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Latent Growth Curve Model Evaluation of Illicit Substance and Tobacco Use among Young Adults in Cumberland County, North Carolina

Mongkuo MY[1]*, Mongkuo MYB[2] and Lucas N[2]

[1]Department of Government and History, Fayetteville State University, USA
[2]Department of Clinical Psychology, Virginia Stae University, USA
[3]Fayetteville State University, USA

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***Corresponding author:** Maurice Y Mongkuo, Department of Government and History, Virginia State University, USA with Fayetteville State University, USA, Email: mmongkuo@uncfsu.edu

Abstract

Aim: Young adulthood is a period when individuals experiment health risk substances such as illicit substance and tobacco use that may predispose them to sexually transmitted diseases. Minority young adults living in HIV prevalent urban communities are notably more likely to engage in these behaviors. In the United States, minority young adults over-represented with HIV infection. To resolve this problem, the United States Congress has invested over $100million in grants. In the United States, few studies have examined illicit substance and tobacco use among this vulnerable population. This study aimed to evaluate the impact of a comprehensive HIV prevention program (CIHPP) on illicit substance and tobacco use among minority young adults living in a high prevalence of HIV infection urban community.

Methods: The data of illicit substance and tobacco use was collected using a survey of a random sample of minority young adults who participated in the CIHPP. for12-months. Change in illicit substance and tobacco use during 24 months of minority young adults' participation in CIHPP was recorded. The data was analyzed using the latent growth curve (LGC) model within the framework of the structural equation modeling procedure. The evaluation included the change in the intercept and slope of the Mean, Variance, covariance, and predictor variable in three waves for 24months.

Result: The average score for illegal substance use of 5.411 decreased significantly over the 24months. Young adults exhibited a low rate of increase in their illicit use substance over the 24months. This finding indicates that the CIHPP was effective in decreasing the substance use of young adults under study. There were significant inter individual differences in the original score of illicit substance use between the young adults at the beginning of the implementation of the CIHPP and its change over time, as the as the minority young adult progressed from the beginning of the CIHPP intervention through the 24 months. Using gender as a predictor of change showed no difference between male and female young adults. For tobacco use, the average score for tobacco (16.631) decreased significantly over the three 24months.

There was no meaningful difference between minority young adult males and minority young adult females in illicit substances use at the beginning of CIHPP. However, during CIHPP intervention, minority young adult's males had an increase in the rate of change in tobacco use than minority young adult females. The mean estimate for tobacco use indicates that the average score for tobacco use increased significantly over the three 12-months periods. The covariance between the intercept and slope factor for tobacco use was statistically significant. Minority young adult males exhibited a higher rate of tobacco use than their female counterparts over the 24 months. This finding suggests that the Comprehensive, integrated HIV prevention program was not effective in decreasing the tobacco use of the minority young adults studied, The variance estimate related

to the intercept and slope for tobacco use is statistically significant (p=.001) suggesting that there were vast inter-individual differences both at the beginning of CIHPP and the rate of change of tobacco use between the minority young adults at the beginning of the implementation of the CIHPP and its rate of change over time, as the young adult progressed from the beginning of the CIHPP intervention through the 24months. Such evidence provides sturdy support for further investigation of variability or heterogeneity related to the growth trajectory. Specifically, the incorporation of time-invariant of change into the model can explain the young adults' tobacco use variability. This incorporation involves testing the latent growth curve model with the demographic or static variable as a time-invariant predictor of change. This study incorporated *gender* in the LGC model as a predictor of change. The prediction module with gender as predictor found that there was no meaningful difference in illicit substance and tobacco use between minority young adult males and females.

Keywords: Comprehensive HIV Prevention Programs; Illicit Substance Use; Tobacco Use; Latent Growth Curve Model; Structural Equation Modeling; Minority Young Adults

Abbreviations: LGC: Latent Growth Curve; SA: Substance Abuse; PLHI: Prevalence of Persons Living with HIV Infection; NCSCHS: North Carolina State Center for Health Statistics; NCDHHS: North Carolina Department of Health and Human Service; STIs: sexually Transmitted Infections; CIHPP: Comprehensive, Integrated HIV Prevention Program; PBT: Problem Behavior Theory; SEM: Structural Equation; IRB: Institutional Review Board's; EFA: Exploratory Factor Analysis; CFA: Confirmatory Factor Analysis; KMO: Kaiser-Meyer-Olkin; MSA: Measure of Sampling Adequacy; FIML: Full Information Maximum Likelihood; RMSEA: Root Mean Square Errors of Approximation; TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; CAIC: Consistent Version of the AIC; ECVI: Expected Cross-Validation Index: CN: Critical N.

Introduction

In 2017, approximately 25% of adults in the United States had some form of a substance use disorder, and those adults consume 40% of all cigarette smoke by adults [1,2]. Among young adults, research shows a disproportionate number of people with mental health problems engage in risky sexual behavior such as tobacco and illegal substance use; Glossary of Terms for Nebraska Behavioral Health System 2006. *Mental Health board Training Self-Study*. In Cumberland County, the Survey on Drug Use and Health reports that in 2014, Cumberland County's total population was 272,192 of this total, 7.8% had substance abuse (SA) problems, which was slightly above North Carolina's (SA) prevalence rate of 7.3% for young adults ages 18-25, in 2014, the (SA) prevalence rate was 16.9%, which was two times more than the County's and the State's S.A. rates. In 2015, the (SA) rate for Cumberland County, North Carolina, and young adults ages 18-25 increased to 8.9%, 8.6%, and 18.5%, respectively North Carolina Department of Public Health and Human Services (2014) North Carolina HIV/STD Quarterly Surveillance Report: Vol. 2014, No. 4, Raleigh, North Carolina.

