urban/rural residence. We also included dummy variables for the three sites, since the contrast between these was anticipated to be analytically important. Finally, we included a geographic variable related to remoteness from services—such as hospitals, markets, and government offices. This indicator was based on time it would take to travel using the public transport available from neighborhood of residence to the closest police station. The distance was classified into five categories: less than 30 minutes, 30 minutes to an hour, 1 to 2 hours, 2 to 4 hours, and over 4 hours.

2.4 | Analytic strategy

First, we used descriptive statistics to explore the main indicators of wealth, wellbeing, and sociodemographic characteristics by site. Then, we used two linear regression models

to examine associations between the main wealth and poverty indicators and wellbeing outcomes, controlling for covariates. To assess homogeneity of effects across sites, we also assessed interactions of the two main wealth dimensions (cash economy wealth and agricultural wealth) with geographic sampling areas and retained those interactions with $P < .10$. Regression models were performed using SPSS 24.

3 | RESULTS

3.1 | Descriptive characteristics

Out of 4055 interviewed participants, 53% were female; the average age was 40 years old. Approximately 72% of sampled Cornillon's household heads reported no education, compared to 36% in Ouanaminthe, and only 16% in Martissant. The average French literacy score was estimated at 2.6 in Martissant, compared to 0.5 in Cornillon. As concerns household income, more than 90% of Cornillon's households had a monthly income less than 18 000 HTG, while 59% fell into this income bracket in Martissant. However, subjective financial stress was similar in Cornillon and Martissant, where 48% and 52%, respectively, claimed that their income "is not enough for you and you are having a hard time." Food insecurity was similar across the three sites, but rural Cornillon was the highest.

Table 1 also shows that rural Cornillon reflects the lowest mean level for both depression and anxiety scores (9.5 and 7.3, respectively), compared to urban Martissant (13.8 and 13.1, respectively) and Ouanaminthe town (11.6 and 11.6, respectively). For rural Cornillon, the SD of both outcomes was higher than the mean value, which indicates an overdispersion of both depression and anxiety scores in the site. As expected, the cash economy wealth measure was lowest in Cornillon (−1.1) and highest in urban Martissant (0.7). With respect to the agricultural wealth measure, rural Cornillon had the highest agricultural wealth score (0.1), while Ouanaminthe had the lowest level (−0.2). The low level in Ouanaminthe may be associated with the economic dualism of the site, in which market economy counterbalanced the weight of agricultural goods in the score.

3.2 | Modeled associations of wealth with anxiety and depression symptom levels

Models 1 and 2 reveal that both wealth dimensions—cash economy and agricultural—were significantly associated with lower depression symptom scores, although the effect of agricultural wealth was about three times the magnitude of the cash economy wealth effect (Table 2). Specifically, an increase of one SD in cash economy wealth was associated with a decrease of 0.7 points (95% CI: −1.2 to −0.1) in depression symptom score, while for agricultural wealth, it was associated with a decrease of −1.4 points (95% CI: −2.2 to −0.7).

A similar relationship is observed for anxiety. The decline in depression symptoms from one SD increase in cash economy was estimated at −0.3 (95% CI: −0.8 to 0.3), and at −1.8 points (95% CI: −2.6 to −0.1) for agriculture wealth.

As would be expected, the results show that depression and anxiety levels were higher for those who claimed that their income "is not enough for you and you are having a hard time," compared to those who said that it "is good enough for you and you can save from it," the reference group (depression: 1.6 [95% CI: 0.8 to 2.3]; anxiety: 1.4 [95% CI: 0.6 to 2.2]). Food insecurity was also significantly associated with both increased depression scores (1.1 [95% CI: 1.0 to 1.2]) and anxiety scores (0.6 [95% CI: 0.5 to 0.8]). We found that the dichotomous measure of water insecurity was significantly and positively associated with a higher depression score (0.9 [95% CI: 0.3 to 1.5]) but not anxiety.

Results also showed, as expected, a protective effect of increasing education against both depression and anxiety symptoms. Those with higher education levels had a lower score for both depression and anxiety levels. For example, compared with those with no education, attaining the primary level was associated with lower depression and anxiety scores (−1.3 [95% CI: −2.1 to −0.5] and − 2.5 [95% CI: −3.4 to −1.6], respectively); the secondary level was associated by −0.9 [95% CI: −1.8 to −0.1] and 1.5 [95% CI:−2.5 to −0.5], respectively; and the university or vocational level by −0.9 and − 1.1 (respectively, though not statistically significant). French literacy showed a similar trend, but the association was statistically significant only for anxiety score (−0.3 [95% CI: −0.6 to −0.1]).

Less expected, compared to those who make less than 18 000 HTG monthly, those with higher income had higher anxiety scores, once other poverty-related variables were taken into account. In particular, those with at least 20 000 HTG monthly had 2.0 points [95% CI: 1.0 to 3.0] higher anxiety scores than those with less than 18 000 HTG monthly. No statistically significant association was found with depression scores. Remoteness from basic service also revealed an unexpected pattern. While results show that living far from basic public services was significantly associated with higher anxiety scores, distance was inversely associated with depression scores. Women household heads reported significantly higher depression and anxiety scores (1.0 [95% CI: 0.4 to 1.5] and 1.6 [95% CI: 0.9 to 2.2]) compared to men. Only anxiety (0.4 [95% CI: 0.1 to 0.6]) score was positively associated with age, though with small effect sizes.

