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Triple Challenges of Psychosocial Factors, Substance Abuse, and HIV/AIDS Risky Behaviors in People Living with HIV/AIDS

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1. Introduction

Thirty years ago, the first cases of Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) garnered the world's attention. Since then, the lives of people living with HIV/AIDS (PLWHA), their families, communities, and the society as a whole are all affected by the HIV/AIDS pandemic. Not only does HIV/AIDS elicit detrimental physical manifestations but psychosocial health is affected negatively as well in PLWHA. Since the discovery of the Highly Active Antiretroviral Therapy (HAART) in the mid-nineties, PLWHA have overcome the fear of what previously was a certain death sentence. Their life expectancy, as a result of HAART, is now approaching that of the general population (The Antiretroviral Therapy Cohort Collaboration, 2008). However, many PLWHA confront a broad range of challenges that are multiple and chronic in nature. These challenges may yield adverse psychosocial consequences that can lead, eventually, to substance abuse and other HIV/AIDS-risky behaviors.

The discovery that one is infected with the HIV is associated with reduced psychosocial health in China, the United States (U.S), and South Africa (Freeman et al., 2007; Sun, 2007; Vanable, 2006). Studies show that PLWHA have complicated histories including substance abuse, mental illness, mood disorders, and social stigma (Stoskopf, 2004; Pence, 2007a; Whetten, 2006). These negative experiences have been seen across a wide range of populations including adult men and women (Kelly, 1993), men who have sex with men (MSM) (Martin, 1998, Strathdee, 1998), HIV-positive adults (Kelly, 1993), minority women (Champion, 2002), substance users (Camacho, 1996), gay and bisexual men (Rogers, 2003), adolescents, and young adults (Ramrakha, 2000). Furthermore, these negative experiences have been associated with psychosocial disorders which in turn can contribute to increased substance abuse and HIV/AIDS-risky behaviors among PLWHA (Pence, 2007b; Leserman, 2003; Tucker, 2003). Similarly, substance abuse can contribute to numerous problems for PLWHA. For example, alcohol abuse can modify liver drug metabolism, thus complicating treatment for patients with HIV/AIDS hepatitis C virus co-infection as alcohol may

compromise pegylated interferon therapy and exacerbate the progression of liver disease (Kresina, 2002).

Since the first cases of HIV/AIDS emerged in the early 1980s HIV/AIDS-related stigma and its resulting discrimination continue to traverse across countries, religious groups, communities, and individuals. According to United Nations Secretary-General Ban Ki Moon, "Stigma remains the single most important barrier to public action. It is the main reason why too many people are afraid to see a doctor to determine whether they have the disease, or to seek treatment if so. It helps make AIDS the silent killer, because people fear the social disgrace of speaking about it, or taking easily available precautions. The stigma associated with it is a chief reason why the AIDS pandemic continues to devastate societies around the world" (Ban Ki-Moon, 2008). For example, if they feel a need to conceal their HIV-positive status within their social network, PLWHA may refuse to use protection during sex for fear that their partners may interpret condom use as a sign of being they are HIV positive (Klitzman, 2004). Stigmatization has been linked to higher risk behaviors in France, South Africa, and China (Mahajan, 2007).

The impact of HIV/AIDS is not only biological but psychosocial in nature. Increasingly it has become evident that psychosocial factors, substance abuse, and HIV/AIDS- risky behaviors co-exit together and therefore contribute to ongoing HIV/AIDS transmission pathways in many regions of the world. Importantly, as newer and more effective treatment therapies continue to evolve psychosocial factors, substance abuse problems, and other co-occurring risky behaviors in PLWHA must be addressed to develop more effective treatment protocols and to formulate highly-effective public health policies and prevention and control strategies to address the HIV/AIDS pandemic. Further, the high prevalence of comorbid medical and psychosocial conditions highlights the urgent need to co-locate varied health services and specialists who understand HIV/AIDS-related psychosocial factors in relation to HIV-risky behaviors so they can provide comprehensive care for the special needs of and overlapping medical and psychological conditions for PLWHA. Sweat and colleagues (2004) suggest a multidisciplinary, integrated approach to HIV/AIDS prevention be adopted to cater to the needs of PLWHA.

With this in mind, a study to address the triple challenges of psychosocial, substance abuse, and HIV/AIDS-risky behaviors among PLWHA has been conducted at the Center for Computational Epidemiology, Bioinformatics and Risk Analysis (CCEBRA), a research center located in the College of Veterinary Medicine, Nursing and Allied Health at Tuskegee University, Tuskegee, Alabama, USA. The specific objective of this study was to determine if significant differences exist in the prevalence of psychosocial factors and HIV/AIDS-risky behaviors before and after establishing HIV infection status among PLWHA.

The study hypothesis tested was: Multi-factorial and quantitative epidemiologic studies which interrelate multiple health determinants can be developed to extrapolate the quantitative contributions of each of these variables that affect the transmission of HIV/AIDS. Based on the epidemiological assessment of factors believed to influence HIV/AIDS-risky behaviors, three underlying assumptions were formulated: 1) With the exception of HIV/AIDS transmission via infected blood/blood products, tissues, or organs, all other HIV/AIDS transmissions occur only as a result of human behaviors; 2) The effects of psychosocial factors and substance abuse on HIV/AIDS-related risky behaviors are particularly pronounced among PLWHA; and 3) Psychosocial factors and substance abuse help to predict an increase or decrease in HIV/AIDS-related risky behaviors. It was

hypothesized that psychosocial variables would be associated with substance abuse which in turn would be associated with HIV/AIDS-risky behaviors.

This chapter presents the findings of our original research with respect to triple factors that influence HIV/AIDS transmission among PLWHA. The research methodology and findings are presented under their respective sections. In addition, recommendations for a multidisciplinary approach to research and interventions are provided to address the triple challenges and interrelationships of psychological factors, substance abuse, and HIV/AIDS risky behaviors that are commonly seen in PLWHA.

2. The relationship between psychosocial factors and HIV/AIDS-risky behaviors

A substantial amount of literature indicates depression is one of the most commonly occurring mental disorders identified among PLWHA. HIV/AIDS, its related infections, and the anti-viral drugs used to treat these illnesses can cause depression along with number of other psychiatric disorders (Desquilbet et al., 2002). Psychosocial problems have been associated also with HIV/AIDS-risky behaviors, non-adherence to medications, and shortened survival (Farinpour et al., 2003; Cook et al., 2004). Despite the prevalence of psychosocial distress experienced by PLWHA, the available body of evidence indicates that depression is frequently undiagnosed and goes untreated on a large scale. For example, in a large cohort of patients undergoing care for HIV/AIDS in the U.S., nearly half of those who met the criteria for major depression had no mention of such a diagnosis in their medical records (Asch et al., 2003); and one-third of PLWHA who needed psychosocial health services were not receiving them (Taylor et al., 2004).