These data clearly show that Cumberland has a substance abuse problem which is on the rise, especially among person ages 18-24 years. Collectively, these data suggest a need for a comprehensive, integrated, evidence-based (SA) HIV and HCV prevention and environmental prevention strategies, policies, and practices in Cumberland County. Recent (2016) National Minority SA/HIV Prevention Initiative survey of minority young adults showed variation in attitude toward different types of substance abuse among this population. A vast majority (76%-97%) viewed illicit drugs, prescription drug use without doctor's prescription, and injected drug use as having moderate to high physical risk. But, a vast majority (78.9%) considered marijuana use as having no to slight physical risk.

Tobacco use refers to smoking cigarettes, cigars, smokeless tobacco, e-cigarette and pipe tobacco in the past year and past month. Studies show that one in five individuals within the U.S. have a mental health disorder, yet this population consumes almost half of all cigarettes sold within the U.S [2].As a result, individuals with mental health disorder account for more than 40% of tobacco-related deaths each year and incur additional social constraints such as discrimination and stigma which contribute to increased alienation and poorer mental health [3].

Illicit substance includes, but not limited to, ecstasy, opioid, crack cocaine, methamphetamine, and inhalants that reduce pain, including prescription drugs and heroin, which has found to be associated with increased HIV risk if people share needles and other injection equipment (University of California-San Diego. 2007. High-risk Behaviors Could Lead To HIV Epidemic In Afghanistan. *Science Daily*, August 29 2007). Recent data indicate that one-third of new HIV infection the United States attributed to no injecting substance use such as ecstasy, methamphetamine, inhalants, and crack cocaine.

Prevalence of Persons Living with HIV Infection (PLHI)

The NCDHHS reports that Cumberland County continues to battle against sexually transmitted and other diseases. For example, in 2013, there were 1,339persons living with HIV infection (PLHI) in Cumberland County of this total, 866 were infected with HIV, and 473 had AIDS. There were 158 PLHI young adults ages 15-24years old, representing 0.6% with a corresponding HIV infection rate of 27.7per 100,000population in Region 5, which includes Cumberland County. This HIV infection rate is higher than North Carolina's rate of 25.7per 100,000 people. Desegregating PLHI rate in Region 5 which include Cumberland County by race/ethnicity shows that except for Hispanics and Asian/ Pacific Islanders, rate of PHLI was higher than that of North Carolina, with the PHLI rate and percent of American of 4.9% and 189.6 per 100,000 population is seven times higher than North Carolina's 0.7% and 175.2 per 100,000 people; African Americans were 69.4% and 710.4 per 100,000 population compared to North Carolina's 65.4% and 857.8 per 100,000 people.

Prevalence of Newly diagnosed HIV Infection and AIDS

In 2013, Cumberland County had 97 newly diagnosed HIV infections, which rank 3rd among all North Carolina Counties in newly diagnosed HIV infection rate with 26.0% HIV infections per 100,000 populations (97 cases) compared to N.C. rate of 15% per 100,000 people. From 1983-2013, Cumberland County had a cumulative number of HIV cases of 2,087, which ranks 6th out 100 Counties in North Carolina. During the same period, the County had 910 increasing cases of AIDS, which ranks 6th among the 100 counties in North Carolina. North Carolina State Center for Health Statistics (NCSCHS) reported that during the period 2007-2011, Cumberland County's HIV rate of infection of 27.3/100,000 population was 1.54 times higher than the State of North Carolina's HIV infection rate of 17.7 per 100,000 people. Also, NCHHS reported that during 2007-2011, Cumberland County's total AIDS rate of 3.4p/100,000 population was 1.7 times higher than North Carolina State's total AIDS rate of 2.0 p/100,000 population was 13% higher than all its peer counties, except for one (Mecklenburg County) in the State. These statistics suggest the need for HIV prevention intervention for HIV positive persons in Cumberland County as well. This HIV prevalence data indicate that the newly diagnosed HIV infection rate of our target population is higher than expected and hence the need for HIV prevention with HIV positive person's interventions for our target populations. In summation, these HIV infections and substance abuse prevalence data clearly show not only a higher than expected rate of HIV infection among young adults aged 18-24 who use illicit substances was in Cumberland County but also that substance abuse problem exceeds expectation in Cumberland County, and it is on the rise, especially among persons ages 18-24 years.

HIV Infection Risk Behavior and Integrated HIV Prevention Program (CIHPP)

Existing data show that minority young adults use illicit substances more than other racial and age groups in Cumberland County (North Carolina Department of Public Health and Human Services (2014) North Carolina HIV/ STD Quarterly Surveillance Report: Vol. 2014, No. 4, Raleigh, North Carolina). This minority young adults account for a higher rate of sexually transmitted infections (STIs), including HIV. This high-risk sexual behavior in minority communities across the United States making STD prevention a top priority, for example, in the last decade alone, the U.S. Department of Health and Human Services has invested heavily by awarding over 100million dollars in grants to community-based organizations and institutions of higher learning to design and implement innovative culturally and linguistically appropriate evidence-based strategies to reduce health risk behaviors among this subpopulation.