TABLE 2 Linear regression model of wealth and depression/anxiety symptom levels

Predictors	Depression score β (95% CI)	Anxiety score β (95% CI)
Material wealth—Cash economy	−0.7 (−1.2,−0.1)**	−0.3 (−0.8,0.3)
Material wealth—Agricultural	−1.4 (−2.2,−0.7)***	−1.8 (−2.6,−1.0)***
Food insecurity	1.1 (1,1.2)***	0.6 (0.5,0.8)***
Remoteness from basic services Less than 30 min (ref.)		
30 min-1 h	1.1 (0.3,1.9)***	1.5 (0.7,2.4)***
1-2 h	−1.5 (−2.6,−0.5)***	1.6 (0.5,2.7)***
2-4 h	−1.6 (−3.0,−0.3)**	1.7 (0.3,3.2)**
Over 4 h	−4.4 (−8.2,−0.7)**	−1.2 (−5.3,2.9)
Missing value	−0.8(−2.7,1.1)	1.3(−0.7,3.1)
Income Less than 18 000 HTG (ref.)		
18 000-20 000 HTG	0.5 (−0.3,1.4)	0.7 (−0.2,1.6)
Plus de 20 000	−0.5 (−1.4,0.4)	2.0 (1.0,3.0)***
Financial stress You can save from it (ref.)		
You do not have major problems	−1.1 (−2.3,0.2)****	−2.6 (−3.9,−1.2)***
You are stretched	0.4 (−0.5,1.3)	−0.9 (−1.9,0.1)****
You are having a hard time	1.6 (0.8,2.3)***	1.4 (0.6,2.2)***
Missing value	0.2(−0.7,3.4)	0.9(0.2,5.2)**
Water insecurity	0.9 (0.3,1.5)***	0.4 (−0.2,1.1)
Female	1.0 (0.4,1.5)***	1.6 (0.9,2.2)***
Age (10-year increase)	0.4 (0.2,0.6)****	0.4 (0.1,0.6)***
French literacy (0-10 scale)	−0.1 (−0.3,0.1)	−0.3 (−0.6,-0.1)
Education No education (ref.)		
Primary	−1.3 (−2.1,−0.5)***	−2.5 (−3.4,−1.6)***
Secondary	−0.9 (−1.8,0.1)****	−1.5 (−2.5,−0.5)***
University or vocational	−0.9 (−2.3,0.5)	−1.1 (−2.7,0.4)
Rural area	0.2 (−1,1.5)	0.3 (−1,1.7)
Region Cornillon (ref.)		
Ouanaminthe	3.1 (2.1,4.2)***	6.5 (5.3,7.6)***
Martissant	5.2 (3.9,6.5)***	9.6 (8.2,11)***
Intercept	3.8 (2,5.6)***	1.4 (−0.6,3.4)

Note: In total, 4.5% of the sample (n = 4055) were excluded in the analysis in Table 2 because they lacked values for the outcomes or covariates. Linear Regression in SPSS/R-squared = 0.48 (depression model) 0.43 (Anxiety model). N = 3.873.
*$P < .05$; **$P < .01$; ***$P < .001$; ****$P < .10$.

3.2.1 | Differential effect by study site

Models 1 and 2 show a strong association between our outcomes (depression and anxiety scores) and the study sites. Living in Ouanaminthe (mixed urban/rural area) or in Martissant (urban area) was significantly associated with higher depression scores (3.1 [95% CI: 2.1 to 4.2] and 6.5 [95% CI: 5.3 to 7.6], respectively) and higher anxiety scores (5.2 [95% CI: 3.9 to 6.5] and 9.6 [95% CI: 8.2 to 11.0]), compared with Cornillon (rural). To assess the homogeneity of effects of wealth across sites, the models were re-estimated to include interaction terms between site and the cash

economy and agricultural economy measures, separately. Tests of interactions indicate these associations were consistent across the three sites. However, in the urban site, depression score was not significantly associated with agricultural wealth (0.9 [95% CI: −1.6 to 3.9]).

4 | DISCUSSION

Geographically sampling households within three highly vulnerable communities in Haiti with very different economic/subsistence profiles, we confirm that agricultural dimensions of wealth demonstrate a strong and significant association with both lower depression and anxiety symptoms (our markers of wellbeing). This association was much stronger than the association of cash economy wealth with depression scores (−1.8 vs −0.3) and anxiety scores (−1.4 vs −0.7) or other aspects of poverty normally highlighted in studies connecting mental health to poverty in lower income countries. The only deviation from this pattern was that the relationship of agricultural wealth with depression disappears in the urban area. We can only speculate about the reasons for this. It may be due to the low variability in this variable in the neighborhood site in the capital of Port-au-Prince. It may also be due to lower social valuation of agricultural activities in the urban area relative to the more rural areas.