However, health care service providers and associated facilities may be unaware of the depressive experiences of their HIV/AIDS patients and the effects these experiences can have on both behaviors and health outcomes. As a result, prevention and treatment of depression and provision of psychosocial support are often neglected in PLWHA, despite the fact that they are critical components of their health care. So, to support and promote mental health throughout the lifespan of the illness a number of interventions, including psychosocial support and basic counseling for depression, are required. As the medical community adapts to managing HIV/AIDS as a chronic disease, understanding the conjoint influence of depression and substance abuse on HIV/AIDS risky behaviors is very important. Failure to recognize these variables may endanger both HIV/AIDS patients and others in the community.

Studies of patients who seek HIV/AIDS treatment or preventive health services have reported a fairly high prevalence of psychosocial problems including depression, anxiety, and hostility (Kalichman, 2000; Cohen et al., 2002). Other research shows that psychosocial variables, such as depression and other mental health problems, drug or alcohol addictions, or any combination of these are most commonly prevalent among PLWHA (Moore et al., 2008; Wyatt et al., 2002; Whetten et al., 2006). It is estimated that up to 50% of PLWHA suffer from a mental illness, such as depression, and 13% have both mental illness and substance abuse issues (Bing et al., 2001). The same study indicates also that one-half of adults living with HIV/AIDS had symptoms of a psychiatric disorder; 19% had signs of substance abuse; 13% had co-occurring substance abuse and mental illness (Bing et al., 2001); and one-half of PLWHA had depression (Lesser, 2008).

These psychosocial problems, in turn, have been shown to influence high-risk sexual behaviors and HIV/AIDS transmission (Benotsch et al., 1999). However, study findings have been inconsistent about the relationship between psychosocial problems and unsafe sexual practices. Some studies have failed to find any relationship (Kalichman, 1999) while other research has demonstrated a negative relationship between psychosocial problems and high-risk sexual behaviors (Robins et al., 1994). The inconsistency in these research findings may be related to the fact that the specific link between HIV/AIDS and psychosocial problems is still not clearly defined. For example, depressive symptoms may lead patients to engage in high-risk behaviors [(e.g., injection drug use (IDU)] and subsequently lead to HIV infection (Angelino, 2002)]. On the other hand, rather than being direct the relationship between negative mood states and high-risk behaviors might be mediated by cognitive factors: being infected may affect mood states which in turn might affect an individual's ability to consistently make rational decisions about safe sex which may then at times lead to high-risk sexual behaviors and eventually lead to HIV/AIDS transmission (Binson et al., 1993). Thus, further research is need to gain a clear understanding of how psychosocial problems are likely to influence PLWHA and impact their ability to consistently make rational decisions is required to fully understand high-risk sexual behaviors among PLWHA.

In addition, depression is noted to be oftentimes associated with substance abuse (Saylors & Daliparthy, 2005) and other HIV/AIDS risky behaviors (Kelly et al., 1993). Substance abuse can cause cognitive impairment (Rippeth et al., 2004) which could also lead to depression (NIDA, 2006). Bing and colleagues (2001) assessed a national probability sample of nearly 3,000 PLWHA and found that more than one-third screened positive for clinical depression, the most common disorder identified. These researchers also indicated that half of the 3,000 PLWHA who participated in the study reported use of illicit drugs. Drug use was associated with screening positive for depression. The study showed also that 36% of HIV-infected individuals screened positive for depressive symptoms in the previous year (Bing et al., 2001). Another study found similar levels, as 35% of participants screened positive for depression (Pence, et al., 2007a). Additionally, studies have indicated higher rates of depression symptoms, ranging between 26% and 49%, in HIV-positive people compared with HIV-negative control groups (Boarts et al., 2006; Spiegel et al., 2003; Ickovic et al., 2001; Pence et al., 2006). The association between depression and substance abuse in predicting HIV/AIDS-risky behaviors has been examined and presented in this chapter.

3. The relationship between substance abuse and risky sexual behaviors

Substance abuse or other drug-taking activities, such as IDU, have long been recognized for their role in HIV/AIDS transmission (National Institute of Drug Abuse, 2006). Sexual intercourse while under the influence of drugs and/or alcohol can generally lower the use of condoms which can increase the risk of HIV/AIDS transmission (Saylors & Daliparthy, 2005) and quite possibly disease progression is more rapid (Zablotska et al., 2006).

PLWHA are more likely to abuse alcohol at some time during their lives (Abderhalden, 2007). A study by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), National Institutes of Health, U.S. Department of Health and Human Services (2008) shows that 80% of people infected with the HIV in the U.S. drink alcohol; between 30% and 60% have been diagnosed with an alcohol-related abuse disorder. In the U.S., a one-month

national representative sample of current alcohol use among PLWHA showed a prevalence of 53%, with 8% classified as heavy alcohol consumers (Galvan et al., 2002).

Needles and syringes are the second most common route of HIV transmission in the U.S. [World Health Organization (WHO)/UNAIDS, 2004; WHO, 2005]. Each year more than 8,000 people are newly infected with HIV through the sharing of HIV-contaminated syringes and needles (CDC, 2005). Since the beginning of the HIV pandemic, the CDC (2005) estimates that IDU has directly and indirectly accounted for approximately one-third (36%) of AIDS cases in the U.S. Globally, approximately 10% of HIV infections are a direct result of transmission through IDU (Aceijas et al., 2004).

HIV/AIDS intervention studies that target risky behaviors in various groups have been conducted in an assortment of settings. A study in France, for example, found that the proportion of HIV-positive patients reporting sexual behavior at risk for HIV transmission increased from 5.1% in 1998 to 21.1% in 2001-2002 (Desquilbet, 2002). In addition it has been shown that risky sexual behaviors, including unprotected sex and multiple sexual partners, occur among PLWHA (Schiltz and Sandfort, 2000). For example, a study by Binson (1993) indicates that a considerable percentage of PLWHA (range of 10% to 60% depending on the specific sex acts) continue to engage in unprotected sexual behaviors that place others at risk for infection and place themselves at risk for contracting secondary STDs (e.g., syphilis) which may accelerate HIV infection (Lowry, 1994). In another study conducted between 1999 and 2001 in San Francisco, California, found that the proportion of MSM reporting to have had unprotected anal sex with two or more partners of unknown serostatus increased from 19% to 25% for HIV positive MSM, compared to an increase from 10% to 15% for HIV-negative MSM participants (Chen et al., 2002).

