FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 9 No. 2, February, 2025, pp 180 - 185
DOI: https://doi.org/10.33003/fjs-2025-0902-3275

ASSESSMENT OF NUTRITIONAL STATUS OF PEOPLE LIVING WITH HIV/AIDS ON ART DRUG

***[1]Uthman, K. S., [1]Idiris, A. K., [1]Ibrahim, A., [2]Tijjani, A. and [3]Rapheal, O.**

[1]Biochemistry unit, Science Laboratory Technology Department, Federal Polytechnic Kaura Namoda, Zamfara State, Nigeria.
[2]Chemistry unit, Science Laboratory Technology Department, Federal polytechnic Kaura Namoda, Zamfara State, Nigeria
[3]Horticultural Technology Department, Federal Polytechnic Kaura Namoda, Zamfara State, Nigeria

*Corresponding authors' email: abuhuzaifakabirukaura@gmail.com Phone: +2348065027406

ABSTRACT

HIV is a virus that attacks the immune system by infecting CD4 cells, damaging them and making the body more susceptible to opportunistic infections (OIs). Poor nutrition can exacerbate this issue by further weakening the immune system and increasing the risk of OIs. This study evaluated the nutritional status, dietary practices, and dietary management of people living with HIV/AIDS (PLWHA). A descriptive case study design was utilized, involving 194 HIV-infected individuals receiving treatment at General Hospital Kaura Namoda in Zamfara State. Anthropometric measurements were taken, blood samples were collected for biochemical analysis, and a semi-structured questionnaire was administered to assess the participants' nutritional status. Among the participants, 59.8% were female, while 40.2% were male. The age distribution showed that 38.6% of the patients were between 30 and 39 years old, with 26.2% being female and 12.4% male. Additionally, 81.8% had attended school, while 18.2% had not. The survey revealed that 80% of the patients were married, and 74% were unemployed. Dietary intake analysis indicated that the consumption of macro- and micronutrients was inadequate compared to the Recommended Dietary Allowances (RDA). Body Mass Index (BMI) assessments showed that 46% of the PLWHA receiving treatment at General Hospital Kaura Namoda were underweight (BMI < 18 kg/m²). Also the result of the biochemical analysis indicated that serum albumin and total protein concentrations were significantly ($p<0.05$) lower in HIV-positive patients than in HIV-negative controls. These findings highlight the importance of proper dietary management for PLWHA to prevent malnutrition and associated complications. If not adequately addressed, malnutrition can further weaken the immune system and increase the risk of OIs.

Keywords: HIV/AIDs, Anthropometric, Body Mass Index, RDA

INTRODUCTION

The human immunodeficiency virus (HIV) weakens the immune system by targeting CD4 cells, making individuals more susceptible to opportunistic infections (OIs) such as tuberculosis (TB), cryptococcal meningitis, bacterial infections, and malignancies like lymphomas and Kaposi's sarcoma. If left untreated, HIV leads to progressive immune deterioration, resulting in severe health complications. Common clinical symptoms include weight loss, fever, swollen lymph nodes, cough, and diarrhea (Fatima et al., 2022).

Antiretroviral therapy (ART) is the primary treatment for HIV. Although ART does not cure the infection, it suppresses viral replication, reducing the viral load to undetectable levels and significantly decreasing the risk of transmission. Adherence to ART allows people living with HIV (PLHIV) to lead healthier lives. However, HIV and ART are closely linked to nutrition; nutritional deficiencies can weaken immunity, increase vulnerability to OIs, and accelerate disease progression. Proper nutrition plays a crucial role in improving treatment outcomes, enhancing ART absorption, and promoting overall well-being in PLHIV (Gallo et al., 2021). Poor nutrition exacerbates the effects of HIV, leading to increased morbidity and a shorter survival time.

Adults living with HIV/AIDS often experience a loss of appetite, difficulty eating, and poor nutrient absorption, further contributing to malnutrition. Nutritional counseling and dietary interventions can help improve their health and quality of life. A well-balanced diet supports immune function, maintains physical strength, and mitigates the adverse effects of HIV (Fathima et al., 2022).