One such strategy is the comprehensive, integrated HIV prevention program (CIHPP). The CIHPP is a high impact approach to HIV, and other infectious disease prevention targeted to at-risk populations. The approach has been highly endorsed by the Center for Disease Control, Health Resource and Service Administration and the Institute of Health as the most effective evidence-informed strategy to prevent infection and spread of HIV and other infectious diseases among at-risk populations. This approach to HIV prevention is premised on the ecological epidemiology framework which recognizes that health risk behaviors such as excessive alcohol consumption, illicit substance use, and tobacco use involve complex interactions between social and biological factors [4-8]. This framework is derived from Jessor's (1991) problem behavior theory (PBT), which proposes interrelated conceptual domains of risk factors, for adolescent and young adults [9]. This theory suggests that young adult risk factors consist of a personality system, social environment, and behavior. The theory has been extended to the domain of psychosocial theory that views health risk behaviors as co-occurring among young adults. Collectively [9,10], these theories suggest that assessing the effectiveness of prevention programs should include an examination of the association between externalizing problems (such as illicit substance use, and tobacco use) and internalizing problems (Bronfenbrenner U, et al. Ecological Models of human development. International Encyclopedia of Human Development. 2nd Edition. Oxford, U.K: Elsevier, 1994, pp. 1643-1647) ecological epidemiology framework,

effective prevention strategies should identify and address predisposition of the high sexually transmitted prevalence of sexually transmitted infections in individuals and communities at all four levels (i.e., individual, interpersonal, community, and societal) that predispose minority young adults to risky sexual behavior.

The prevalence of individual-level risk behavior includes having multiple sex partners, having sex without condoms, having concurrence partnerships, sharing infected needles, etc. that are affected by community illicit substance and tobacco use environment. The prevalence of interpersonal risk behavior refers to social and sexual network structure (i.e., network size, density, mixing, and turnover) and compositional factors (i.e., characteristics of network members) that influence minority young adult HIV transmission. Community-level risk factors include the density of tobacco and illicit substance outlets [11-14]. Societal level risk factors encompass public policies that shape the environment of the community such as policies that promote high density of alcohol and other risky sexual behavior products outlets in poor and minority neighborhoods leading to segmentation of drinkers in hot spots for HIV risk behaviors and HIV transmission [13].

The ecological epidemiology framework is a multilevel structure in which social and environmental fabrics and contexts influence health outcomes, such as mental health problems. This framework, and by extension Jessor's problem behavior theory, proposes a complex disease system characterized by disease and mental health problems with multiple causative factors that are manifested in both social and physical contexts in a particular population. The numerous levels of influence are viewed as concentric circles beginning with the individual level, the neighborhood or community level, and societal level [15]. The framework is based on the idea that individuals operate within spheres of influence at the individual, interpersonal, community, and societal levels. The individual level is considered the microsystem where individuals operate within their family and home environment, school and peers, work-peer networks, peer support, family support, parental mentoring, and parental involvement in health risk behaviors networks. This individual-level characteristic is nested within the larger community, which consists of community norms, attitudes regarding health risk behavior, cultural norms, gender norms, spiritual and religious norms, and ideological and political norms. The individual-level health risk behaviors may include tobacco and illicit substance use, which predisposes the individual to unsafe sexual practice or behavior. Interpersonal characteristics are social and sexual networks, social norms, illicit substance use, and setting/situational factors.

Community risk behaviors include community social and economic disadvantages, crime, and homelessness. Societal risks are racism, stigma, segregation, formal and informal public policies, and religious and cultural norms. The macro-policy level may also include the biological and physiological status of important systems of the body that regulate behavior, including the nervous system, endocrine system, the digestive system, immune system, and renal system. The macro-policy level consists of advertisements and marketing policies related to health risk behaviors. Hence, effective prevention strategies and policies should include a continuum of activities that address these multiple spheres of influence to achieve desired health outcomes.

The ecological epidemiology framework of the comprehensive HIV prevention program germane to our study implies identifying the prevalence of HIV infection and transmission rates in the target population by conducting needs assessments of measurable constructs at each level or domain of influence, at cross-level connections at both the micro and macro levels, as well as by examining the macro social and micro social or protective factors (risk regulators) that can either constrain or promote the occurrence of individual-level behavior associated with the risk of HIV infection. The needs assessments, in turn, provide objective data for developing a strategic HIV prevention plan for the target population and community. So far, no research that we know of have has validated the psychometric properties of the expected outcome of CHIPP, much less evaluated the anticipated results of CHIPP.

Purpose of the Study

HIV infection among this vulnerable population. The purpose of this study is to begin a line of inquiry of the effectiveness of CIHPP in rising in reducing illicit substance and tobacco use among minority young adults. The information obtained from this s sexual behaviors among minority young adults. The information collected from this s policy-relevant information that be relied upon in designing efficient and effective public policies to reduce the use of tobacco among minority young adults.

Research Question

This study sought to provide an empirically-ground answer to the following research question:

1. How effective is the comprehensive, integrated HIV prevention program in raising awareness of illicit substance use risk of young adults?
2. How effective is the comprehensive, integrated HIV prevention program reducing tobacco use of young adults?

Research Hypothesis

1. The comprehensive integrated HIV prevention program has a increses illicit substance use risk awareness of young adults.
2. The comprehensive integrated HIV prevention program reducing tobacco use of young adults.

Materials and Methods

Research Design

The study used a pre-experimental One-shot case Study Design [16-18]. A schematic representation of the study design is displayed in Table 1.

Treatment	Post-Test
X	$O1_{t1}$, $O2_{t2}$ ...On_{tn}

Where X is the participation of a young adult's in the Comprehensive Integrated HIV prevention program. Illicit substance use and tobacco use O_2 is the level of minority young adult's level of illicit substance use risk awareness and tobacco use risk awareness. A limitation of this type is the absence of a control group. However, using the latent growth curve model within the framework of structural equation modeling (SEM) to analyze the data modulated this limitation. In summation, the LGC modeling approach to estimating change has six important unique features that make it superior to other longitudinal methods in assessing domain outcomes change over time.