The reasons that underlie the correlation between substance abuse and high-risk behaviors among PLWHA have been described to include: decreased inhibitions and risk perception; belief that alcohol and other drugs enhance sexual arousal and performance; deliberate substance abuse as an excuse for high-risk behaviors; and the indirect association that bars (taverns) are common places to meet potential sexual partners. The mechanisms by which substance abuse influences risky behaviors are associated with situational factors, such as cognitive impairment, social modelling, or the fact that substance abuse and risk-taking behaviors often occur in the same social venues (Abderhalden, 2007).

4. Epidemiologic modelling to study HIV/AIDS dynamics at the macro-population level

Computational models and simulations are emerging as vital research tools in the fields of epidemiology, biology, and other sciences. Increasingly, scientific researchers are recognizing the enormous potential of these research tools to solve some of today's biggest and most complex health problems. Computational epidemiology permits the examination and investigation of diseases and risk agents in plants, animals, and humans without jeopardizing lives or creating hazards. This relatively recent branch of science is being used by researchers to understand the overwhelming complexity of the 21st century's health problems. In light of this, computational models that study HIV/AIDS viral dynamics at the macro-population levels by examining the dynamics of HIV/AIDS among different racial groups have been developed by the CCEBRA at Tuskegee University.

4.1 Systems dynamics modelling at the macro-population level

Systems dynamics (SD) is a concept based on systems thinking where dynamic interaction between the elements of the system is considered in order to study the behavior of the system as a whole. This methodology, introduced in the mid-1950s by Forrester and first described at length in his book *Industrial Dynamics* (1961) with some additional principles presented in his later works (Forrester, 1969; 1971; and 1980), involves development of causal diagrams and computer simulation models that are unique to each problem setting. A central principle of SD is that the complex behaviors of organizational and social systems are the result of ongoing accumulations of people, material or financial assets, information, or even biological or psychological states. Both balancing and reinforcing feedback mechanisms and the concepts of accumulation and feedback have been discussed in various forms for centuries (Richardson, 1991). However, SD uniquely enables the practical application of these concepts in the form of computerized models so that alternative policies and scenarios can be tested in a systematic way that answers the questions of "what if" and "why" (Sterman, 2001).

SD modelling is an iterative process of scope selection, hypothesis generation, causal diagramming, and quantification (Sterman, 2000); it consists of an interlocking set of differential and algebraic equations developed from a broad spectrum of relevant data. A completed SD model may contain scores or even hundreds of equations along with the appropriate numerical inputs. Importantly, epidemiologic SD models are designed to reproduce historical patterns and capable of generating useful insights. The data extrapolated from these epidemiological models are useful not only to study the past, but are reliable also to explore predictive and intervention possibilities (Forrester, 1980; Homer, 1996). With this in mind, a SD model incorporating various HIV/AIDS-risky behaviors has been developed by CCEBRA to model HIV/AIDS.

SD modelling, a tool widely used in epidemiological and mathematical modelling, allows researchers to study and develop a holistic way to assess not only the behavior of the system, but the relationships and interactions between different entities within the system so that scientists can predict what will happen if these systems behaviors persist into the future. If developed carefully, mathematical and statistical models can serve as tools to better understand the epidemiology of HIV/AIDS (Todd et al., 1999). Mathematical models of HIV/AIDS transmission dynamics also play an important role in understanding the epidemiological patterns and methods for disease control as they provide short- and long-term predictions of HIV and AIDS incidence, prevalence, and its dependence on various factors (Todd et al., 1999).

The principles of SD are well suited for modelling and are applicable to HIV/AIDS problems (Dangerfield et al., 2001). The dynamic systems analysis model developed by CCEBRA was performed using the Structural Thinking Experimental Learning Laboratory with Animations (STELLA) software (High Performance Systems, 2000). Applications of systems dynamics methodologies, which employ STELLA software to develop HIV/AIDS models (Dangerfield et al., 2001), addresses the utility of the software in a variety of modelling environments that are suitable for HIV/AIDS modelling purposes.

4.2 The equations that describe the changes in susceptible populations

The HIV infection rate in a given susceptible population directly depends on the proportion of people engaged in HIV/AIDS-risky behaviors. Equations defining all transition states,

rates, and parametric variables are very critical in the development of an epidemiologic model. The proportion of people who are not using condoms is the primary focus addressed by this study. Manipulation of the condom use-related variable changes the behavior of the system and results in an increase or decrease of the incidence and prevalence of HIV infections; thus allowing the critical evaluation of alternative HIV/AIDS prevention and control strategies.

A number of basic assumptions are made in the development of the model. These include the assumptions that: 1) the number of susceptibles at a given time are the total population at that point in time; 2) a susceptible can become infected only if he/she engaged in HIV/AIDS-risky behaviors; 3) an individual can move from high HIV/AIDS-risky behaviors to low HIV/AIDS-risky behaviors or vice versa within the infective sub-populations; and 4) the changes in behavior from high-risk to low-risk may be as a result of educational programs that enhance awareness and counseling.

Mathematically, the model parameters are defined as follows. Three major ethnic populations were considered: white, black, and Hispanic, which are designated as ethnic, groups 1, 2, and 3 respectively. Within each group, an individual is considered to be in one of three sex-related statuses: female, heterosexual male, and bisexual/homosexual male, which are designated as sex-related statuses 1, 2, and 3 respectively. Each individual is also considered to be either a non-injecting drug user or injecting drug user. The HIV/AIDS infection rate in a given susceptible population directly depends on the proportion of injecting-drug users, proportion of homosexuals, proportion of people engaged in multiple sexual partnerships, and proportion of people not using condoms. Manipulation of one or several of these variables changes the trend of the system and results in an increase or decrease in the incidence of the HIV/AIDS, thereby supporting the critical evaluation of alternative disease prevention and control strategies.

Mathematically, let:

$S_{ijk}(a,t)$ denote the number of susceptible individuals of ethnic group i, sex-related status j, drug use status k, age a at time t,

$I_{ijk}(a,t,u)$ represent the number of incubating individuals of drug use status k (non-injecting drug user or injecting drug user), sex-related status j, ethnic group i, age a, at time t, who are infected by HIV at time t-u.

Similarly:

$A_{ijk}(a, t, v)$ denote the number of AIDS patients of ethnic group i, sex-related status j, drug use status k, age a, at time t, who become AIDS patients at time t-v.