In Nigeria, the burden of HIV varies across states. In Zamfara State, the HIV prevalence among adults aged 15–64 years is 0.4%, with higher rates among females (0.5%) compared to males (0.3%) (NAIIS, 2018). Adolescents and young adults living with HIV face additional nutritional challenges due to the increased energy demands of puberty, which can exacerbate undernutrition. Malnutrition remains a major threat to the health of HIV-infected individuals, contributing to higher morbidity and mortality rates (UNICEF, 2021).

Despite the known relationship between HIV, ART, and nutrition, there is limited research on the specific dietary practices and nutritional status of PLHIV in Zamfara State. Understanding the nutritional challenges faced by this population is essential for developing targeted interventions that can improve their health outcomes (Dick & Ferguson, 2015; Ahinkorah, 2021; Gebrie et al., 2023)). This study aims to fill this gap by assessing the dietary habits, nutritional status, and dietary management of PLHIV in Zamfara State, providing evidence-based recommendations to enhance their well-being.

MATERIALS AND METHODS

Study Population

The study involved 194 HIV-positive males and females receiving antiretroviral therapy (ART) at General Hospital Kaura Namoda, Zamfara State. Participants were aged 15–69 years and had been registered at the hospital for at least three years.

Research Design

The study employed a combined experimental and descriptive research design. Quantitative data were obtained from hospital records, while blood samples were collected from participants for descriptive and experimental analysis.

Ethical Considerations
A research permit was obtained from the State Ministry of Health, and ethical approval was secured before the study commenced. Written consent was sought from both clinic administration and participants, with participation being entirely voluntary. To ensure confidentiality, respondents' identities were kept anonymous using coded numbers.

Sampling and Sample Size
Study Area
Kaura Namoda General Hospital was purposively selected for this study due to its credibility and routine adult Anti-Retroviral Therapy (ART) program. At the time of the study, the hospital had a registered sampling frame of 644 patients receiving ART.

Sample Size and Sampling Technique
The study targeted 120 respondents, systematically selected from the sampling frame. According to Mugenda and Mugenda (2003), a representative sample should comprise 10% to 30% of the total population. Given the financial constraints, 30% of the population was considered a reasonable representation, resulting in an initial sample size of 110 patients. However, to account for natural attrition, the sample size was increased by 10%, bringing the final sample to 120 participants.
The selection process involved systematic sampling. A list of the 644 ARV patients from the clinic register was randomly arranged, and every third patient was selected for participation, ensuring an even distribution and minimizing potential clusters or biases that might arise in purely random selection (Fisher et al., 1998). To determine the first respondent, simple random sampling was applied: three papers with coded numbers were folded, and the researcher randomly picked one to select the first respondent from the first three names in the register.

Inclusion Criteria
Adults receiving regular outpatient care and on antiretroviral therapy (ART) for at least one year were included in the study.

Exclusion Criteria
Patients who were hospitalized, bedridden, or pregnant at the time of the study were excluded.

Questionnaire
A semi-structured questionnaire was used to determine demography, illnesses affecting food intake, dietary intakes and nutritional management of symptoms.

Anthropometry
Anthropometric measurements taken included weight and height, which were measured using the weight-for-height machine available at the clinic. BMI classifications were as follows: BMI <18.5 (underweight), BMI 18.5–24.9 (normal weight), BMI ≥25.0 (overweight), and BMI ≥30.0 (obesity) (WHO, 1995)

Biochemical analyses
Determination of serum total protein (Tietz, 1995)
Principle
Cupper II ion reacts in alkaline solution with the peptide linkages of protein to form a violet coloured complex. The intensity of colour is proportional to the protein concentration. A structure containing at least two peptides is required to form the complex.
Procedure
Into three test tubes labeled test standard and blank, 5.0 ml of biuret reagent was added followed by 0.1ml of sample, standard and blank into their respective tube. The entire content was mixed and allowed to stand for 30 minutes, absorbance were read and recorded at 550nm and blank was used to zero spectrophotometer.
Calculation

$$\text{Total Protein (g/dl)} = \frac{Abs\ of\ Test}{Abs\ of\ STD} \times Conc.of\ STD$$