1. The approach can accommodate anywhere from three to thirty waves of longitudinal data equally well. Indeed, Willett (1988,1989) has shown that the more waves of data collected, the more precise the estimated growth trajectory and higher will be the reliability of the measurement of change.
2. There is no requirement of the time between each wave of assessments to be equivalent, which suggests that the LGC modeling approach can comfortably accommodate irregularly spaced measurements with the caveat that participants are measured on the same set of occasions.
3. Individual change can be represented by either a linear growth or a non-linear growth trajectory, although linearity is usually assumed. This assumption can be tested, and the model re-specified to address curvilinearity if needed.
4. In contrast to traditional longitudinal methods used in measuring change, with the LGC allows for estimating measurement error and accounts for autocorrelation and fluctuation across the time when the test for the assumptions of independence and homoscedasticity is untenable. Fifth, multiple predictors of change can be included in LGC as fixed or time-varying.
5. Finally, independence of measurement error variances and homoscedasticity of measurement is tested by comparison to nested models.

Participants and Method of Data Collection

Participants in this study were a random sample of minority young adults (18-24 years old) living in a high prevalent community in the southeastern United States who volunteered to participate in the study. After receiving Institutional Review Board's (IRB) approval, culturally and linguistically appropriate announcements and advertisements were made to residents of the high HIV prevalence community through various young adult outlets including social media, radio, print media, community organizations, word-of-mouth and distribution of flyers in the community to attend community health events and participate in a health risk behavior study survey.

Participants who volunteered to participate in the study were informed that a survey will be conducted periodically over 24months to obtain their opinion about key risky behaviors such as excessive alcohol consumption risk awareness, excessive alcohol consumption, illicit substance use risk awareness, illicit substance use, tobacco use risk awareness, tobacco use, and risky sexual behavior that may predispose people to HIV infection. They were also informed that their participation was strictly voluntary and that they may either opt not to participate in the survey and leave or not provide a response to any of the statements. In addition, the community residents were informed that a no-cash incentive in the form of $30 gift card would be provided for their participation in the surveys. The community residents who agreed to participate in the survey were provided with a linguistically appropriate consent form to read, sign, and date. The consent form explained to the community residents that their participation was voluntary and that their identity would be kept strictly confidential, and their names would not appear in any report.

The survey instrument used in this study is the National Minority Substance/HIV Prevention Initiative Adult Questionnaire approved on March 15, 2016, by the United States Office of Management and Budget. Items measuring the two constructs (i.e., illicit substance use, and tobacco use risk awareness) of this study were extracted from this Questionnaire. It should be noted that the validity of the constructs in this measurement instrument has never been validated before our research. Hence, we first had to use the data collected from participants in the CIHPP to test the reliability and validity of the instrument conducting exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) before preceding our evaluation of the effectiveness of the CIHPP.

The Questionnaire included items measuring the four constructs listed above, and demographic information of the participants. Upon Institutional Review Board (IRB) approval, we administered the survey to the participants who volunteered, read and signed the consent form. We adhered to all American Psychological Association research guidelines. The survey was anonymous in that no identifying information was connected to individual participants or included in the study data set. Participants completed the survey in less than 25minutes during the event and returned them before leaving. A total of 518minority young adults participated in the survey, and 498 of them completed the entire survey representing a 96 percent response rate.

Measures

Substance use risk awareness was measured by five items such as "During the past 30 days, on how many days did you use synthetic marijuana (also called K2, Spice, fake weed, King Kong, Yucatan Fire, Skunk, or Moon Rocks)?". The items were scored on a Likert Scale ranging from 0 days-0 to 30 days=30. Tobacco use risk awareness was measured by 2 items such as, "How much do people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day?".

Statistical Analysis

This study used the latent growth curve modeling (LGC) within the SEM framework to evaluate the in in traindividul with intra-individual change of CIHPP participant's excessive alcohol consumption risk awareness, excessive alcohol consumption, illicit substance use risk awareness illicit substance use, safe sex practice, risky sexual behavior, and tobacco use risk awareness over time. The hierarchical levels to be used in assessing invariance consist of:

1. Configural Invariance test to determine if the same factor structure exists in all groups.
2. Metric Invariance to test whether the loading estimates are equal in all groups which allows comparisons of relationships.
3. Scalar Invariance to test whether the intercept terms for all equations are equal in all groups which allow for comparisons of means.
4. Factor Covariance Invariance to test whether the covariances matrix among latent constructs is the same in all groups.
5. Factor Variance Invariance to test whether the factor variances are the same in all groups.
6. Error Variance Invariance to test whether error variance terms are the same in all groups.

The analytic method used to assess the psychometric properties of the National Minority SA/HIV Prevention Initiative Adult Questionnaire (NMSPIAQ) will consist of four interrelated SEM procedures.

1. Exploratory Factor Analysis (EFA) to assess the factorability of each factor and assessing the internal consistency (i.e., Cronbach's alpha) of the psychometric properties of NMSPIAQ using SPSS version 26.0.
2. Single group Confirmatory Factor Analysis (CFA) of NMSPIAQ to determine to construct and content validity of NMSPIAQ.
3. A series of Multi-group CFA to test the invariance of NMSPIAQ across static factors groups.
4. Latent Growth Curve (LGC) modeling within the SEM framework using Analysis of Moment Structure (AMOS) version 26.0 to answer questions about systematic intra-individual with minority young adults innate and inter-individual minority young adults differences in change over time of minority young adult's likelihood risk of illicit substance and tobacco use. AMOS statistical software version 26.0 was used to analyze the second through the fourth procedure. A description of each method is presented below.