When comparing the study sites, fully rural Cornillon has less cash economy wealth and worse access to services than the other two sites, yet lower levels of depression symptoms. This is exactly the type of equivocal or counter-intuitive findings that prior reviews linking mental health and poverty have observed in lower income countries (Das et al., 2007; Lund, 2014). Our findings suggest that such equivocal findings result from privileging certain forms of wealth (eg, derived from cash economies) and simultaneously neglecting alternative forms of wealth (eg, derived from agricultural activities) that may be most relevant in a given context.

Specifically, in countries and regions where agricultural activity remains an important part of many people's lives, we would expect success in agricultural activities to be associated with reduced symptoms of anxiety and depression for a number of reasons. First, in the full range of rural, peri-urban, and urban areas, availability of crops and animals for household consumption can provide food security (Ayenew et al., 2011; Sen, 1982) which, in turn, has shown associations with improved mental health (Weaver & Hadley, 2009). More indirectly, livestock and land can contribute to the household income, which also has shown associations with improved mental health (Berinyuy & Fontem, 2011; Burns, Tomita, & Lund, 2017; Fone et al., 2013; Hruschka et al., 2017; Vikram Patel et al., 2018; Pickett & Wilkinson, 2015). Beyond such direct effects on food security, nutrition, and income, success in agricultural activities might also enhance social capital and status to provide further buffering effects for mental health (Glass et al., 2014; Grabe et al., 2015; Hoke, 2017; Nanama & Frongillo, 2012; Pike & Patil, 2006; Rao, 2006).

This is not to say that managing agricultural assets is not also potentially stressful. Animals can die or be stolen, and crops can fail, meaning assets can be lost or forfeited. These losses can be emotionally as well as financially devastating: for example, in the wake of widespread droughts and associated livelihood damage, farmer suicide rates can jump (eg, Hanigan, Butler, Kokic, & Hutchinson, 2012).

Strengths of this study are the inclusion of multiple measures of poverty/wealth and socioeconomic status, including measures of material wealth (market-based and agricultural), basic resource access (food insecurity, water insecurity, remoteness), income (household income and financial security), and human capital (education and French literacy), as well as use of culturally adapted and/or validated measures of depression and anxiety symptoms. Our study has several notable limitations. The data used in the study were cross-sectional; therefore, it was not designed to detect cause-effect relationships. Second, our data were collected in three low-income regions chosen for their distinctiveness in relation to the cash economy and using random household sampling, but the sites themselves are not necessarily representative of all rural, semi-urban, or urban areas at the national level. Further, the aim of controlling for all relevant confounders of the association between poverty and mental distress may not have been achieved. Finally, we used standardized instruments to measure key variables, such as depression/anxiety and food insecurity. Although all are designed to capture the current and recent status of households, these do not capture precisely the same time frames, and this may have affected results.

5 | CONCLUSION

Poverty is a major force shaping human biology. Better explanations of how and why poverty matters require consideration of what poverty means *in context* (Braveman et al., 2005; Cooper et al., 2012; Galobardes, Shaw, Lawlor, Lynch, & Smith, 2006; Howe et al., 2009; Hruschka et al., 2017; Kaiser et al., 2017). In this analysis, we considered how agricultural forms of household wealth might matter differently for mental health in comparison to cash economy ones. Through direct comparison of three very different—but all high poverty—communities in Haiti, agricultural forms of wealth were protective against anxiety symptoms beyond effects captured in standard wealth index measures. This was not just in rural and mixed rural/urban settings, but in fully urban settings as well. Agricultural wealth measures

also were associated with lower depression symptom levels in the rural and mixed community, although not the fully urban one.

Broadly, this adds to the prior study by Hadley et al. (2019), showing that multidimensional assessments of household assets differentially explain how deprivation can shape health and human biology. Their study focused on infectious disease risk, and here we show that the same general finding applies to risk of common mental disorder symptoms. That is, we are suggesting that—even in urban settings—it can be valuable to consider (lack of) assets related to agricultural production—like household crops and animals—as potentially important to shaping household vulnerabilities. Here, we also demonstrate that specifically focusing on agricultural assets explains what would be otherwise counter-intuitive findings for rural households.

Mental health, our focus here, is increasingly recognized as a core—if understudied—aspect of human biology, and one undermined by lack of wealth and power (eg, Hadley and Patil 2006; Kohrt et al. 2015).

This study further underscores the benefits of a more context-sensitive framework in this domain specifically (Cooper et al., 2012; Kaiser et al., 2017; Lazzarino et al., 2014), including the translation of human biological approaches to improve wellbeing of vulnerable populations (eg, Kohrt et al 2015).