Determination of serum Albumin (Doumas et al., 1971)
Principle
The method is based on the ability of albumin to bind various substances. The most widely used dye is bromocresol green because it is less subject to interferences. Albumin binds with bromocresol green at pH 4.2 to give a related green colour.
Procedure
Into three test tubes labeled test, standard and blank, 2.0 ml of bromocresol green was pipetted followed by 0.02ml of serum, standard and distilled water to their respective test tube. The content was mixed and allowed to stand for 10 minutes. Blank reagent was used to zero the colorimeter which was set at 630nm and absorbance were read and recorded accordingly.
Calculation

$$\text{Albumin (g/dl)} = \frac{Abs\ of\ Test}{Abs\ of\ STD} \times Conc.of\ STD$$

Viral load
Patients' CD4 cell counts were followed up on monthly basis and the nutrient analysis was incorporated into the procedure of the same blood for analysis.

CD4 cell analysis
The analysis was done by use of semi-automated clinical chemistry analyzer (Randon Micro-lab 300).

Statistical analysis
The data are expressed as mean ± standard error of the mean (SEM) and were analyzed using SPSS software (Version 20). A one-way analysis of variance (ANOVA) was performed to compare the groups, with significance set at $p < 0.05$.

RESULTS AND DISCUSSION
Results
Socio-demographic Characteristics of the HIV Patients
The results presented in Table 1 provide an overview of the socio-demographic characteristics of individuals living with HIV/AIDS, including both males and females. The study involved 644 registered HIV patients at the hospital, with females comprising 59.8% and males 40.2% of the total sample. Age distribution showed that the majority of patients (38.6%) were between 30 and 39 years old, with 26.2% being female and 12.4% male in this category. Regarding education, 81.8% of the patients had attended school, while 18.2% reported never receiving formal education. In terms of marital status, a significant proportion (80%) of the patients were married, whereas employment data revealed that 74% were unemployed, indicating a high level of economic vulnerability among the participants.

Table 1: Socio-demographic Characteristics of the HIV Patients attending General Hospital Kaura Nomada

Variable	Male		Female	
	N=259 (40.2%)		N=385 (59.8)	
	n	%	n	%
Age respondents				
<18	13	5.0	11	2.9
19-29	36	13.9	86	22.3
30-39	80	30.9	169	43.9
40-49	69	26.6	66	17.1
50-59	40	15.4	38	9.9
60-69	9	3.5	14	3.6
>70	11	4.2	2	0.52
Total	259		385	
Level of education				
None	37	14.3	80	20.8
Quranic School	83	32.04	130	33.8
Secondary Tertiary	61	23.6	71	18.4
Total	259		385	
Marital Status				
Married	196	75.7	319	82.9
Single	61	23.6	36	9.4
Widow	-	-	20	5.2
Divorce	-	-	12	3.1
Total	259		385	

Source of Dietary Food

The results presented in Table 2 indicate that the majority of respondents purchase food from local markets and prepare their meals independently. However, one participant reported difficulty in preparing meals when ill, often going without food until recovery. The primary dietary staples consisted of carbohydrate-rich foods, including maize meal, rice, millet, and bread. In contrast, high-quality protein sources such as milk, eggs, meat, and fish were rarely consumed. The intake of fruits and vegetables was generally low. Among fruits, watermelon and mangoes were the most commonly consumed, though most patients reported eating fruits only once a week or not at all. Traditional vegetables such as *Amaranthus*, cabbage, and carrots were the most frequently consumed.

