ORIGINAL RESEARCH

# Moderating Effect of Country of Residence in Predicting Adherence to Treatment Among Black Adults Diagnosed with Hypertension

Ednah Madu[1*], Chinyere Nwajiuba[2], Chiamaka Madu[3] & Tina Nweze[4]

[1]Adelphi, University, College of Nursing and Public Health, Garden City, NY, USA; [2]Alex Ekwueme Federal University, Ndufu-Alike, Abakaliki, Ebonyi State, Nigeria; [3]American University of Antigua, College of Medicine, Antigua; [4]Ebonyi State University, Abakaliki, Ebonyi State, Nigeria

***Corresponding Author:** Ednah Madu, College of Nursing and Public Health, Adelphi University, Garden City, NY, USA.
Email: emadu@adelphi.edu
https://doi.org/10.47988/janany.64582823.2.1

## Abstract

**Background:** Uncontrolled hypertension (HTN) is the major global risk factor for cardiovascular diseases (CVD). Black individuals have worse cardiovascular health outcomes than their racial counterparts. High incidences of HTN-related strokes, heart failure, and chronic kidney diseases are prevalent in Black communities. Long-term adherence to HTN treatment is efficacious in hypertension control but challenged by psychosocial factors and the asymptomatic nature of HTN. **Purpose:** This research aims to assess if the country of residence moderates the relationship between adherence and each of its potential predictors in Black adults with HTN residing in the United States and Nigeria. **Methodology:** This is a secondary data analysis of two studies conducted in New York and southeast Nigeria (n=226). Data were analyzed using SPSS Statistical software Version 27. Descriptive differences in adherence and predicting variables, bivariate analyses for significant predicting variables within each sample, and general linear model analyses with plots for country of residence interaction effects were conducted. **Results:** The mean ages of the US and Nigerian samples were 57.3 ± 11.9 years (70.9% female) and 46.6 ± 8.9 years (67.1% female), respectively. Significant differences ($p < .05$) were noted between levels of adherence, age, self–efficacy, illness perception, annual income, and herbal use. Adherence was significantly associated ($p < .05$) with social support, self-efficacy, provider-patient communication, depressive symptoms, herbal use, employment, and income status within the Nigerian sample. Adherence was significantly associated with depressive symptoms and income status within the US sample. The interaction of country of residence with illness perception, social support, self-efficacy, and provider-patient communication significantly predicted adherence but not for the other variables. Interestingly, there was an opposite relationship between illness perception and adherence between the two samples. **Conclusions:** The country of residence moderated the relationship between adherence and illness perception, social support, self-efficacy, and provider-patient communication. These findings have clinical, cultural, and policy implications. Understanding the similarities and differences between the US and Nigeria will help clinicians working with Black patients and tailor interventions to meet the unique needs of this population. Future studies and culturally relevant strategies to improve HTN treatment adherence could target factors unique to hypertensive patients' country of residence.

***Keywords:*** hypertension, adherence, non-adherence, treatment regimens, Blacks or African Americans

***Funding:*** The authors did not receive any funding from public, commercial, or not-for-profit sectors.

***Conflict of Interest:*** The authors declare no actual or potential conflict of interest.

***Acknowledgments:*** The first author acknowledges partners in data analysis (Dr. William Bannon, Dr. Bernard Gorman), and Dr. Jennel Osborne for her assistance with editing the work, and my family for their unwavering support.

Date Submitted: April 16, 2021 Date Accepted: May 11, 2021 Date Published Electronically: February 1, 2022

# Moderating Effect of Country of Residence in Predicting Adherence to Treatment Among Black Adults Diagnosed with Hypertension

Uncontrolled hypertension (HTN) is the major and most preventable global risk factor for cardiovascular diseases (CVD) and their related diseases. Cardiovascular disease accounts for approximately 17.3 million deaths annually, constituting 31% of global deaths (World Health Organization [WHO], 2021). Eighty-five percent of those deaths were attributed to HTN-related myocardial infarction and stroke (Mozaffarian et al., 2016). In 2006, the Lancet Commission on Hypertension identified elevated blood pressure (BP) as the strongest modifiable risk factor for CVD worldwide despite extensive knowledge on the prevention and treatment of HTN (Olsen et al., 2016). Hypertension-related complications were related to inadequate prevention, treatment, and control of the disease in our world of increasing longevity. The Lancet Commission made a global call to address the concerns of elevated BP in current and future generations.