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AUTHOR CONTRIBUTIONS

AB designed the study and oversaw data collection processes; JL designed the sampling. All authors conceived the manuscript. JL and DJH ran all analyses. All authors contributed to the study conceptualization and analytic plan. JL, DJH, and AB drafted the manuscript. All authors edited, critically reviewed, and approved the final content of the manuscript.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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REFERENCES

Ali, D., Bowen, D., Deininger, K., & Duponchel, M. (2016). Investigating the gender gap in agricultural productivity: Evidence from Uganda. *World Development*, *87*, 152–170. https://doi.org/10.1016/j.worlddev.2016.06.006

Ayenew, Y. A., Wurzinger, M., Tegegne, A., & Zollitsch, W. (2011). Socioeconomic characteristics of urban and peri-urban dairy production systems in the north western Ethiopian highlands. *Tropical Animal Health and Production*, *43*(6), 1145–1152. https://doi.org/10.1007/s11250-011-9815-3

Balarajan, Y., Ramakrishnan, U., Özaltin, E., Shankar, A. H., & Subramanian, S. V. (2011). Anaemia in low-income and middle-income countries. *The Lancet.*, *378*, 2123–2135. https://doi.org/10.1016/S0140-6736(10)62304-5

Berinyuy, J. E., & Fontem, D. A. (2011). Evaluating post harvest opportunities and constraints to utilization and marketing of African leafy vegetables in Cameroon. *African Journal of Food Agriculture Nutrition and Development*, *11*(2), 4647–4663. https://doi.org/10.4314/ajfand.v11i2.65919

Bhattacharya, J., Currie, J., & Haider, S. (2004). Poverty, food insecurity, and nutritional outcomes in children and adults. *Journal of Health Economics.*, *23*, 839–862. https://doi.org/10.1016/j.jhealeco.2003.12.008

Bingenheimer, J. B. (2007). Wealth, wealth indices and HIV risk in East Africa. *International Family Planning Perspectives*, *33*(02), 083–084. https://doi.org/10.1363/3308307

Braveman, P. A., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic status in health research: One size does not fit all. *Journal of the American Medical Association*, *294*(22), 2879–2888. https://doi.org/10.1001/jama.294.22.2879

Burns, J. K., Tomita, A., & Lund, C. (2017). Income inequality widens the existing income-related disparity in depression risk in post-apartheid South Africa: Evidence from a nationally representative panel study. *Health and Place*, *45*, 10–16. https://doi.org/10.1016/j.healthplace.2017.02.005

Calixto, O. J., & Anaya, J. M. (2014). Socioeconomic status. The relationship with health and autoimmune diseases. *Autoimmunity Reviews*, *13*(6), 641–654. https://doi.org/10.1016/j.autrev.2013.12.002

Coates, J., Bilinsky, P., & Coates, J. (2007). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator Guide VERSION 3*. Washington, D.C: Academy for Educational Development.

Cohn, A. S., Newton, P., Gil, J. D. B., Kuhl, L., Samberg, L., Ricciardi, V., … Northrop, S. (2017). Smallholder agriculture and climate change. *Annual Review of Environment and Resources*, *42*(1), 347–375. https://doi.org/10.1146/annurev-environ-102016-060946

Cooper, S., Lund, C., & Kakuma, R. (2012). The measurement of poverty in psychiatric epidemiology in LMICs: Critical review and recommendations. *Social Psychiatry and Psychiatric Epidemiology*, *47*(9), 1499–1516. https://doi.org/10.1007/s00127-011-0457-6

Cooper-Vince, C. E., Arachy, H., Kakuhikire, B., Vořechovská, D., Mushavi, R. C., Baguma, C., … Tsai, A. C. (2018). Water insecurity and gendered risk for depression in rural Uganda: A hotspot analysis. *BMC Public Health*, *18*(1), 1143. https://doi.org/10.1186/s12889-018-6043-z

Dangour, A. D., Green, R., Häsler, B., Rushton, J., Shankar, B., & Waage, J. (2012). Symposium 1: Food chain and health: Linking agriculture and health in low- and middle-income countries: An interdisciplinary research agenda. *Proceedings of the Nutrition Society*, *71*, 222–228. https://doi.org/10.1017/S0029665112000213

Das, J., Do, Q. T., Friedman, J., McKenzie, D., & Scott, K. (2007). Mental health and poverty in developing countries: Revisiting the relationship. *Social Science and Medicine*, *65*(3), 467–480. https://doi.org/10.1016/j.socscimed.2007.02.037

Decaro, J. A., Manyama, M., & Wilson, W. (2016). Household-level predictors of maternal mental health and systemic inflammation among infants in Mwanza, Tanzania. *American Journal of Human Biology : The Official Journal of the Human Biology Council*, *28*(4), 461–470. https://doi.org/10.1002/ajhb.22807

Diagnostic & Develpment Group. (2017). *Rapport d'études*: *Types de conflits et leurs méthodes de résolution formelle et informelle dans les zones rurales*, *desservies ou éloignées*. Port-au-Prince.