Exploratory Factor Analysis

The first phase of our investigation was to assess the reliability or internal consistency of the key CIHPP outcome constructs by performing an exploratory factor analysis (EFA) to determine the meaningful factor loading structure of the items or observed variables were measuring the CIHPP outcome constructs. The EFA began by checking the assumptions necessary for proceeding with factor analysis. The check involved assessing the degree of in tercorrelation of the items from both the overall and individual variables perspectives. The overall measure of in tercorrelation was evaluated by

a. Computing the partial correlation or anti-image correlation among the variables, with small values indicating the existence of "true" factors in the data [19].
b. Performing Bartlett's Test of Sphericity, with significant approximate chi-square (χ) indicative of significant correlation among at least some of the construct's observed variables; and
c. Estimating the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA) value, with MSA values above .50 considered acceptable to proceed with factor analysis [19].

The variable-specific measure of in tercorrelation was assessed by estimating the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) value for each observed variable or item with values below .50 considered to be unacceptable [19,20]. The variable with the lowest MSA value was deleted, and the factor analysis was repeated. This process continued until all the observed variables

had acceptable MSA values, and we proceeded with factor analysis. Principal component factor analysis applying the varimax rotation reduced or organized the item pool into a smaller number of interpretable factors. The number of factors was determined by joint consideration of (Cattell RB, et al. "The Scree Test for the Number of Factors". *Multivariate Behavioral Research* 1, 629-637, 1966) scree plot, a priori, and percentage of factors to be extracted criteria [19]. The latent root residual (eigenvalue) criterion was inappropriate if the number of observed variables falls below or outside the acceptable range of 20 to 50 [19,20]. (hurstone LL, et al. *multiple-Factor Analysis*. Chicago: University of Chicago Press, Chicago, Ill, 1947) Subsection titled Multi-Group analysis principle of simple structure using pattern coefficients of absolute 0.35 as the lower bound of essential per factor and interpretability of the solution to determine the final solution [21]. After rotation, variables with cross-loading and communalities lower than 50 were deleted [19].

The second step of the analysis involved reviewing the items measuring each dynamic factor by calculating the internal consistency estimates (Cronbach's alpha) for the items representing each factor retained from the exploratory factor analysis procedure. Cronbach's alpha of 0.6 is the minimum acceptable level of internal consistency for using a factor [19]. For factors with Cronbach's alpha below this minimum benchmark, the internal consistency of the factors improved by identifying and removing items with low item-test correlation and item-rest correlation [22]. If no improvement of the reliability score occurred, the factor deleted.

Single Group Confirmatory Factor Analysis

After establishing the reliability of the CIHPP, expected outcomes constructs (i.e., illicit substance and tobacco use) were validated by performing a single group CFA. This validation involved testing for the factorial stability of the scores for each CIHPP outcome construct [23]. This test aimed to determine the extent to which items designed to measure each CIHPP outcome factor (i.e., latent construct) do so. Because the analysis was performed on original data and not data summary, missing data will be handled by using the full information maximum likelihood (FIML) procedure. This FIML allowed for the performance of maximum likelihood estimation on a dataset containing missing data, without any form of imputation [24].

Several indices evaluated the goodness of fit of the 6-factor orthogonal CIHPP measurement model. The guidelines for determining model fit consisted of adjusting each index cutoff values based on model characteristics as suggested by simulation research that considers different sample size, model complexity, and degree of error in the model specification as a basis for determining how various accurate indices perform [25]. The model's absolute fit assessed using chi-square statistic, $\chi 2$, with low, insignificant $\chi 2$ considered a good fit [26]. The evaluation of incremental fit was examined using Root Mean Square Errors of Approximation (RMSEA) with a value less than 0.8 indicating a relatively good fit, along with Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) with a value of 0.97 or higher considered desirable [26]. Convergent validity among items was determined by estimating the unstandardized factor loadings and Cronbach's alpha with significant loadings and alpha of 0.70 or higher considered good reliability [19]. Construct validity of the model was evaluated by examining the completely standardized factor loadings with approximately factor loadings of 0.5 or higher and construct reliability (Cronbach's alpha) equal or greater than 0.7 considered to be good [19,27]. Also, a parametric test of the significance of each estimated (free) coefficient was performed. Insignificant loadings with low standardized loading estimates were deleted from the model. To assess problems of the overall model, the completely standardized loadings were examined for offending estimates, such as loadings above 1.0. Any identified offending estimates were dropped from the model. Finally, internal consistency estimates (Cronbach's alpha) calculated for the item representing the CIHPP outcome factor retained. Cronbach's alpha of 0.7 considered as a minimum acceptable level of internal consistency for retaining the factor. For factors with Cronbach's alpha below this minimum threshold, an attempt to improve the internal consistency was made by identifying and removing items with low item-test correlation and item-rest correlation [28-35]. The factor model deleted if, no improvement of the reliability score occurred, the factor removed from the model of the construct.

An assessment of the likelihood that the model's parameter estimates from the original sample will cross-validate across in future samples by examining the Information Criterion (AIC) and consistent version of the AIC (CAIC) with lower values of the hypothesized compared to the independent and saturated models considered to be an appropriate fit. The likelihood that the model cross-validates across similar-sized samples from the same population was determined by examining the Expected Cross-Validation Index (ECVI) with an ECVI value for the hypothesized model lower compared to both the independent and saturated models considered to represent the best fit to the data. Finally, Critical N (CN) was estimated to determine if the study's sample size is sufficient to yield an adequate model fit for a $\chi 2$ test (with a value over 200 for both .05 and .01 C.N. indicative of the CIHPP outcome measurement model adequately representing the sample data. The normality of the distribution of the variables in the model was assessed by Mardia KV, et al. [31,32] normalized estimate

of multivariate kurtosis with a value of 5 or less reflexive of normal distribution. Multivariate outliers were detected by computation of the squared Mahalanobis distance (D2) for each case with D2 values standings distinctively apart from all the other D2 values indicative of an outlier

Multi-Group Analysis

After validating the factorial structure of NMSPIAQ, we proceeded to conduct a series of multiple groups CFA to test the invariance of CIHPP outcome factors across static factors groups. The multiple-group analysis of this study involved performing three types of CFA.