A 2021 update from the Lancet Commission on Hypertension consisted of a comprehensive global analysis of trends in HTN prevalence, detection, treatment, and worldwide control (Zhou et al., 2021). Data from 184 countries were analyzed using a standardized protocol and statistical model designed to incorporate how HTN and its care and control varied with age, geography, and time (Zhou et al., 2021). The results showed that improvements in the detection, treatment, and control of HTN had varied substantially across countries, with some middle-income countries now outperforming most high-income nations. High-income countries, central Europe, and some upper-middle-income geographic locations had the most improvement, with little change noted in most sub-Saharan Africa and Oceania countries. The improvements were attributed to the dual approach of reducing HTN prevalence through primary prevention and enhancing its treatment and control.

In the United States (US), HTN is a risk factor for heart disease and stroke, the two leading causes of death and disability in the nation (Center for Disease Control [CDC], 2020; Forouzanfar et al., 2017). According to the CDC (2020), only one in four adults with HTN in the US has their condition under control; almost half of adults in the US (108 million, or 45%) have HTN as defined by Systolic Blood Pressure (SBP) ≥ 130mmHg or Diastolic Blood Pressure (DBP) ≥ 80mmHg. About half of those with uncontrolled HTN had their BP levels ≥140/90mmHg. Nearly half of all deaths in the US in 2018 had HTN as a primary or contributory cause. In addition, the economic burden of HTN costs the US about $131 billion annually (CDC, 2020).

Studies conducted in the US consistently reported disparity in HTN prevalence, with risks differing by race. The age-adjusted HTN prevalence in 2015-2016 was 8.5% higher among non-Hispanic Blacks than non-Hispanic Whites (Dorans et al., 2018). Al-Kibria (2019) analyzed the US National Health and Nutrition Examination Survey data collected from 6,103 US adults with HTN between 2011 and 2016. The results showed that non-Hispanic Blacks had the highest proportion of people with unmet treatment goals (63.8%, 95% CI: 60.0%–67.5%). A more significant proportion of non-Hispanic Blacks required pharmacological therapy for HTN control than other races (Muntner et al., 2018). Meanwhile, higher incidences of HTN-related strokes, congestive heart failure (CHF), and chronic kidney diseases (CKD) were noted in Black communities compared to other racial and ethnic groups (Ferdinand et al., 2017; Gasevic et al., 2015; Ritchey et al., 2016).

Black adults outside of the US also have a high HTN prevalence. In Nigeria, West Africa, a high HTN rural and urban prevalence necessitated a call for change in public health policies to address the emerging disease burden (Odili et al., 2020). The nationwide survey (n= 4,192) analyzed by Odili et al. (2020) showed age-standardized HTN prevalence in the nation as 38.1%. With variations across the geopolitical regions, the survey found that HTN prevalence rates in South Nigeria (ranging from 42.1% to 52.8%) was significantly higher than the rates in the North (ranging from 20.9% to 27.5%). With a prevalence of 52.8%, Nigerians residing in the South East had the highest HTN prevalence (Odili et al., 2020).

Overall, suboptimal adherence to HTN treatment contributes to uncontrolled HTN and its associated complications. Pharmacological and non-pharmacological therapy are necessary to control HTN and reduce CVD complications (Mozaffarian et al., 2016). Adherence describes the extent to which an individual's behaviors (taking medication, following recommended dietary and lifestyle changes) corresponded with the agreed recommendations (Sabaté & Sabaté, 2003). Most Black adults with HTN will require pharmacological therapy in addition to lifestyle modifications (Williams et al., 2016). Over the years, international experts and authors developed consensus statements and strategies to address the challenges associated with adherence and health outcomes (Gossec et al., 2007; Vrijens et al., 2012; Moise et al., 2015).

Multiple factors influence adherence to HTN treatment. The WHO characterized adherence barriers into five domains: patient, condition, therapy, socioeconomic, and health care system factors (Sabaté & Sabaté, 2003). However, factors influencing adherence behaviors seemed to vary considerably depending on the countries and their access to medications. Healthcare system disparity could account for differences in healthcare access and health outcomes. While the US runs a multi-payor, heavily private health insurance system (Niles, 2019), Nigeria has a Tier-3 governmental management system (local, state, and Federal) with an overreliance on patients paying before treatment can be initiated (Aregbeshola, 2016).

The literature identifies overlapping factors influencing adherence between Black adults who reside in the US and Nigeria (Lewis et al., 2012; Okwuonu et al., 2014; Schoenthaler et al., 2016). However, it is unclear if the country of residence influences adherence and predicting variables. Therefore, this study's purpose was to assess if, among Black adults with HTN, the country of residence (US and Nigeria) moderated the relationship between adherence and each of its potential predictors.