The equations that describe the changes in susceptible populations, HIV-infected populations, and AIDS populations of ethnic group i, age a at time t were then defined as follows:

$$\frac{\partial S_{ijk}(a,t)}{\partial t} + \frac{\partial S_{ijk}(a,t)}{\partial a} = \{\sigma_{ijk}(a)[1 - \gamma_{ijk}(a,t)] - 1\}S_{ijk}(a,t) \tag{1}$$

$$\frac{\partial I_{ijk}(a,t)}{\partial t} + \frac{\partial I_{ijk}(a,t)}{\partial a} + \frac{\partial I_{ijk}(a,t)}{\partial \overline{u}} = \{\sigma_{ijk}(a,t)[1 - tr(u)] - 1\}I_{ijk}(a,t,u) \tag{2}$$

$$\frac{\partial A_{ijk}(a,t,v)}{\partial t} + \frac{\partial A_{ijk}(a,t,v)}{\partial a} + \frac{\partial A_{ijk}(a,t,v)}{\partial v} = \{\mu(v) - 1\} A_{ijk}(a,t,v) \qquad (3)$$

Where the indices i = ethnic group status, j= sex-related status, and k = individuals of drug use status:

$\sigma_{ijk}(a)$ is the age-specific survival rate of individuals of i, j, and k status;

$\gamma_{ijk}(a,t)$ is the HIV infection rate of individuals of age a at time t with i, j, and k status;

tr(u) is the probability that an individual infected by HIV at time t-u becomes an AIDS patient at time t; and

$\mu(v)$ is the survival rate of individuals who become AIDS patients at time t-v.

The number of individuals of age a at time t who acquire HIV by sexual contacts and/or injecting drug use during [t, t+dt] is defined as follows:

$$I_{ijk}(a + da, t + dt, 0) = \sigma_{ijk}(a)\, \gamma_{ijk}(a,t)\, S_{ijk}(a, t). \qquad (4)$$

Note that I_{ijk} is the critical HIV infection rate and it relies either on injecting drug use and/or sexual contact. Since interest is to examine condom use as an intervention (HIV preventive approach), how the HIV infection rate via sexual contact is derived is shown.

Let $F_{ijk}(a,t)$ denote the events that an individual of age a, drug use status k, sex related status j, in ethnic group i is infected by HIV during [t, t+dt) due to sexual contact. An individual may have sexual contacts with partners from different ethnic groups. The probability of HIV transmission due to sexual contacts is formulated in terms of the number of partners, number of sexual contacts with each partner, the probability that a partner is infected, and the probability that one contact with an infected partner will result in infection. Since three ethnic groups were considered in this study, each consisting of three sex-related sub groups, the HIV prevalence differs from group to group. The probability that an individual of age a, drug use status k, sex-related status j, in ethnic group i, is infected by HIV at time t, due to sexual contacts is given by:

$$P\left[F_{ijk}(a,t) \right] = 1 - \prod_{e=1}^{3} \left\{ 1 - q_e(a,t) \right\} \qquad (5)$$

Where:

$$q_e(a,t) = 1 - \left\{ 1 - p_{je}(a,t)\left[1 - (1-r)^{m_{ijk,e}} \right] \right\}^{n_{ijk,e}}$$

- is the probability that an individual of age a, drug use status k, sex-related status j, in ethnic group I, is infected by HIV during [t, t+dt) due to sexual contacts with partners from ethnic group e,
- r is the probability of HIV transmission associated with a single sexual contact,
- $n_{ijk,e}$ is the number of sexual partners from ethnic group e,
- $m_{ijk,e}$ is the number of sexual contacts with a partner from ethnic group e, and
- $p_{je}(a,t)$ is the probability that a partner from group e is infected at time t.

If a condom is used during sexual contact, it is assumed to be 100% protective. Although low levels of condom breaks have been reported condom use is considered to be highly

effective in preventing transmission of HIV and other sexually transmitted diseases. Three proportions of condom use at 25%, 50%, and 75% were considered, respectively, in each population to simulate and evaluate the impact on reducing the incidence of HIV by preventing disease transmission from infected to healthy individuals.

Once an individual is infected with HIV, after what is most often a long and varied incubation period, the disease advances to the stage of AIDS. The number of individuals of age a at time t, who progress to AIDS status during $[t,t+dt)$ is represented by:

$$A_{ijk}(a+da, t+dt, 0) = \sum_{u=1}^{u_{max}} \sigma_{ijk}(a)p(u)I_{ijk}(a,t,u)$$

(6)

Where u_{max} is the maximum incubating time, and $p(u)$ is the probability that an individual infected at time $t-u$ progresses to AIDS status at time t. The systems of equations for different ethnic groups are connected through the HIV infection rate, $\gamma_{ijk}(a,t)$. The results of the model simulations are shown in Figure 1.

4.3 Simulation results

Model parameters were estimated using CDC surveillance data. Computer simulations were carried out on a PowerPC with C as the programming language. In this study, focus was on the use of condoms and its impact on reducing the incidence of the transmission of HIV in sexually active adults in the U.S. The model (Figure 1) shows that if active HIV/AIDS prevention and control interventions are not pursued the HIV/AIDS incidence in the black population would increase from 60 per 100,000 in 1990 to 110 per 100,000 in 2020. In the Hispanic population, incidence would increase from 40 per 100,000 to 68 per 100,000 and in the white population it would increase from around 16 per 100,000 to 23 per 100,000, respectively. This represents an increase in AIDS incidence of 49%, 28%, and 21% for blacks, Hispanics and whites, respectively. As can be seen, these are significant increases for all populations but they are much more devastating for the black subpopulation. Condom use was evaluated in 25% (the status quo used until approximately 1995), 50%, and 75% of sexually active adult populations. The baseline of 25% was used in the model although the rates of condom use varied from low levels of 5% to 10% to 50% or more in previous surveys (CDC, 1996). Figure 1 shows that increased condom use in 50% - 75% of the sexually active population can decrease the rates to the pre-1991 levels, which were 47.9% for blacks, 27.5% for Hispanics, and 11.6% for whites respectively. By the year 2020, the percentage reduction of AIDS would be expected to be 53% in blacks, 49% in Hispanics, and 43% in whites. Previous meta-analysis indicated that condom use could reduce HIV/AIDS by about 69% to 87% (Weller, 1993). A meta-analysis showed that condom use could be effective when used consistently and could potentially reduce HIV by 90% – 95% (Pinkerton and Abramson, 1997). The model simulation examined the proportion of condom use of up to 75%, but if higher levels are evaluated the rate of reduction would be higher and more consistent with the reported findings in the meta-analysis.