1. Examining the factorial invariance of CIHPP illicit substance and tobacco use risk scales (1st Order CFA Model).
2. Testing the invariance of dynamic factor mean structure.
3. Examining the invariance of CIHPP factors causal structure. The central concern of measurement invariance is the testing of measurement equivalence across groups (Byrne B, Shavelson R, Muthén B Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. Psychol. Bull. 1989, 105, 456–466 [CrossRef]). We conducted the test at two types of models: first-order models and second-order models (Little TD Mean, and covariance structures (macs) analyses of cross-cultural data: Practical and theoretical issues. *Multivariate Behavior Research*. 1997, 32, 53-76). These tests are the suggested procedures for testing measurement invariance across a hierarchical series of models, and their collective purpose is maximizing the interpretability of the results sought at each step of the hierarchy [33-40].

Latent Growth Curve (LGC) Modeling

The LGC modeling within the SEM framework evaluated the illicit substance and tobacco use risk of each minority young adult periodically based on time-invariant and CIHPP outcome factors, including indicators of progress and regression of CIHPP substance and tobacco use risk reduction expected to change. At the same time, young adults participated in CIHPP intervention. Unlike like the usual "scape shots" approach of taking the status of illicit substance and tobacco use risk before and after CIHPP intervention time-invariant and dynamic factors, the LGC model captures the actual development of the processes and outcome domains of interest following a trajectory over time to reveal the intricacies of in traindividual and in terindividual changes of young adults. Therefore, the approach capitalizes on the richness of continuous multi-wave data to provide a somewhat superior program evaluation approach for answering questions about systematic intra-individual young adults CIHPP outcome factor change and inter-individual young adults differences in CIHPP outcome factors change [41-46].

Measuring young adult's increase or reduction change over time for CIHPP illicit substance and tobacco use risk, a representative sample of young adults were tested systematically over time, and their status in illicit substance and tobacco use risk was measured on several temporal-spaced occasions based on four conditions [47-49].

1. The illicit substance and tobacco use risk must be an interval level of measurement [47,50-52].
2. While the time lag between occasions can be either evenly or unevenly spaced, both the number and spacing of these assessments must be the same for all CIHPP participants.
3. When the focus of individual CIHPP participants, change was structured as an LGC model, with analyses was conducted using the SEM approach, and the data was collected for each CIHPP participant on three or more occasions.
4. The sample size should be large (i.e., a minimum 200) enough to allow for the detection of person-level effects [47,53,54]. Our proposed LCG model met all of these four conditions.

The basic building block of the LGC model comprised of two sub-models referred to as Level 1 model and Level 2 model [47]. Level 1 model is a within-person regression model that represents an individual's change over time of the outcome variables, which in our case are the two CIHPP outcome domains mentioned earlier. Level 2 model is the between-person model that focuses on inter-individual differences in CIHPP outcome factors change over time. Level 1 (i.e., intra individual minority young adult change) focuses on capturing the measurement model, which is the portion of the model that incorporates only linkages between observed and latent construct or factor (i.e., likelihood of illicit substance and tobacco use). As in any measurement model, the primary interest is the strength of the factor loading or regression paths linking the observed variable to the unobserved variable. As such, the only parts of the model that are relevant in the modeling of intra individual change are the regression paths linking the observed variables to the unobserved factor (both intercept and slope) [55-59], the factor variances and covariances, and the related measurement errors associated with these observed variables. This part of the modeling is an ordinary factor analysis model with the following two unique features. First, all the loadings were fixed (i.e., there are no unknown factor loadings) [60,61]. Second, the pattern of fixed loadings plus the mean structure allows us to interpret the factors as intercept and slope factors. As in all factor models, the present case argues that each minority young adults: likelihood of illicit substance and tobacco use at each temporal time point (i.e., Time 1=0; Time 2=1; Time 3 = 2),

are a function of three distinct components:

a. A factor loading matrix of constants (1:1:1) and known time values (0:1:2) that remain invariant across all individual minority young adults, multiplied by
b. A latent growth curve vector containing individual minority young adult-specific and unknown factors called unique CIHPP participant growth parameter (Intercept, Slope), plus
c. A vector of individual CIHPP participant-specific and unknown errors of measurement (Byrne BM 2016. Structural Equation Modeling with AMOS: Basic Concept, Applications, and Programming. New York: Routledge: Taylor and Francis). Whereas a latent growth curve vector represents the within-person true change in the likelihood of illicit substance and tobacco use over time, the error vector represents the within-person likelihood of illicit substance and tobacco use risk "noise" that serves to erode these actual change values [47].

Level 2 argues that, over and above the hypothesized linear change in CIHPP outcome domains over time, trajectories will necessarily vary across CIHPP participants as a consequence of differences in intercepts and slopes. Within the framework of SEM, this portion of the model reflects the "structural model" component [62-66], which in general portrays relationships among unobserved factors and postulated relations among their associated residuals. However, within the more specific LGC model, this structure is limited to the means of the Intercept and Slope factors, along with their related variances, which represent deviations from the Mean [67]. The Mean carries information on individual differences in intercept and slope values [68,72]. The specification of these parameters, then, makes possible the estimation of intra individual differences in change. A regression analysis was performed using AMOS 26.0 LGC Models with static factors as Time-Invariant Prediction of change [73,74]. The investigation was to determine the existence of statistically significant heterogeneity in the individual growth trajectories (i.e., intercept and slope) of illicit substance and tobacco use risk can be explained by the static variable as time-invariant predictors of change. This next test answered two questions.