**Research Questions (RQ)**

RQ1: Were there significant differences in the levels of adherence and each of the potential predictors between Black adults with HTN living in the US and Nigeria?

RQ2: Did country of residence moderate the relationships between the independent variables and adherence?

### Significance of the Study

Identification of the differences in the levels of adherence and its predictors between the samples could facilitate targeting those variables to enhance hypertension control in this population. Future studies and intervention strategies could focus on the identified differences.

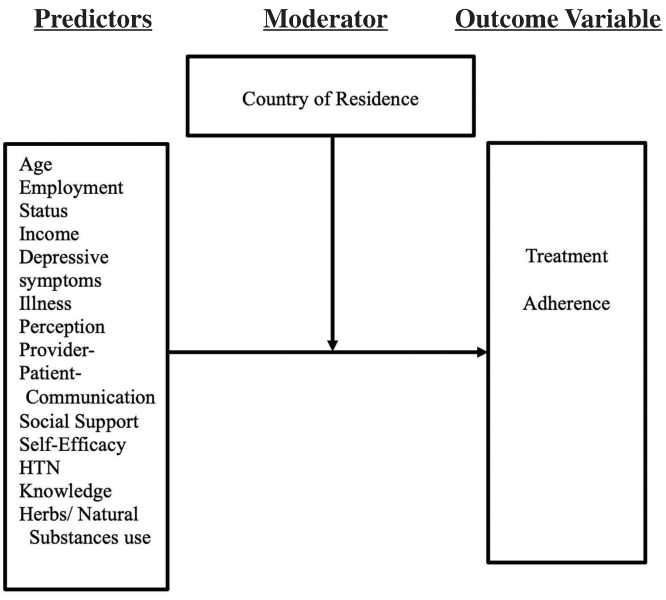
### Conceptual Framework

The review of the literature on the moderation effect model guided this study. Factors that influence adherence to HTN treatment among Black adults are multifactorial and include patient, provider, clinical, and healthcare system factors (Sabaté & Sabaté, 2003; Lewis, 2012). Salient factors identified with impacting HTN treatment adherence among Black adults included patient factors: age (Lewis et al., 2012), self-efficacy (Richardson et al., 2014), illness beliefs (Al-Noumani et al., 2019; Awotidebe et al., 2016; Pettey et al., 2016), hypertension knowledge (Iyalomhe & Iyalomhe, 2010) and preferential use of natural herbs and alternative healing agents (Cuffee et al., 2020). Clinical factors included depressive symptoms (Ademola et al., 2019; Cené et al., 2013; Schoenthaler et al., 2016) and income level (de Terline et al., 2019; Lewis et al., 2010). Healthcare system factors were provider-patient communication (Schoenthaler et al., 2012) and social support (Ojo et al., 2016; Osamor, 2015).

Figure 1 shows the diagrammatic representation of the conceptual model that guided this study's research purpose and methods. The diagram includes potential factors identified in the literature, country of residence as a moderating factor, and adherence as an outcome variable.

**Figure 1**

*Conceptual Framework*




*Note. Framework Based on the Authors' Review of the Literature*

## Methods

### Design

This study is a secondary analysis of data from two separate cross-sectional studies. The research purpose for each of the two studies was to determine the strongest factors associated with adherence to hypertension treatment regimens among the salient factors identified by prior research. The data from the two studies were analyzed to examine if the country of residence moderated relationships between adherence and each of its potential predictors.

### Study Participants and Setting

One of the parent studies recruited participants from New York, USA, and the other from Ebonyi State, Nigeria, in 2018 and 2019, respectively. To be eligible for the parent studies, participants had to self–identify as Black, be age 18 years or older, and be informed at least once in the past by a healthcare practitioner of having high blood pressure or being treated for primary HTN. The participant had to be able to read, write and sign an informed consent form written in the English language. The secondary data was a combination of the two de-identified datasets. The current study's researchers could not link the data to specific participants directly or indirectly. The current dataset included all of the variables and participants from the parent studies.

### Variables and Measures

The variables under study, measures, and psychometric properties are displayed in Table 1. Preferential use of alternative healing agents was assessed using a three-response question that inquired the type of remedies used to treat HTN. Participants selected from the following options: (a) used only natural herbs or alternative healing agents in place of treatments recommended by their healthcare provider; (b) used both natural substances and prescribed medications; or, (c) used only prescribed medications.