Dohrenwend, B. P., Levav, I., Shrout, P. E., Schwartz, S., Naveh, G., Link, B. G., … Stueve, A. (1992). Socioeconomic status and psychiatric disorders: The causation-selection issue. *Science*, *255*(5047), 946–952. https://doi.org/10.1126/science.1546291

Evans, G. W., & Kim, P. (2007). Childhood poverty and health: Cumulative risk exposure and stress dysregulation. *Psychological Science*, *18*(11), 953–957. https://doi.org/10.1111/j.1467-9280.2007.02008.x

Ezeh, O. K., Agho, K. E., Dibley, M. J., Hall, J. J., & Page, A. N. (2015). Risk factors for postneonatal, infant, child and under-5 mortality in Nigeria: A pooled cross-sectional analysis. *BMJ Open*, *5*(3), e006779. https://doi.org/10.1136/bmjopen-2014-006779

Ferguson, J. (1992). The Cultural topography of wealth: Commodity paths and the structure of property in rural Lesotho. *American Anthropologist*, *94*(1), 55–73. https://doi.org/10.1525/aa.1992.94.1.02a00040

Filmer, D., & Pritchett, L. (1999). The effect of household wealth on educational attainment: Evidence from 35 countries. *Population and Development Review*, *25*(1), 85–120. https://doi.org/10.1111/j.1728-4457.1999.00085.x

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. https://doi.org/10.2307/3088292

Fone, D., Greene, G., Farewell, D., White, J., Kelly, M., & Dunstan, F. (2013). Common mental disorders, neighbourhood income inequality and income deprivation: Small-area multilevel analysis. *British Journal of Psychiatry*, *202*(4), 286–293. https://doi.org/10.1192/bjp.bp.112.116178

Fotso, J. C., Madise, N., Baschieri, A., Cleland, J., Zulu, E., Kavao Mutua, M., & Essendi, H. (2012). Child growth in urban deprived settings: Does household poverty status matter? At which stage of child development? *Health and Place*, *18*(2), 375–384. https://doi.org/10.1016/j.healthplace.2011.12.003

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Smith, G. D. (2006). Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health.*, *60*, 7–12. https://doi.org/10.1136/jech.2004.023531

Glass, N., Perrin, N. A., Kohli, A., & Remy, M. M. (2014). Livestock/-animal assets buffer the impact of conflict-related traumatic events on mental health symptoms for rural women. *PLoS One*, *9*(11), e111708. https://doi.org/10.1371/journal.pone.0111708

Goodman, A. H., & Leatherman, T. L. (Eds.). (2010). *Building a new biocultural synthesis: Political-economic perspectives on human biology*. Ann Arbor: University of Michigan Press.

Grabe, S., Grose, R. G., & Dutt, A. (2015). Women's land ownership and relationship power: A mixed methods approach to understanding structural inequities and violence against women. *Psychology of Women Quarterly*, *39*(1), 7–19. https://doi.org/10.1177/0361684314533485

Grabner, R. M. (2017). *The lives of suburban peasants: Agricultural change and mobility in Haiti*. University of South Florida. Retrieved from. http://scholarcommons.usf.edu/etd/6849

Greenacre, M. J. (2010). Correspondence analysis. *Wiley Interdisciplinary Reviews: Computational Statistics*, *2*(5), 613–619. https://doi.org/10.1002/wics.114

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: An overview. *Nigerian Journal of Clinical Practice*, *10*(4), 272–282. https://doi.org/10.1001/jama.298.16.1943

Hadley, C., & Patil, C. L. (2006). Food Insecurity in Rural Tanzania Is Associated with Maternal Anxiety and Depression. *American Journal of Human Biology*, *18*(3), 359–368. https://doi.org/10.1002/ajhb.20505

Hadley, C., Maxfield, A., & Hruschka, D. (2019). Different forms of household wealth are associated with opposing risks for HIV infection in East Africa. *World Development*, *113*, 344–351. https://doi.org/10.1016/j.worlddev.2018.09.015

Hanigan, I. C., Butler, C. D., Kokic, P. N., & Hutchinson, M. F. (2012). Suicide and drought in new South Wales, Australia, 1970–2007. *Proceedings of the National Academy of Sciences*, *109*(35), 13950–13955. https://doi.org/10.1073/pnas.1112965109

Harvey, S. B., Henderson, M., Lelliott, P., & Hotopf, M. (2009). Mental health and employment: Much work still to be done. *British Journal of Psychiatry.*, *194*, 201–203. https://doi.org/10.1192/bjp.bp.108.055111

Hebblethwaite, B. (2012). French and underdevelopment, Haitian creole and development: Educational language policy problems and solutions in Haiti. *Journal of Pidgin and Creole Languages*, *27*(2), 255–302. https://doi.org/10.1075/jpcl.27.2.03heb

Hoke, M. K. (2017). Economic activity and patterns of infant growth in a high altitude district of Peru. *American Journal of Human Biology*, *29*(6). https://doi.org/10.1002/ajhb.23038

Hosseinpoor, A. R., Parker, L. A., Tursan d'Espaignet, E., & Chatterji, S. (2012). Socioeconomic inequality in smoking in low-income and middle-income countries: Results from the world health survey. *PLoS One*, *7*(8), e42843. https://doi.org/10.1371/journal.pone.0042843

Howe, L. D., Hargreaves, J. R., Gabrysch, S., & Huttly, S. R. A. (2009). Is the wealth index a proxy for consumption expenditure? A systematic review. *Journal of Epidemiology and Community Health*, *63*, 871–877. https://doi.org/10.1136/jech.2009.088021

Howell, R. T., & Howell, C. J. (2008). The relation of economic status to subjective well-being in developing countries: A meta-analysis. *Psychological Bulletin*, *134*(4), 536–560. https://doi.org/10.1037/0033-2909.134.4.536