Clearly, the significance of HIV/AIDS and its devastation of minority communities pose a great concern. Among racial/ethnic groups, the impact of HIV is greatest among Blacks. According to the CDC (2008), Blacks, who represent approximately 13% of the U.S. population (U.S. Bureau of Census, 2000), have an estimated rate of HIV diagnoses that is 9 times higher than that of whites and nearly 3 times higher than that of Hispanics. The

lifetime risk for HIV infection is 1 in 16 for African American men and 1 in 30 for African-American women (Hall, 2008). Hispanics are also disproportionately impacted by HIV/AIDS, representing approximately 15% of the U.S. population but accounting for an estimated 17% of new HIV infections (Hall, 2008). The lifetime risk of an HIV diagnosis is 1 in 36 for Hispanic males and 1 in 106 for Hispanic females (CDC, 2010).
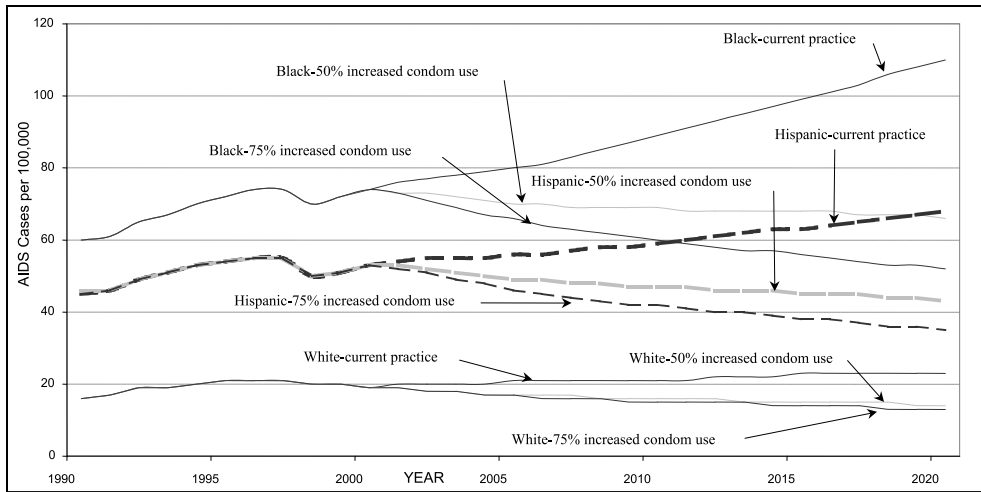

Fig. 1. Projections of AIDS Cases in blacks, Hispanics and whites (under various levels of condom use)

4.3.1 HIV/AIDS as a health disparity in the United States

Among diseases that disproportionately affect African Americans, the HIV/AIDS epidemic has been particularly devastating for this community at every stage of the disease. Despite extraordinary improvements in HIV treatment, African Americans accounted for 48% of new HIV or AIDS diagnoses in 2005 (CDC, 2007). AIDS remains the leading cause of death among black women between 25-34 years and the second leading cause of death in black men between 35-44 years of age (CDC, 2007). HIV infection levels are especially high (3.6%) among blacks aged 40-49, with males in this age group having an HIV prevalence (4.5%) (McQuillan et al., 2006) that approaches the region-wide prevalence in sub-Saharan Africa (5.0%) (UNAIDS, 2008). The rate of AIDS diagnoses for black adults and adolescents was 10 times the rate for whites and nearly 3 times the rate for Hispanics (CDC, 2007), and for black men it was 8 times more than the rate for white men (CDC, 2007). African-American women had a 23 times greater diagnosis rate than white women (Hader et al., 2001). More than 90 % of babies born with HIV belong to minority groups. African Americans are ten times more likely to die of AIDS than whites (U.S. Department of Health and Human Services, 2008).

Studies have also shown higher rates of HIV/AIDS in low-income populations, suggesting that this pandemic is spreading most rapidly among the poor (Hu et al., 1994). This is significant, especially for the South where half of all African Americans live below 200% of the poverty line. Notably, they have significantly less access to health care than people of other races and ethnicities (Preston et al., 2004; Whetten et al., 2005). In Georgia, Jackson,

Mississippi, and North Carolina, African Americans accounted for 70%, 84%, and 62%, respectively, of all PLWHA (Henry J. Kaiser Family Foundation, 2007).

Research suggests SES may affect the likelihood of contracting HIV/AIDS (Simon et al., 1995). In a cross-sectional study, Hargreaves (2002) found that men and women of low SES are at greater risk of newly acquired HIV infection. A study of HIV transmission among African-American women in North Carolina found that women with HIV infection were more likely than non-infected women to be unemployed, receive public assistance, have had 20 or more lifetime sexual partners, have used crack or cocaine, or have traded sex for drugs, money, or shelter (CDC, 1982). A lack of SES resources is linked also to HIV/AIDS-risky behaviors and leads to HIV infection (Simon et al., 1995). For each of the HIV/AIDS risk factors examined, low educational level was more common among minority populations and in women (Diaz et al., 1994).

SES is a key factor that determines the quality of life for PLWHA. Those individuals with fewer resources are often left with limited treatment options (Simon et al., 1995). A study by Diaz and colleagues (1994) indicated that HIV-positive people with lower SES also died sooner than HIV-positive people with higher SES because of their lack of access to medical care, the high cost of antiretroviral drugs, and a lowered immunity from other illnesses. SES is a correlate of behaviors that affect health, access to and use of health care, risk of disease, and mortality (Diaz at al., 1994). When HIV/AIDS rates are examined in light of SES both HIV/AIDS prevalence and incidence are found to be higher among minority populations experiencing high rates of unemployment (Aday, 2001; Fenton, 2001), and lower SES is among the most important determinants of HIV infection among African Americans (Diaz et al., 1994).

These findings have significant implications for the development of effective strategies to prevent and treat HIV/AIDS and other health disparities, particularly for the poor and racial and ethnic minority communities.

5. Community-based epidemiologic research to address the impact of psychosocial factors and substance abuse on HIV/AIDS-risky behaviors

This study is critical to the development of effective strategies to prevent and control a complex disease challenge such as HIV/AIDS, which is faced by millions of people globally. We conducted a community-based epidemiologic study that integrates multiple determinants – including psychosocial and SES factors – that facilitate HIV/AIDS transmission in all populations. The purpose of this study was to assess the quantitative contributions of each of these factors upon HIV/AIDS transmission. The objectives were: 1) to assess the relationships between psychosocial variables and HIV/AIDS-risky behaviors among PLWHA, and 2) to determine if significant differences exist in substance abuse among PLWHA both before and after their HIV infection status has been established.