### Data Collection

Data collection for the two-parent studies occurred after approval by the Institutional Review Boards of the institutions. Data were collected using a face-to-face survey that combined demographic and structured questions and validated instruments. The questionnaire was pilot tested using ten eligible participants for both parent studies to evaluate the feasibility and timing of the survey, and both were completed between 30-40 minutes. Each participant completed an informed consent form, written in the English language, before each data collection, and after the PI provided the description and purpose of the study.

### Ethical Considerations

The Institutional Review Boards of Adelphi University, New York, approved the first parent study. Both Adelphi University and the Ethics committee of Alex Ekwueme Federal University, Ndufu-Alaike Ikwo (AEFUNAI), Ebonyi State, Nigeria, approved the second parent study. The de-identified secondary data were stored in a password-protected computer. Only the PI and two partners in conducting data analysis had access to the secondary data.

**Sample Size**

For the parent study, a priori sample size was calculated with G*power, using a power of 0.80, medium effect size (Cohen's $f^2$ = .15), significance level of 0.05 and 7 predictors (Verma & Verma, 2020). One hundred and three participants were needed for each of the parent studies. The combined sample size of both parent studies was 226 (US: n=148, Nigeria: n= 78).

**Statistical Analyses**

Data were analyzed using the IBM SPSS Statistical Software for Windows, Version 27.0, and the Jamovi (2021) Statistical Software Version 1.6. Data analysis occurred in three phases. The first phase consisted of descriptive analyses. The second phase involved sets of bivariate analyses, and in the third phase, the data analysis assessed the interaction effect between the country of residence and each variable.

Regarding all continuous study variables, outliers ±3SD of the mean assessed by inspection of a boxplot were excluded from the analyses. Researchers removed observed missing data using pairwise deletion. All continuous variables, including adherence, were normally distributed. In answer to RQ1, differences in the levels of adherence and each of the potential predictors between the countries were analyzed descriptively and with independent samples t-tests. Data analyses to answer RQ2 occurred in two steps. First, a series of bivariate tests identified potential predictors for adherence. Specifically, independent-samples t-tests and Pearson's r correlations identified explanatory variables significantly related to adherence scores within each country of residence. All the explanatory variables related to adherence scores at $p < .05$ via bivariate analyses were identified. In the second step of answering RQ2, the general linear model analyses examined whether there was significant predictor interaction by the country of residence. This approach accommodated both categorical and continuous variables. Each predictor was analyzed separately, with the continuous variables as covariates and categorical variables as factors. The figures of the interaction analysis plots were obtained.

**Table 1**

*Variables and Validated Instruments*

| Variables | Instrument Name | Author | # Items | Cronbach Alpha |
|---|---|---|---|---|
| Adherence | Hill-Bone Compliance to High Blood Pressure Therapy Scale (HBCHBPTS) | Kim et al. (2000) Lambert et al. (2006) | 10 | 0.79 |
| Social Support | The multidimensional scale of perceived social support (MSPSS) | Zimet et al. 1988) | 12 | 0.98 |
| Self-Efficacy | Medication Adherence Self-Efficacy Scale (MASES) | Fernandez et al. (2008) | 13 | 0.97 |
| Hypertension Knowledge | Hypertension Knowledge-Level Scale (HK-LS) | Baliz-Erkoc et al. (2012) | 9 | 0.82 |
| Illness Perception | The Brief Illness Perception Questionnaire | Broadbent et al. (2006) | 9 | 0.76 |
| Provider-Patient Communication | Communication Assessment Tool (CAT) | Makoul et al. (2007) | 15 | 0.98 |
| Depressive Symptoms | Patient Health Questionnaire (PHQ-9) | Kroenke et al. (2001) | 9 | 0.87 |

## Results/Findings

**Analyses Results for RQ1**

The comparative analyses of the differences in adherence and the predicting variables between Black adults who resided in the US and Nigeria are presented in Table 2 (categorical variables) and Table 3 (continuous variables). Significant differences at $p<.05$ were noted between the two countries in the following variables: adherence, age, self-efficacy, illness perception, annual income, and whether the participant preferred using a combination of herbs with prescribed medications for HTN or only prescribed medications to treat HTN. No significant differences were noted between the two samples in gender, employment status, social support, HTN knowledge, provider-patient communication, or depressive symptoms.