1. "Do the CIHPP illicit substance, and tobacco use risk differ for the subsets of a static factor at time 1 (i.e., 2018)?
2. "Do illicit substance and tobacco use risk for CIHPP participants change differ over time for a subset of a static variable?" To answer these questions, the predictor variable "static factor" must be incorporated into the Level 2 (or structural) path of the model. This predictor model represented an extension of our final best-fitting multiple domain model (Model 3) of important here is the addition of four new model components [75].
3. The regression paths that flow from the static factors to the intercept and slope factors associated with illicit substance and tobacco use risk are of primary interest in this predictor model as they hold the key in answering the question of whether the trajectory of illicit substance and tobacco use risk differs for the subset groups of the static factor [76-79].
4. There is now a latent residual associated with each of the intercept and slope factors. This addition is a requirement that these factors are now dependent variables in the model due to the regression paths generated from the predictor variables of the static factors. Given that in SEM dependent variables cannot be estimated, the latent factor residuals serve as proxies for the intercept and slope factors in capturing the variances. These residuals now represent variation remaining in the intercepts and slopes after all variability in their prediction by the static factors are explained [47].
5. The covariances link the appropriate residuals rather than the illicit substance and tobacco use risk themselves.
6. Finally, the means of the residuals were fixed at 0.0.

The first step in building the LGC model was to determine the direction and extent of change of each CIHPP participant's change in illicit substance, and tobacco use risk score over the specified time of participation in the CIHPP programming. Byrne (2016) suggests that in defining and testing of the LGC model, the shape of the growth trajectory must be known in advance [80,81]. A typical assumption in LGC modeling is that the specified model is linear which suggest that the specified model includes growth parameters:

a. An intercept representing an individual CIHPP participant's illicit substance and tobacco use risk score at time 1, and
b. Slope parameters representing an individual CIHPP participant's rate of change over the period of interest. In our study, the intercept represented a CIHPP participant's illicit substance and tobacco use risk score at the end of 2018; and the slope represented the rate of change of the illicit substance and tobacco use risk score over the 24-month transition from 2016 to 2019. The hypothesized link between the individual growth parameter (i.e., slope) and the intercept parameter of levels 1 and level 2 models was the analysis of change in the CIHPP process and outcome domains.

There two main advantages in testing for individual change within the framework of structural equation modeling over other longitudinal approaches.

a. The LGC modeling within the SEM framework evaluation approach uses the analysis of mean and covariance structures. Hence, it can distinguish group effects observed in means from individual effects observed in covariance [82,83].
b. A distinction is made between observed and unobserved (or latent) variables in the specification of models. This

capability allows for both the modeling and estimation of measurement error. Hence, our LGC analytic approach explains the heterogeneity of inter-individual differences based on one or more predictors and covariates or moderators. The analysis used plugins of IBM AMOS version 26.0 [84].

Results

The results of this study consist of estimates of mean, covariance, and Variance of the latent growth curve model of each domain of the two CIHPP outcome domains of interest including, illicit substance use and tobacco use risk. The results of each of these CIHPP outcome domains is presenting below [85].

Illicit Substance Use Latent Growth Curve Model Results

Mean Estimate: The results indicate that the mean estimate of illicit substance use for the intercept and slope suggests that both the intercept and slope is statistically significant. Specifically [86-89], the findings reveal that the average score for illegal substance use of 5.411 decreased significantly over the 24months periods, as indicated by the value of -14.174; p=001 (Table 1).

	Estimate	Standard Error	t-Value	Significance	Label
Intercept	5.411	0.371	14.59	0.001	I Mean
Slope	-.6.531	461	-14.174	0.001	S Mean

Table 1.1: Mean estimate for excessive Illicit substance use Intercept and Slope.

Covariance Estimate: The covariance between the intercept and slope factor for illicit substance use was statistically significant (t=-9.572=.001). The negative estimate of -49.547 suggests that young adults exhibited a low rate of increase in their illegal substance use over the 24 months. This finding indicates that the Comprehensive, integrated HIV prevention program was effective in decreasing the substance use of young adults under study (Table 2).

	Estimate	Standard Error	t-Value	Significance	Label
Intercept<-->Slope	-49.547	5.172	-9.572	0.001	Covariance

Table 1.2: Covariance Estimate for illicit substance use Intercept and Slope.

Variance Estimate: The variance estimate related to the intercept and slope for illegal substance use is statistically significant (p=.001). This finding reveals significant in terindividual differences in the original score of illicit substance use between the young adults at the beginning of the implementation of the CIHPP and its change over time, as the young adult progressed from the beginning of the CIHPP intervention through the 24months [90]. Such evidence provides powerful support for further investigation of variability related to the growth trajectory. Specifically, the incorporation of time-invariant of change into the model can explain the young adults' illicit substance use variability [91-93]. This incorporation involves testing the latent growth curve model with a static variable as a time-invariant predictor of change (Byrne, 2016) [94]. This study incorporated gender in the LGC model as a predictor of change (Table 3) displays the result

	Estimate	Standard Error	t-value	Significance	Label
Intercept	43.797	4.24	10.329	0.001	I Variance
Slope	47.774	6.723	7.103	0.001	S Variance

Table 1.3: Variance Estimate of illicit substance use intercept and slope.

Regression Weight with Gender as Predictor: Gender was found not to be statistically significant illicit substance use predictor of both initial status (409) at p=.685 and rate of change (.400) at p=.400. This finding suggests that there was no meaningful difference in illicit substance use between minority young adult males and females both at the beginning of CIHPP and the rate of change during the 24 months intervention period [95].

	Estimate	Standard Error	t-value	Significance	Label
Intercept	.309	.309	-.409	.685	Par_5
Slope	.794	.944	.400	.400	Par_6

Table 1.4: Regression Estimate of illicit substance uses intercept and slope with Gender Predictor.