Materials and methods

Study design

The data was collected by a questionnaire instrument survey of the HIV-positive clients of a community-based HIV/AIDS outreach facility (CBHAOF) located in Montgomery, Alabama, USA. The CBHAOF provides treatment and prevention services through education, quality services, and compassionate care for HIV/AIDS clients and their families in 27 counties in Alabama. In addition, the CBHAOF has a medical component/clinic that

provides complete primary health care which includes physician visits and laboratory tests to diagnose HIV infection. The study questionnaire was designed to collect data on behaviors that could be associated with HIV/AIDS transmission in the Black Belt Counties (BBC) of Alabama, which stretch centrally across the state west to southeast. The BBC have a higher percentage (more than 50%) of African-American residents as compared to white residents. The questionnaire was pretested in collaboration with the CBHAOF to assess whether the materials were understood by and could be answered by the target participants. Tuskegee University's Institutional Review Board approved the final questionnaire, informed consent forms, and study protocol. The major modules of the questionnaire included: SES and demographic information; knowledge about HIV/AIDS and HIV testing; and substance abuse and other HIV/AIDS-risk behaviors before and after the knowledge of their HIV infection status. Participants filled out a questionnaire anonymously without any individual identifying information.

Data collection procedures

The data was collected in collaboration with the CBHAOF. The questionnaires and the informed consent forms were given to the facility staff to administer to and retrieve from study participants. The defined criteria to enroll study participants included: age equal to or greater than 18 years; being diagnosed as HIV positive by a laboratory test at the CBHAOF; or having AIDS diagnosed by a physician. A convenience sampling method was used to select the study group. During their regular medical visits eligible participants were informed about the study by the facility's staff. Each participant was approached individually at the end of his/her office visit by a trained interviewer who explained the goals of the study and requested consent for participation in the study. Although a convenience sampling method was used, almost all the clients approached were eligible and agreed to participate in the survey in one of two ways: 1) by signing or returning the consent form prior to their response to the questionnaire, or 2) by simply filling out the questionnaire at clinical sites. Participant's names were not included in the questionnaire, thus maintaining their anonymity.

A total of 341 questionnaires were distributed at the convenience of the participants and returned to CBHAOF staff in a sealed envelope. A total of 326 questionnaires were completed fully and returned; this represents a response rate of 96%. The remaining 15 questionnaires were returned to the facility but were not fully completed and as a consequence they were discarded and not used in the analysis. This represents a 4% refusal/dropout rate. Upon receiving the completed questionnaire CBHAOF staff gave each participant a Wal-Mart gift card valued at $15.00. Tuskegee University provided the gift card as an incentive and a token of appreciation for completing the questionnaire. Researchers at the CCEBRA collected the completed questionnaires from the CBHAOF staff, kept the surveys in a secured location, and entered data into a FileMaker Pro 6.0v4 database.

Statistical analyses

The data was analyzed using SAS System for Windows (SAS Institute Inc. Version 9.0.1 Software). Demographic variables were summarized using descriptive statistics. A path analysis model used the Analysis of Moment Structures (AMOS) version 17.0 Software (Arbuckle et al., 1999) to examine the relationships between all variables of the hypothesized model. A chi-square test was used to examine the association between depression and substance abuse to predict HIV/AIDS-risky behaviors among PLWHA. Regression and Pearson's Correlation analysis were used to determine if significant correlations existed

between the quantity of alcohol consumed and select risky sexual behaviors. A paired t-test was used to determine if significant differences existed in the prevalence of substance abuse before and after the knowledge of HIV infection status. The McNemar test was used to test the differences between proportions in the matched-pair case.

5.1 Results

Table 1 shows a summary of the demographic characteristics of the respondents.

Table 2 illustrates standardized regression weights for psychosocial factors regarding HIV/AIDS-risky behaviors among PLWHA. The participants who indicated having lost interest in aspects of life that were important before establishing HIV infection status is significantly related to the use of drugs before sex (total effects' standardized regression coefficient = 0.11, p = 0.02); IDU (total effects' standardized regression coefficient = 0.28, p = <0.001); sharing the same syringe/needle with another person(s) to inject him/herself (total effects' standardized regression coefficient = 0.27, p <0.001); number of sexual partners within one year (total effects' standardized regression coefficient = 0.17, p = 0.001); sex with a prostitute(s) (total effects' standardized regression coefficient = 0.16, p = 0.004); and sex with a person(s) who inject drugs intravenously (total effects' standardized regression coefficient = 0.27, p <0.001). Further, Table 2 indicates that depression is strongly correlated with IDU (total effects' standardized regression coefficient = 0.16, p = 0.002); number of sexual partners within one year (total effects' standardized regression coefficient = 0.22, p <0.001); and condom use (total effects' standardized regression coefficient = 0.34, p <0.001).

The regression coefficients for drinking alcohol before sex were also significantly related to all HIV/AIDS-risky behaviors. As indicated in Table 2, drinking alcohol before sex is correlated directly with using drugs before sex (total effects' standardized regression coefficient = 0.44, p <0.001); sharing the same syringe/needle with another person(s) who self-injects (total effects' standardized regression coefficient = 0.14, p <0.001); number of sexual partners within one year (total effects' standardized regression coefficient = 0.25, p <0.001); condom use (total effects' standardized regression coefficient = 0.17 p = 0.001); and sex with a prostitute(s) (total effects' standardized regression coefficient = 0.17, p = 0.003). The results suggest that drinking alcohol leads to promiscuity and then to increased HIV/AIDS-risky behaviors.

Further analysis of the association between psychosocial variables, especially depression, and HIV/AIDS-risky behaviors among PLWHA, shown in Table 3, indicates that IDU, syringe/needle sharing, substance abuse before sex, and sex with injecting drug users are significantly associated with depression. Among those participants reported to have used drugs intravenously, 60% were depressed compared to 40% not depressed. This indicates that PLWHA who experience depression were significantly more likely to report to have used drugs intravenously compared to non-depressed participants (p = 0.005). Results in Table 3 indicate also that depressed participants were more likely report having shared the same syringe/needle with another person to inject him/herself compared to participants who were not depressed (73 % versus 27 %, p <0.001). Depressed participants were significantly more likely to report alcohol consumption before sex compared to non-depressed participants (57 % versus 43 %, p = 0.002). Furthermore, depression is associated with drug use before sexual intercourse (p = 0.006) and sex with injecting drug users (p = 0.01).