**Table 2**

*Descriptive Analysis Results: Differences in the predictors between the US and Nigeria*

| Variable | N (%) | | $x^2(df)$ | *P* |
|---|---|---|---|---|
| | US. | Nigeria | | |
| **Gender** | | | 0.35 (224) | .55 |
| Male | 43 (29.1) | 25 (32.9) | | |
| Female | 105 (70.9) | 51 (67.1) | | |
| **Work Status** | | | 19.3 (222) | .30 |
| Working | 98 (66.2) | 69 (93.2) | | |
| Not working | 50 (33.8) | 5 (6.8) | | |
| **Herbal use preference** | | | 5.72 (223) | .02 |

| | | | | |
|---|---|---|---|---|
| Use Both herbs and prescribed medications | 54 (36.7) | 16 (21.1) | | |
| Only prescribed medications | 93 (63.3) | 60 (78.9) | | |
| Annual income | | | 64.6 (3,214) | <.001 |
| <$10,000 | 37(25) | 55(83.3) | | |
| $10,000-$40,000 | 21(14.2) | 3 (4.5) | | |
| $40,001-$80,000 | 40(27) | 1(1.5) | | |
| >$80,000 | 50(33.8) | 7(10.6) | | |

Note: Significance level at p < 0.05

**Table 3**

*Differences in adherence and its predictors between the US and Nigeria (Continuous variables)*

| Variable | *M±SD* U.S (n=148) | *M±SD* Nigeria (n=76) | *t(df)* | ***p*** |
|---|---|---|---|---|
| Adherence | 1.6±0.4 | 1.4±0.4 | -3.67 (224) | .00 |
| Age | 57.3±11.9 | 46.6±8.9 | -7.46 (217) | .00 |
| Social Support | 5.6±1.0 | 5.6±1.4 | -.083 (224) | .93 |
| Self-Efficacy | 3.2±0.8 | 2.7±0.6 | -5.31(224) | .00 |
| HTN Knowledge | 11.3±2.7 | 11.6±2.2 | .891 (224) | .89 |
| Illness Perception | 4.9±1.8 | 6.2±1.1 | 6.74 (224) | .00 |
| Provider-Patient Communication | 3.9±0.9 | 4.0±0.62 | .60 (224) | .55 |
| Depressive Symptoms | 3.0±3.7 | 3.7±3.5 | 1.39 (224) | .17 |

*Note: Significance level at p < 0.05*

**Bivariate Analysis Results for RQ2**

A two-step analysis answered RQ2. The first step consisted of bivariate analyses. Table 4 shows the results of the independent-sample t-test used to compare the differences in adherence between the types of each categorical variable within each sample. The data analysis showed income status, herbal use, and employment status to be significantly (p < .05) associated with adherence within the US and the Nigerian samples. Table 5 shows the results of the Pearson's r correlation tests used to analyze the associations between adherence and continuous explanatory variables within each sample. Adherence was significantly (p < .05) associated with social support, self-efficacy, provider-patient communication, and depressive symptoms within the Nigerian sample. Adherence was significantly (p < .05) related with only depressive symptoms within the US sample. Interestingly, adherence was not significantly linked to age, HTN knowledge, or provider-patient communication in either sample. Notably, adherence was statistically significant with depressive symptoms in both the US and Nigerian samples.

**Table 4**

*Independent-samples t-test Examining Differences in Adherence between Explanatory Categorical Variables within each Country.*

| Independent Variable | US. | | | Nigeria | | |
|---|---|---|---|---|---|---|
| | M±SD | *t/F* | *p* | M±SD | *t* | *p* |
| Income | | 4.14 | .01 | | 4.65 | **.01** |
| <$10,000 | 1.40±0.50 | | | 1.40±0.35 | | |
| $10,000-$40,000 | 1.63±0.38 | | | 1.00±0.35 | | |
| >$40,001-$80,000 | 1.63±0.31 | | | .60±0.00 | | |
| >$80,000 | 1.64±0.24 | | | 1.66±0.22 | | |
| Herbal Use | | -.91 | .36 | | -3.02 | **.00** |
| Yes | 1.54±0.38 | | | 1.16±0.34 | | |
| No | 1.60±0.35 | | | 1.46±0.35 | | |
| Work Status | | -.23 | .82 | | 2.22 | **.03** |
| Working | 1.57±0.34 | | | 1.42±0.35 | | |
| Not working | 1.59±0.40 | | | 1.06±0.32 | | |