Hruschka, D. J., Gerkey, D., & Hadley, C. (2015). Estimer la richesse absolue des ménages. *Bulletin of the World Health Organization*, *93*(7), 483–490. https://doi.org/10.2471/BLT.14.147082

Hruschka, D. J., Hadley, C., & Hackman, J. (2017). Material wealth in 3D: Mapping multiple paths to prosperity in low- and middle-income countries. *PLoS One*, *12*(9), e0184616. https://doi.org/10.1371/journal.pone.0184616

Huppert, F. A., Marks, N., Clark, A., Siegrist, J., Stutzer, A., Vittersø, J., & Wahrendorf, M. (2009). Measuring well-being across Europe: Description of the ESS well-being module and preliminary findings. *Social Indicators Research*, *91*(3), 301–315. https://doi.org/10.1007/s11205-008-9346-0

Ismayilova, L., Gaveras, E., Blum, A., T -Camier, A., & Nanema, R. (2016). Maltreatment and mental health outcomes among ultra-poor children in Burkina Faso: A latent class analysis. *PLoS One*, *11*(10), e0164790. https://doi.org/10.1371/journal.pone.0164790

Jones, A. D. (2017). Food insecurity and mental health status: A global analysis of 149 countries. *American Journal of Preventive Medicine*, *53*(2), 264–273. https://doi.org/10.1016/j.amepre.2017.04.008

Kaiser, B., Kohrt, B., Keys, H., Khoury, N., & Brewster, A. (2013). Strategies for assessing mental health in Haiti: Local instrument development and transcultural translation. *Transcultural Psychiatry*, *15*(4), 532–558. https://doi.org/10.1177/1363461513502697

Kaiser, B. N., Hruschka, D., & Hadley, C. (2017). Measuring material wealth in low-income settings: A conceptual and how-to guide. *American Journal of Human Biology*, *29*(4). https://doi.org/10.1002/ajhb.22987

Kaplan, G. A., Shema, S. J., & Leite, C. M. A. (2008). Socioeconomic determinants of psychological well-being: The role of income, income change, and income sources during the course of 29 years. *Annals of Epidemiology*, *18*(7), 531–537. https://doi.org/10.1016/j.annepidem.2008.03.006

Kohrt, B. A., Ramaiya, M. K., Rai, S., Bhardwaj, A., Jordans, M. J. D. (2015). Development of a scoring system for non-specialist ratings of clinical competence in globalmental health: a qualitative process evaluation of the Enhancing Assessment of Common Therapeutic Factors (ENACT) scale. *GlobMent Health (Camb)*, *2*. pii: e23. https://doi.org/10.1017/gmh.2015.21. Epub 2015 Dec 9.

Kolenikov, S., & Angeles, G. (2009). Socioeconomic status measurement with discrete proxy variables: Is principal component analysis a reliable answer? *Review of Income and Wealth*, *55*(1), 128–165. https://doi.org/10.1111/j.1475-4991.2008.00309.x

Lachaud, J., LeGrand, T. K. T. K., & Kobiané, J.-F. J.-F. (2017). Intergenerational transmission of educational disadvantage in the context of the decline of family size in urban Africa. *Population Review*, *56*(1), 102–126. https://doi.org/10.1353/prv.2017.0004

LAPOP. (2016). Core questionnaire. Latin American Public Opinion Project. Retrieved from https://www.vanderbilt.edu/lapop/haiti.php

Lawson, D. W., Mulder, M. B., Ghiselli, M. E., Ngadaya, E., Ngowi, B., Mfinanga, S. G. M., … James, S. (2014). Ethnicity and child health in northern Tanzania: Maasai pastoralists are disadvantaged compared to neighbouring ethnic groups. *PLoS One*, *9*(10), e110447. https://doi.org/10.1371/journal.pone.0110447

Lazzarino, A. I., Yiengprugsawan, V., Seubsman, S. a., Steptoe, A., & Sleigh, A. C. (2014). The associations between unhealthy behaviours, mental stress, and low socio-economic status in an international comparison of representative samples from Thailand and England. *Globalization and Health*, *10*(1), 10. https://doi.org/10.1186/1744-8603-10-10

Lelliott, P., Tulloch, S., Boardman, J., Henderson, M., & Knapp, M. (2008). *Mental Health and Work*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/212266/hwwb-mental-health-and-work.pdf

Lever, J. P. (2004). Poverty and subjective well-being in Mexico. *Social Indicators Research*, *68*(1), 1–33. https://doi.org/10.1023/B:SOCI.0000025567.04153.46

Little, P. D., Mcpeak, J., Barrett, C. B., & Kristjanson, P. (2008). Challenging orthodoxies: Understanding poverty in pastoral areas of East Africa. *Development and Change*, *39*(4), 587–611. https://doi.org/10.1111/j.1467-7660.2008.00497.x

Lund, C. (2014). Poverty and mental health: Towards a research agenda for low and middle-income countries. Commentary on Tampubolon and Hanandita (2014). *Social Science and Medicine*, *111*, 134–136. https://doi.org/10.1016/j.socscimed.2014.04.010