Tobacco use Latent Growth Curve Model Results

Mean Estimate: The results indicate that the mean estimate of tobacco use for the intercept and the slope are statistically significant. Specifically, the findings reveal that the average score for tobacco (16.631) decreased significantly over the three 24-months periods as indicated by the value of (-8.573); p=001. Hence, we can conclude that CIHPP was effective in reducing tobacco use among minority young adults [96].

	Estimate	Standard Error	t-value	Significance	Label
Intercept	16.631	1.315	12..649	.001	I Mean
Slope	-10.707	1.249	-8.573	.001	S Slope

Table 2.1: Mean Estimate for tobacco use Intercept and Slope.

Covariance Estimate: The covariance between the intercept and slope factor was statistically significant (p=.001). The negative sign suggests that young adults exhibited a low rate of increase in their tobacco use over the 24months. This finding indicates that the Comprehensive, integrated HIV prevention program was effective in decreasing the tobacco use of young adults under study [97-99].

	Estimate	Standard Error	t-Value	Significance	Label
Intercept<-->Slope	-264.717	45.383	-5.833	0.001	Covariance

Table 2.2: Covariance Estimate for Tobacco Use Intercept and Slope.

Variance Estimate: The variance estimate related to the intercept and slope for tobacco use is statistically significant (p=.001). This finding reveals strong intra individual differences in the original score of tobacco use between the young adults at the beginning of the implementation of the CIHPP and its change over time, as the young adult progressed from the beginning of the CIHPP intervention through the 24 months. Such evidence provides powerful support for further investigation of variability related to the growth trajectory. Specifically, the incorporation of time-invariant of change into the model can explain the young adults' tobacco use variability. This incorporation involves testing the latent growth curve model with the demographic or static variable as a time-invariant predictor of change (Byrne 2016 is: Byrne BM 2016. Structural Equation Modeling with AMOS: Basic Concept, Applications, and Programming. New York: Routledge: Taylor and Francis) [100-103]. This study incorporated gender in the LGC model as a predictor of change. The result is presented in Table 3.

	Estimate	Standard Error	t-value	Significance	Label
Intercept	656.596	55.697	11.789	0.001	Intercept Value
Slope	234.781	57.392	5.203	0.001	Slope Value

Table 2.3: Variance Estimate of tobacco use Intercept and slope.

Regression Weight with Gender as Predictor: Gender was found not to be statistically significant tobacco use predictor of both initial status (-1.935) at p=.473 and rate of change (3.265) at p=.202. This finding suggests that there was no meaningful difference in tobacco use between minority young adult males and females both at the beginning of CIHPP and the rate of change during the 24 months intervention period.

	Estimate	Standard Error	t-value	Significance	Label
Intercept	-.1935	2.695	-.718	.473	Par_5
Slope	.3.265	2.557	1.277	.202	Par_6

Table 2.4: Regression Estimate of excessive alcohol consumption intercept and slope with Gender Predictor.

Conclusion

The mean estimate for illegal substance use indicated a significantly decreased over the 24 months.. This finding suggests that the Comprehensive, integrated HIV prevention program was effective in reducing illicit substance use among minority young adults under study. The covariance estimate between the intercept and slope factor for illicit substance use indicated that young adult's illicit substance use declined over the 24 months [104]. This finding indicates that the Comprehensive, integrated HIV prevention program was effective in decreasing the substance use of young adults under study [105]. The variance estimate showed evidence of in terindividual differences in the original score of illicit substance use between the young adults and its change over time, as the young adult progressed from the beginning of the CIHPP intervention through the 24months [106-109].

There is a significant in terindividual difference in the original score of illicit substance excessive between the young adults at the beginning of the implementation of the CIHPP and its change over time, as the young adult progressed from the beginning of the CIHPP intervention through the 24months [110,111]. However, there was no meaningful difference in illicit substance use between minority young adult males and females both at the beginning of CIHPP and the rate of change during the 24months intervention period [112,113]. These estimates indicate that the CIHPP was effective in reducing illicit substance use among minority young adults. Hence, hypothesis 1 is confirmed. This finding is consistent with the results of previous research [114-119]. But, there no meaningful difference in illicit substance uses between minority young adults female and young minority adult males during the 24 months implementation of the CIHPP. This finding the need for future studies to test other invariant variables [120].

As for tobacco use, the CIHPP was effective in reducing tobacco use among minority young adults. Hence, hypothesis 2 is confirmed [121,122]. Also, there were inter-individual differences or heterogeneity in tobacco use among the minority young adults between minority young adult at the beginning of CIHPP intervention, and through the 24months [123]. However, there was no meaningful difference in tobacco use between minority young adult males and females, both at the beginning of CIHPP and the rate of change during the 24months intervention period. In other words, the in terindividual difference was not attributable to gender. Collectively, the result of this study is consistent with previous studies [124-129].

Study Limitations

The study used one static variable, gender, as a predictor of both illicit substance use and tobacco use. To more precisely evaluate in terindividual change, we recommend that future studies use two or more static valuables [130,131]. Also, the study did not examine other time-invariant variables such as race/ethnicity and household type. Therefore, as a contribution to theory building, future studies should research similar in two or more domains with similar populations [132-133]. Finally, this study used a sample size of 498 minority young adults. Although this sample meets the recommended minimum threshold of a sample size of 200 for structural equation modeling (Byrne, 2016) [134,138], the sensitivity of statistical significance testing to sample size (Cumming G, Calin-Jageman. 2017. *Introduction to the New Statistics: Estimation, Open Science, & beyond*. New York: Routledge Taylor 7 Francis Group), we recommend that future studies should use effect size instead [139,140].

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