Note: Significance level at p < 0.05

*Higher adherence scores indicate greater adherence*

**Table 5**

*Pearson's r Correlation Analysis between Adherence and Explanatory Study Variables within each Country*

| **Study Variables** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Adherence | – | -.01 | .45** | .35** | .20 | .19 | .34** | -.26* |
| 2. Age | .02 | – | -.05 | -.28* | -.15 | .03 | -.06 | .07 |
| 3. Social Support | .05 | .07 | – | .47** | .26* | .40** | .33** | -.01 |
| 4. Self-Efficacy | .13 | .05 | .27** | – | .21 | .08 | 0.17 | .09 |
| 5. Knowledge | .05 | -.01 | .17** | .21** | – | .15 | .29* | -.15 |
| 6. Perception | -.15 | .15 | .00 | .15 | .20** | – | .37** | .14 |
| 7. Communication | .11 | .01 | .41** | .27** | .20** | -.05 | – | -.20 |
| 8. Depressive symptoms | -.25** | -.07 | -.24** | -.17** | -.12 | .07 | -.38** | – |

*Notes: The coefficients in the upper triangle are for the Nigerian sample and the lower triangle for the US sample*

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

The interaction effects of each variable were reported by the country of residence. Table 6 shows the Estimated Adherence Means and Standard Errors by variable, and Table 7 displays the summary of findings from the general linear model analyses for the interaction effects of each variable with the country of residence. Specifically, the ANOVA statistics showing the F statistics, p-value, and effect sizes were reported for each interaction effect analyzed. The tables and plots of interaction effects between each variable and country of residence are supplementary documents and will be provided upon request. No interaction effect was noted

between the country of residence and herbal use, employment status, age, HTN knowledge, and depressive symptoms. The income variable was excluded from the interaction effects due to the incomparability of the Nigerian Naira and the US dollar income differences in the samples, considering the cost-of-living differences. Standardizing the income by country did not address the comparison issue, as it was not simply about being below or above average in the given country. While the income may reflect buying power, socioeconomic status, and lifestyle that these incomes might provide the person, it was noted that 83% of the participants in the Nigerian sample earned less than $10,000 per annum when the Nigerian naira is converted to the US dollar. That percentage represents middle-income groups able to enjoy a reasonable lifestyle in Nigeria.

**Table 6**

*Estimated Adherence Means and Standard Errors by Variable for the US and Nigerian Samples.*

| Variable | Estimated Means and Standard Errors for US | Estimated Means and Errors for Nigeria |
|---|---|---|
| Herbal Use | Yes 1.56 **(.05)** No 1.60 **(.04)** | Yes 1.16 **(.09)** No 1.46 **(.05)** |
| Work status | Working 1.57 **(.04)** Not working 1.59 **(.05)** | Working 1.42 **(.04)** Not Working 1.06 **(.16)** |
| Age | 1.57 **(.03)** | 1.37 **(.06)** |
| Social Support | 1.58 **(.04)** | 1.39 **(.03)** |
| Self-Efficacy | 1.57 **(.03)** | 1.46 **(.05)** |
| HTN Knowledge | 1.58 **(.03)** | 1.38 **(.04)** |
| Illness Perception | 1.56 **(.03)** | 1.33 **(.03)** |
| Provider-Patient Communication | 1.58 **(.03)** | 1.38 **(.04)** |
| Depressive symptoms | 1.57 **(.03)** | 1.40 **(.04)** |

*Note: The Standard Errors are presented in parenthesis following the Means in each cell of the Table*

**Table 7**

*Summary of Analyses Examining Interaction Effect of Variables with Country of Residence*

| Variable | F Statistic/df | p value | Effect size/ $\mathbf{n^2p}$ |
|---|---|---|---|
| Herb use*group | 4.10 (1, 219) | .04 | .018 |
| Work Status*group | 4.48 (1,218) | .04 | .020 |
| Age*group | .037 (1.215) | .84 | .000 |
| Social Support*group | 11.2 (1, 222) | <.001 | .048 |
| Self-Efficacy*group | 4.61 (1,222) | .03 | .020 |
| HTN Knowledge*group | 1.98 (1,222) | .24 | .006 |
| Illness Perception*group | 5.07 (1,222) | .03 | .022 |
| Provider-Patient | | | |
| Communication*group | 4.70 (1,222) | .03 | .021 |
| Depressive symptoms*group | .039 (1,222) | .84 | .000 |

*Note: Researchers consider any p-value < .05 as statistically significant*

## Discussion

This study's purpose was to assess if, among Black adults with HTN, the country of residence (US and Nigeria) moderated the relationship between adherence and each of its potential predictors. Disproportionately higher HTN-related cardiovascular morbidity and mortality were noted among Black persons who resided in both the US and globally (CDC, 2020; Mozaffarian et al., 2016; Odili et al., 2020). Environmental differences like the country of residence could influence HTN prevalence, access to healthcare, and adherence to recommended treatment regimens.