Demographic and socioeconomic characteristics		n	%
Sex	Female	136	42
	Male	181	56
	Transgender	4	1
	Transsexual	5	2
Race	African American	208	64
	White (non-Hispanic)	94	29
	Hispanic	10	3
	Other races	14	4
Age group	18-29	53	19
	30-39	86	30
	40-49	104	37
	50-59	34	12
	60 and above	6	2
Marital Status	Single	183	56
	Married	47	15
	Divorced	47	15
	Separated	31	10
	Widow (er)	3	1
	Other	13	4
Employment Status	Employed for wages	122	39
	Unable to work	59	19
	Unemployed	50	16
	Student	25	8
	Homemaker	25	8
	Self-employed	18	6
	Retired	12	4
Level of education	Graduate school	11	3
	College 4 years or more	50	15
	College 1 year to 3 years	85	26
	Grade 12 or GED	126	39
	Grades 9 through 11	40	12
	Grades 1 through 8	11	3
Level of income	$9,999 or under	97	31
	$10,000 to $14,999	45	14
	$15,000 to $19,999	38	12
	$20,000 to $24,999	36	11
	$25,000 to $29,999	23	7
	$30,000 to $49,999	20	6
	$50,000 to $74,999	13	4
	Don't know	46	14

Table 1. Demographic and socioeconomic characteristics of the participants

Variable	Total effects	p-value
The relationship between lost interests in aspects of life and		
Using drugs before sex	0.11	0.02
Injecting drugs intravenously (IDU)	0.28	<0.001
Needle sharing	0.27	<0.001
Number of sexual partners within 1 year	0.17	0.001
Sex with prostitutes	0.16	0.004
Sex with injection drug users	0.27	<0.001
The relationship between depression and		
Injection drug users	0.16	0.002
Number of sexual partners within 1 year	0.22	<0.001
Condom use	0.34	<0.001
The relationship between drinking alcohol before sex and		
Using drugs before sex	0.44	<0.001
Needle sharing	0.14	0.01
Number of sexual partners within 1 year	0.25	<0.001
Condom use	0.17	0.001
Sex with prostitutes	0.17	0.003

Table 2. The relationships between selected psychosocial variables and HIV/AIDS-risky behaviors among PLWHA

HIV/AIDS risky behaviors	Depressed		Not depressed		
	n	%	n	%	*p* value
Used drugs intravenously					0.005
Yes (N=52)	31	60	21	40	
No (N=238)	91	38	147	62	
Shared the same syringe/needle with another person					<0.001
Yes (N=37)	27	73	10	27	
No (N=254)	95	37	159	63	
Drinking alcohol before sexual intercourse					0.002
Yes (N=77)	44	57	33	43	
No (N=205)	76	37	129	63	
Drug use before sexual intercourse					0.006
Yes (N=40)	26	65	14	35	
No (N=210)	82	39	128	61	
Sex with injecting drug users					0.01
Yes (N=43)	27	63	16	37	
No (N=171)	64	37	107	63	

Table 3. Depression by substance abuse and other HIV/AIDS-risky behaviors

Findings about the participants' alcohol consumption, both before and after having established their HIV infection status, are presented in Table 4. The variables selected for analysis were about the consumption of alcoholic beverages and frequency and number of alcoholic beverages consumed before sex. A statistically significant difference (p = .001) was observed in the variable "drinking alcoholic beverages before sex" among the participants before and after establishing their HIV infection status (Table 4). The analysis of the question "Did you drink any alcoholic beverage such as beer, wine, wine coolers, or liquor before you had sexual intercourse the last time?" shows that before establishing their HIV infection status, 35% of the participants had consumed an alcoholic beverage before sex. In comparison, 28% of the participants indicated that they had consumed an alcoholic beverage before sex after establishing their HIV infection status. The difference between drinking alcohol before sexual intercourse – both before and after the knowledge of HIV infection status – among PLWHA is 18.50% with a 95% confidence interval (CI) from 8.07% to 27.07%; this is statistically significant (p = .0001). No significant differences were observed in other measures of HIV/AIDS-risky behaviors. These include frequency and quantity of alcohol consumed before sex, IDU, and sharing the same syringe or needle with another person (Table 4).

Variable	Before the knowledge of HIV infection status	After the knowledge of HIV infection status	A 95% CI and p value for the difference between proportions
Drink any alcoholic beverage before sex	n = 229	n = 229	
Yes	80 (35 %)	65 (28 %)	(CI, 8.07 -27.87%; p = 0.001)
No	149 (65 %)	164 (72 %)	
Frequency of alcohol consumed before sex	n = 175	n = 158	
A few times	101 (58 %)	83 (53 %)	(CI, -6.1 -16 %; p = 0.42)
Half of the time	32 (18 %)	32 (20 %)	(CI, -6.8 -10.9 %; p = 0.75)
Most of the time	20 (11 %)	15 (9 %)	(CI, -5 -8.9 %; p = 0.67)
Every time	22 (13 %)	28 (18 %)	(CI, -3.2 -13.3 %; p = 0.27)
Number of drinks before sex	n = 173	n = 162	
1-2 drinks	99 (57 %)	83 (51%)	(CI, -5.1 -16 %; p = 0.32)
2-4 drinks	39 (23 %)	42 (26 %)	(CI, -6.6 -12.6 %; p = 0.61)
5 or more drinks	35 (20 %)	37 (23 %)	(CI, -6.2 -12.2 %; p = 0.59)
Injecting drug use	13% (n =225)	12% (n =225)	(CI, -6.6 -6.7 %; p = 0.89)
Sharing the same syringe or needle with another person	74% (n =235)	79% (n =235)	(CI, -18.7-27.8%;p = 0.87)

Table 4. The difference between drinking alcohol before and after establishing HIV infection status

6. Discussion

The association between low SES and risk of HIV infection has been well documented in the scientific literature (Hargreaves, 2002; Solorio et al., 2002). The HIV/AIDS pandemic is most severe in the poorest countries, worldwide, and among people of color (UNAIDS, 1999). Similarly, HIV/AIDS prevalence in the U.S. is disproportionately high in poor communities and runs rampant among African Americans. Although HIV/AIDS affects all races in the U.S. there is no single explanation for why HIV/AIDS affects African Americans disproportionately. A combination of biomedical, behavioral, and SES factors, often working together conjointly, seems to be responsible for this health disparity. Poverty, income inequality, and lack of or limited access to appropriate and high-quality health care programs are some of the social determinants that influence the health of PLWHA.

Studies have shown the prevalence of psychosocial problems not only to be common in PLWHA but related to increased high-risk behaviors. These include drug use before sex, sharing the same syringe/needle with another person to inject themselves, and having had multiple sexual partners. The findings suggest that psychosocial problems influence HIV/AIDS-risky behaviors and may contribute to the high probability of HIV infection within high-risk populations. The most plausible explanation for this finding is that psychosocial problems, such as depression, impair both physical and cognitive functioning and can interfere with the decision to practice safe sexual behaviors. Moreover, depression is a barrier to behavior change. Currently, treating depression is the most successful strategy to effectively reduce the risk of acquiring and spreading HIV/AIDS (Paterson et al., 2000).