Lund, C., Breen, A., Flisher, A. J., Kakuma, R., Corrigall, J., Joska, J. A., … Patel, V. (2010). Poverty and common mental disorders in low and middle income countries: A systematic review. *Social Science and Medicine*, *71*(3), 517–528. https://doi.org/10.1016/j.socscimed.2010.04.027

Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. *Science*, *341*(6149), 976–980. https://doi.org/10.1126/science.1238041

Martorell, R. (2017). Improved nutrition in the first 1000 days and adult human capital and health. *American Journal of Human Biology*, *29*(2), e22952. https://doi.org/10.1002/ajhb.22952

Mayén, A. L., Marques-Vidal, P., Paccaud, F., Bovet, P., & Stringhini, S. (2014). Socioeconomic determinants of dietary patterns in low- and middle-income countries: A systematic review. *American Journal of Clinical Nutrition*, *100*(6), 1520–1531. https://doi.org/10.3945/ajcn.114.089029

McDade, T. W., Ryan, C. P., Jones, M. J., Hoke, M. K., Borja, J., Miller, G. E., … Kobor, M. S. (2019). Genome-wide analysis of DNA methylation in relation to socioeconomic status during development and early adulthood. *American Journal of Physical Anthropology*, *169*(1), 3–11. https://doi.org/10.1002/ajpa.23800

Mendenhall, E., Kohrt, B. A., Norris, S. A., Ndetei, D., & Prabhakaran, D. (2017). Non-communicable disease syndemics:

Poverty, depression, and diabetes among low-income populations. *The Lancet.*, *389*, 951–963. https://doi.org/10.1016/S0140-6736(17)30402-6

Mulligan, K., Dixon, J., Joanna Sinn, C.-L., & Elliott, S. J. (2015). Is dengue a disease of poverty? A systematic review. *Pathogens and Global Health*, *109*(1), 10–18. https://doi.org/10.1179/2047773214y.0000000168

Mustafa, H. E. (2008). Socioeconomic determinants of infant mortality in Kenya. *Humanities and Social Sciences*, *2*(2), 1–16.

Nanama, S., & Frongillo, E. A. (2012). Altered social cohesion and adverse psychological experiences with chronic food insecurity in the non-market economy and complex households of Burkina Faso. *Social Science and Medicine*, *74*(3), 444–451. https://doi.org/10.1016/j.socscimed.2011.11.009

Pampel, F. C., Krueger, P., & Denney, J. (2010). Socioeconomic disparities in health behaviors. *Annual Review of Sociology*, *36*, 349–370. https://doi.org/10.1146/annurev.soc.012809.102529.Socioeconomic

Patel, V., Abas, M., Broadhead, J., Todd, C., & Reeler, a. (2001). Depression in developing countries: Lessons from Zimbabwe. *BMJ (Clinical Research Ed.)*, *322*(7284), 482–484. https://doi.org/10.1136/bmj.322.7284.482

Patel, V., Araya, R., De Lima, M., Ludermir, A., & Todd, C. (1999). Women, poverty and common mental disorders in four restructuring societies. *Social Science and Medicine*, *49*(11), 1461–1471. https://doi.org/10.1016/S0277-9536(99)00208-7

Patel, V., Burns, J. K., Dhingra, M., Tarver, L., Kohrt, B. A., & Lund, C. (2018). Income inequality and depression: A systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry*, *17*, 76–89. https://doi.org/10.1002/wps.20492

Patel, V., Kirkwood, B. R., Pednekar, S., Weiss, H., & Mabey, D. (2006). Risk factors for common mental disorders in women: Population-based longitudinal study. *British Journal of Psychiatry*, *189*(DEC.), 547–555. https://doi.org/10.1192/bjp.bp.106.022558

Peters, D. H., Garg, A., Bloom, G., Walker, D. G., Brieger, W. R., & Hafizur Rahman, M. (2008). Poverty and access to health care in developing countries. *Annals of the New York Academy of Sciences.*, *1136*, 161–171. https://doi.org/10.1196/annals.1425.011

Phaswana-Mafuya, N., Peltzer, K., Chirinda, W., Musekiwa, A., & Kose, Z. (2013). Sociodemographic predictors of multiple non-communicable disease risk factors among older adults in South Africa. *Global Health Action*, *6*(1), 20680. https://doi.org/10.3402/gha.v6i0.20680

Pickett, K. E., & Wilkinson, R. G. (2015). Income inequality and health: A causal review. *Social Science and Medicine.*, *128*, 316–326. https://doi.org/10.1016/j.socscimed.2014.12.031

Pike, I. L., & Patil, C. L. (2006). Understanding women's burdens: Preliminary findings on psychosocial health among Datoga and Iraqw women of northern Tanzania. *Culture, Medicine and Psychiatry*, *30*(3), 299–330. https://doi.org/10.1007/s11013-006-9022-2

Popkin, B. M. (2014). Nutrition, agriculture and the global food system in low and middle income countries. *Food Policy*, *47*, 91–96. https://doi.org/10.1016/j.foodpol.2014.05.001

Rao, N. (2006). Land rights, gender equality and household food security: Exploring the conceptual links in the case of India. *Food Policy*, *31*(2), 180–193. https://doi.org/10.1016/j.foodpol.2005.10.006