Significant differences were noted in adherence scores and potential predictors between Black adults with HTN living in the US and Nigeria ($p < .001$) relative to RQ1. Adherence is complex, and factors influencing adherence are multifarious (Sabaté &Sabaté, 2003). Differences in environmental conditions and access to treatment may have contributed to the differences in the levels of adherence noted between the two countries. Predictors of adherence may have also differed based on the location of residence. In the current study, bivariate analyses identified factors that predicted adherence within the Nigerian sample as income status, herbal use, employment status, social support, self-efficacy, provider-patient communication, and depressive symptoms. Income status and depressive symptoms were significantly associated with adherence within the US sample, but not the other variables. Age, HTN knowledge, and illness perception were not significantly associated with adherence within either sample.

Some prior studies have found similarities in adherence factors in both samples, while others found divergent results. For example, Boima et al. (2015) found a similar non-significant relationship between income and adherence to HTN regimens using the sample from their study that recruited participants from hospitals in Nigeria and Ghana. However, a meta-analysis of twenty-two studies on factors regarding the lack of HTN medication adherence in low and middle-income participants showed that most factors affecting HTN treatment non-adherence fell within the WHO-defined dimension of "social and economic factors" (Nielsen et al., 2017). The five dimensions of adherence included social and economic factors, health care team and system-related factors, conditions-related factors, therapy-related factors, and patient-related factors. One of the key components of the social and economic dimension was income status or economic stability (Sabaté & Sabaté, 2003). Studies in the US affirmed the vital role of socioeconomic variables (including income status) in hypertension management (Anstey et al., 2019). Social support was not consistently associated with adherence in US studies (Schoenthaler et al., 2016). Most studies conducted

in Nigeria found social support as significantly associated with adherence (Ademola et al., 2019, Ojo et al., 2016, Osamor, 2015). Interestingly, depressive symptoms were associated with adherence within both the Nigerian and the US samples. Prior studies confirmed the significant influence of depressive symptoms with adherence in the US (Spikes et al., 2019) and Nigeria (Ademola et al., 2019).

This research also examined if the country of residence moderated the relationships between adherence and the predictors (RQ2). In other words, researchers examined if the country of residence had an interaction effect with any of the variables to predict adherence.

The general linear model analyses and plots showed the strength and directions of the interaction effects between the country of residence and the variables under study. A significant interaction between the country of residence and illness perception, self-efficacy, social support, and provider-patient communication predicted adherence. The literature has identified these variables to influence adherence among Black adults diagnosed with HTN both in the US and Nigeria (Awotidebe et al., 2016, Cené et al., 2013; Magrin et al., 2015; Osamor, 2015; Schoenthaler et al., 2016; Richardson et al., 2014).

Interestingly, the current study showed opposite illness perception and adherence relationships between the two samples. Illness perceptions, the organized cognitive representations or beliefs that patients have about their illness, are essential determinants of behavior. They are associated with important outcomes, such as treatment adherence and functional recovery (Petrie et al., 2007). A review of the literature on adherence showed that most authors assumed that patients would simply obey the recommendations from their healthcare provider (Hsiao et al., 2012). However, clinicians encounter challenges when patients' personal and cultural beliefs regarding their illness and treatment recommendations are not considered. Many factors contributing to non-adherence to chronic diseases like hypertension include lack of association of disease with symptoms, treatment complexity, and possible side effects. These factors and the patient's concerns shaped beliefs about their illness and recommended treatments and were conceptualized as illness perceptions (Hsiao et al., 2012).

The current study showed that participants in the Nigerian sample who had stronger perceptions about their illness were more adherent, and those with weaker illness perceptions were less adherent to treatment. The opposite was the case with participants in the US group, such that participants with stronger illness perceptions were less adherent while those with weaker illness perceptions were more adherent. This finding is consistent with conflicting evidence in the literature regarding the effect of illness perception on HTN treatment adherence. A systematic review (n=30) by Al-Noumani et al. (2019) examined the relationship between health beliefs and HTN medication adherence and found the relationships were unpredictable across and within countries. These authors advised clinicians on the importance of assessing beliefs for individual patients (Al-Noumani et al., 2019). If such beliefs appeared to undermine adherence, educational interventions could modify such beliefs.

Regarding self-efficacy, the direction of the relationship with adherence was similar in both samples, such that participants with low self-efficacy had lower adherence scores. In comparison, those with higher self-efficacy had higher adherence scores. However, participants in the Nigerian sample with high self-confidence and high adherence groups far exceeded the adherence scores of the participants in the US sample. Evidence supported the importance of self-efficacy on treatment adherence among Black adults in the US (Richardson et, 2014) and Nigerian samples (Awotidebe et al., 2016). Strategies to improve self-efficacy remain relevant to improve adherence behaviors for patients with HTN. The findings of this study suggest that individuals who reside in Nigeria may have more profound benefits from interventions that improve self-efficacy.