In this study, results confirmed that psychosocial variables related to HIV/AIDS-risky behaviors are complex. Thus, a detailed understanding of how psychosocial factors impact on HIV/AIDS risk-taking behaviors among PLWHA might be important for prevention and control purposes. Study results demonstrate substance abuse, especially alcohol, is linked to the tendency to have multiple partners and sexual intercourse without condoms. The findings demonstrated the prevalence of depression in PLWHA which occurs concurrently with substance abuse in this population. Participants significantly reduced alcohol intake post-diagnosis – a research finding that highlights the effectiveness of incorporating alcohol-reduction strategies to reduce HIV/AIDS-risky behaviors - however, PLWHA should be advised not to drink excessive amounts of alcohol, which is associated with high-risk sexual and drug injection-related behaviors that increase the likelihood of HIV transmission (Dag, 2008).

The findings of this study also indicate that PLWHA continue to engage in HIV/AIDS risky behaviors after the knowledge of their HIV status. There are several possible explanations for this finding. First, with the advent of HAART in 1996 mortality among PLWHA decreased dramatically (Bouhnik et al., 2007). Most of the PLWHA who get therapeutic benefits from HAART may attain an improved quality of life and functional status with the alleviation of the physiological, social, and psychological consequences of HIV/AIDS. These gains may be accompanied by increases in HIV/AIDS-risky behaviors that include sharing the same syringe/needle with another person. Secondly, PLWHA may have unrealistic beliefs about the impact of HAART on disease transmission rates and therefore may perceive the consequences of transmitting HIV/AIDS as being less serious than in the past. The proven efficacy of HAART in reducing mother-to-child transmission of HIV/AIDS may reinforce these beliefs. PLWHA who have such beliefs may be less likely to use condoms consistently or may have a higher number of sexual partners than those who do not.

Similarly, PLWHA who are using HAART therapy may be less inclined to insist on safer behaviors if they perceive the consequences of HIV infection to be somewhat less terrible because of the availability and efficacy of this antiretroviral therapy. In this era of HAART, addressing the psychosocial health burdens of PLWHA will be an essential component to the development of effective strategies to combat HIV/AIDS.

While the need for effective psychosocial health services for PLWHA is clear, the challenges are equally evident. At least three areas are suggested as high priorities for future research. First, interventions for depression should be developed for PLWHA. Evidence should be gathered on the effectiveness of such interventions not only for improving mental health but also for reducing substance abuse and HIV/AIDS-risky behaviors so as to reduce transmission of HIV/AIDS. Particular attention is warranted for methods or ways to identify PLWHA who are experiencing depression and to understand and address the mechanisms through which these experiences pose barriers to healthy behaviors.

7. Conclusion and recommendations

In this study, an exhaustive review of literature on the epidemiology and determinants of HIV/AIDS transmission has been organized into a repository from which relevant data for building the dynamic epidemiologic models was derived. The results of epidemiologic models can be used to provide important insights into HIV/AIDS transmission dynamics at the macro (human population) level and to evaluate alternative HIV/AIDS prevention and control strategies. Thus, dynamic epidemiologic modelling is an essential research tool that scientists can employ to make prediction estimates of current prevalence and future incidence of HIV/AIDS cases. Computational models can be used to examine alternative strategies for effective interventions that lead to better planning and policy-making for all disease control and prevention efforts.

Despite knowledge of their status, PLWHA are continuing to engage in HIV/AIDS-risky behaviors. Understanding the multiple variables that impact on HIV/AIDS-risky behaviors among PLWHA will be critical in the search for alternatives to the way in which these problems are addressed at the present time. Psychosocial factors and substance abuse variables, which play a significant role in HIV/AIDS-risky behaviors, may contribute to the high probability of HIV/AIDS transmission. Cross-disciplinary research – to include advanced knowledge of basic and applied psychological and social research and the manners in which they interact together – is needed to develop effective HIV/AIDS prevention and control strategies. Scientists interested in HIV/AIDS research can employ these correlation findings to identify factors that covary with behaviors that put people at risk for negative outcomes.

Recognizing that the impact of HIV/AIDS is not only biological but psychosocial in nature, intervention programs, including education and counseling, must be designed holistically to address the complex challenges faced by PLWHA. This population should be offered or provided a comprehensive set of psychosocial interventions at all levels of the health system. In particular, depression-related issues for PLWHA should be addressed and specific psychosocial and psychotherapeutic interventions should be provided to more effectively address associated alcohol and other substance abuse problems. Based on the findings of this study, our recommendations are as follows to identify and create effective strategies to reduce HIV/AIDS and ultimately eliminate this devastating pandemic: 1) Create dynamic epidemiologic models that integrate SES and psychosocial variables as they

are required to explore the epidemiology of HIV/AIDS; 2) Use epidemiologic models to address the social determinants of health as these factors are critical to reduce and eliminate HIV/AIDS and other health disparities; 3) Advance research to examine the resistance to behavior change as well as the motivation for behavior change as these factors also are central to the design of effective HIV/AIDS prevention and intervention strategies; 4) Develop cross-disciplinary research that includes advanced knowledge of basic and applied psychological and social research and the ways in which they interact together; and 5) Encourage strong collaborations among researchers, policy-makers, and communities to identify and address biomedical, behavioral, and psychosocial factors that are responsible for the risky sexual behaviors that ultimately result in further transmission of HIV/AIDS.

8. Acknowledgment

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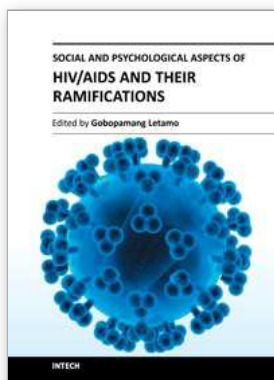
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Edited by Prof. Gobopamang Letamo

This book has assembled an array of chapters on the social and psychosocial aspects of HIV/AIDS and their impact on HIV/AIDS and related behaviours. The book addresses key areas of HIV and AIDS, including, but not in any way limited to, care-seeking behaviour, adherence, access, psychosocial needs and support services, discrimination and the impact the epidemic has on various sectors of the economy. The book has seventeen chapters; seven chapters deal with social aspects of HIV/AIDS, four with psychosocial aspects of HIV/AIDS, and the remaining six chapters with the impact of social and psychosocial factors on HIV/AIDS and related behaviours. The book is an essential reading for academics, students and other people interested in the field of HIV and AIDS.

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