Rasmussen, A., Eustache, E., Raviola, G., Kaiser, B., Grelotti, D. J., & Belkin, G. S. (2015). Development and validation of a Haitian creole screening instrument for depression. *Transcultural Psychiatry*, *52*(1), 33–57. https://doi.org/10.1177/1363461514543546

Ryff, C. D., & Singer, B. H. (2008). Know thyself and become what you are: A eudaimonic approach to psychological well-being. *Journal of Happiness Studies*, *9*(1), 13–39. https://doi.org/10.1007/s10902-006-9019-0

Sapolsky, R. (2005). Sik of poverty. *Scientific American*, *293*(6), 92–99. https://doi.org/10.1038/scientificamerican1205-92

Seligman, H. K., Laraia, B. A., & Kushel, M. B. (2010). Food insecurity is associated with chronic disease among low-income NHANES participants. *Journal of Nutrition*, *140*(2), 304–310. https://doi.org/10.3945/jn.109.112573

Sen, A. (1982). *Poverty and famines. An essay on entitlement and deprivation* (Vol. 32, pp. 881–886). New York: Oxford university press. https://doi.org/10.1086/451432

Seplaki, C. L., Goldman, N., Weinstein, M., & Lin, Y. H. (2006). Before and after the 1999 chi-chi earthquake: Traumatic events and depressive symptoms in an older population. *Social Science and Medicine*, *62*(12), 3121–3132. https://doi.org/10.1016/j.socscimed.2005.11.059

Stevenson, E. G. J., Greene, L. E., Maes, K. C., Ambelu, A., Tesfaye, Y. A., Rheingans, R., & Hadley, C. (2012). Water insecurity in 3 dimensions: An anthropological perspective on water and women's psychosocial distress in Ethiopia. *Social Science and Medicine*, *75*(2), 392–400. https://doi.org/10.1016/j.socscimed.2012.03.022

Tay, L., & Diener, E. (2011). Needs and subjective well-being around the world. *Journal of Personality and Social Psychology*, *101*(2), 354–365. https://doi.org/10.1037/a0023779

Tittonell, P., & Giller, K. E. (2013). When yield gaps are poverty traps: The paradigm of ecological intensification in African smallholder agriculture. *Field Crops Research*, *143*, 76–90. https://doi.org/10.1016/j.fcr.2012.10.007

Tomalski, P., Moore, D. G., Ribeiro, H., Axelsson, E. L., Murphy, E., Karmiloff-Smith, A., … Kushnerenko, E. (2013). Socioeconomic status and functional brain development - associations in early infancy. *Developmental Science*, *16*(5), 676–687. https://doi.org/10.1111/desc.12079

Tsai, A. C. (2013). Intimate partner violence and population mental health: Why poverty and gender inequities matter. *PLoS Medicine*, *10*(5), e1001440. https://doi.org/10.1371/journal.pmed.1001440

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: How to use principal components analysis. *Health Policy and Planning*, *21*(6), 459–468. https://doi.org/10.1093/heapol/czl029

Weaver, L. J., & Hadley, C. (2009). Moving beyond hunger and nutrition: A systematic review of the evidence linking food insecurity and mental health in developing countries. *Ecology of Food and Nutrition*, *48*(4), 263–284. https://doi.org/10.1080/03670240903001167

Weaver, L. J., Tadess, Y., Stevenson, E. G. J., & Hadley, C. (2019). "I want variety!": Dietary variety as aesthetic pursuit, social signal, and nutritional vehicle in Brazil and Ethiopia. *Human Organization*, *78*(2), 122–132. https://doi.org/10.17730/0018-7259.78.2.122

Whitaker, R. C., Phillips, S. M., & Orzol, S. M. (2006). Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics*, *118*(3), e859–e868. https://doi.org/10.1542/peds.2006-0239

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., … Vos, T. (2013). Global burden of disease attributable to mental and substance use disorders: Findings from the global burden of disease study 2010. *The Lancet*, *382*(9904), 1575–1586. https://doi.org/10.1016/S0140-6736(13)61611-6

Winkelmann, R. (2009). Unemployment, social capital, and subjective well-being. *Journal of Happiness Studies*, *10*(4), 421–430. https://doi.org/10.1007/s10902-008-9097-2

World Bank. (2018). No Title. Retrieved from https://www.worldbank.org/en/country/haiti/overvie

Wutich, A., & Brewis, A. (2014). Food, water, and scarcity. *Current Anthropology*, *55*(4), 444–468. https://doi.org/10.1086/677311

Wutich, A., & Ragsdale, K. (2008). Water insecurity and emotional distress: Coping with supply, access, and seasonal variability of water in a Bolivian squatter settlement. *Social Science and Medicine*, *67*(12), 2116–2125. https://doi.org/10.1016/j.socscimed.2008.09.042

Yoshikawa, H., Aber, J. L., & Beardslee, W. R. (2012). The effects of poverty on the mental, emotional, and behavioral health of children and youth. *American Psychologist*, *67*(4), 272–284. https://doi.org/10.1037/a0028015

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