In this study, the interaction effect between the country of residence and social support was such that participants in the Nigerian sample with lower social support had lower adherence scores and those with higher social support had higher scores. In comparison, there was a minimal difference in the adherence scores for the participants in the US sample, regardless of their social support scores. Identifying social support as a key predictor of HTN treatment adherence in the Nigerian sample, but not in the US, is consistent with current literature. Studies conducted in the US have not shown social support as a consistent predictor of compliance. Schoenthaler et al. (2016) found that social support did not have a significant association with adherence directly, but had an indirect association with other variables found to be significantly associated with HTN medication compliance. Spikes et al. (2019) also did not find social support significantly correlated with adherence. However, in studies conducted in Nigeria, the relationship between social support and adherence was consistent. Osamor (2015) investigated the relationship between social support and HTN treatment compliance using a sample of participants residing in Southwest Nigeria and found that social support from friends was significantly associated with good compliance with hypertension treatment. Ojo et al. (2016) also found that strong perceived family support was an independent predictor of controlled blood pressure.

Lastly, the direction of the relationship between provider-patient communication and adherence was similar in both the US and Nigerian samples. Participants who had lower provider-patient communication had lower adherence scores. In contrast, those with higher provider-patient communication had higher compliance scores. In the Nigerian sample, the group with higher provider-patient communication achieved significantly higher compliance scores that reached the same level of high adherence scores as the participants in the US sample. Prior studies found that effective collaborative provider-patient communication fostered patient trust and compliance to treatments among Blacks in the US (Schoenthaler et al., 2018; Zullig et al., 2015) and Nigeria (Onyeajam et al., 2018). A similar direction and pronounced relationship between adherence and self-efficacy were noted in the Nigerian sample in the current study. Effective provider-patient communication, which fosters trust, may be linked to self-efficacy and better adherence.

The country of residence did not moderate the relationship between adherence and age, employment status, herbal use, HTN knowledge, or depressive symptoms. Line charts displaying

interaction effects teased out the potential Type 1 error, presenting false-positive interaction effects. Similar strength and direction were noted on the relationship between depressive symptoms and adherence in the US and Nigerian samples. Depressive symptoms equally influenced adherence regardless of the country of residence. This finding has clinical implications. Prior studies identified significant influences of depressive symptoms in Nigeria (Ademola et al., 2019) and the US (Cené et al., 2013; Schoenthaler et al., 2016). Additional studies and strategies that mitigate the influences of depressive symptoms on adherence among Black persons diagnosed with HTN seem prudent.

## Study Limitations and Recommendations for Further Studies

The current study had some limitations. The two-parent studies used cross-sectional designs, which does not imply causation. The small sample size for the subgroups, especially the Nigerian sample (n=78), is less than the recommended size of 103. This is a study limitation and may have influenced some study findings. A larger sample size and a more diverse sample are recommended in future studies. Part of the challenges in obtaining a higher sample size from the Nigerian group might be related to many potential participants with a known history of high blood pressure declining to participate with comments like *"it is not my portion."* This perception could have validated the differences in the illness perception scores between the US and Nigerian samples.

Multiple testing might have inflated the alpha probability rate leading to Type 1 error. While multiple regression could be performed, it was likely not advantageous. Multicollinearity occurs when variables are highly correlated, making interpretation of regression coefficients difficult, if not meaningless. A typical correction might be the Bonferroni correction. However, no appropriate Bonferroni correction for correlated dependent variables is generally accepted. Therefore, the researchers used separate analyses for the interaction effects. The authors caution readers that multiple testing may have affected the alpha rate.

A recommendation for future studies is to employ qualitative approaches to explore participant views regarding barriers and facilitators of adherence. Exploring participants' perceptions of barriers to the recommended HTN treatment regimens could be beneficial.

## Conclusion and Implications

Consistent with the research questions, this study found statistical differences in the levels of HTN treatment adherence and some predictors of adherence between the US and Nigerian samples. The interaction between the country of residence and illness perception, self-efficacy, social support, and provider-patient communication significantly predicted adherence. The country of residence did not moderate the relationship between adherence and age, employment status, herbal use, HTN knowledge, or depressive symptoms. These findings have clinical, cultural, and policy implications. Planning culturally relevant strategies to improve adherence and HTN control among Black adults should incorporate factors unique to the country of residence.

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