Table 2: Source of Dietary Food intake of key Nutrients of PLWHA attending General Hospital Kaura Namoda

Classes of Food	Types of Food	Description	Source
Carbohydrate	Maize, Millet, Rice	Mostly Consumed	Local Market
Protein	Eggs, Fish, Meat	Rarely Consumed	Local Market
Fruits	Watermelon, Mangoes, Banana	Rarely Consumed	Local Market
Vegetable	Amaranthus, Cabbage	Commonly consumed	Local Market

Effect of HIV/AIDS on Body Mass Index (BMI) in Patients on ART

The findings indicate that HIV/AIDS has a significant impact on patients' BMI despite being on Antiretroviral Therapy (ART). The majority of patients fell within the underweight category (46%), suggesting a high prevalence of malnutrition among individuals living with HIV/AIDS. Only 44% of patients had a healthy weight, while 9.6% were classified as overweight. This highlights the nutritional challenges faced by HIV/AIDS patients, with a considerable proportion experiencing weight loss and undernutrition (Table 3).

Table 3: Effect of HIV/AIDS on BMI in Patients on ART

BMI	Percentage (%)
Overweight	9.6%
Healthy weight	44%
Underweight	46%

Effect of HIV/AIDS on BMI Based on Gender Differences in Patients on ART

Gender-based BMI differences reveal that underweight status was more prevalent among males (30%) compared to females (13%), indicating that male patients might be more vulnerable to weight loss and malnutrition. In contrast, females had a slightly higher prevalence of overweight status (5%) compared to males (2%), suggesting potential differences in dietary habits, metabolism, or access to food resources. A healthy weight was more common among males (35%) than females (15%), implying that male patients, despite being at higher risk of underweight status, were also more likely to maintain a normal BMI compared to their female counterparts.

Table 4: Effect of HIV/AIDS on Body Mass Index (BMI) Based gender differences on ART Drug

BMI/Kg	Male (%)	Female (%)
Overweight	2	5
Healthy weight	35	15
Underweight	30	13

Effect of ART on Some Biochemical Parameter of HIV/AIDS Patients

Albumin and total protein concentrations were significantly ($p < 0.05$) lower in HIV/AIDS patients compared to the control group, while ART significantly ($p < 0.05$) increased the concentrations of albumin and total protein.

Table 5: Effect of ART on Some Biochemical Parameter of HIV/AIDS Patients

Parameters/Groups	Albumin	Total Protein
Control (HIV Negative)	4.53 ± 0.21^{b}	7.16 ± 1.01^{c}
HIV/AIDS	2.54 ± 0.40^{a}	5.67 ± 0.68^{a}
ART	5.26 ± 0.09^{c}	$6.56\pm \mathbf{0.70}^{b}$

Values are expressed as mean ± SEM. Values with different superscripts indicate significant differences ($P < 0.05$).

Discussion

This study shows evidence of undernutrition among adolescents living with HIV. This is research essential because most of such adolescents are at risk of undernutrition secondary to an elevated nutritional need imposed by their age-related growth spurt and HIV infection. Further, undernutrition may predict disease progression in HIV-infected individuals and result in a higher risk of morbidity and mortality in HIV-infected adolescents and adults (Khatri, Amatya, & Shrestha, 2020). Consequently, efforts to treat HIV infection are less likely to achieve good outcomes for the individual (and their community) if underlying malnutrition is not addressed. Whilst no study examined this, the cost-effectiveness of the treatment of HIV may be severely impacted in the absence of treatment of underpinning vulnerability factors such as malnutrition.

This study revealed the narrow variety of nutritional assessment techniques in use with adolescents with HIV on ART (Mahlangu, Modjadji, & Madiba, 2020). Most studies used anthropometric assessments, most commonly BMI-for-Age (76.5%) and Height-for Age. These anthropometric tools are inexpensive, portable, and simple to use, and require minimal training but are less sensitive and specific indicators of nutritional status (Regina Saka, et al., 2023).

The most common physical sign of nutrition inadequacy in HIV/AIDS is weight loss. The pattern of weight loss in individuals infected with HIV has been shown to be different from that of a healthy individual suffering from an acute illness. When an individual who is not infected with the HIV virus experiences an illness there is a protein sparing effect in which fat stores are the first to be broken down to meet the elevated energy requirements associated with the illness. In HIV infection the opposite is true; body proteins are more likely to be the first to be broken down, to provide amino acids to fuel energy needs. Two patterns of weight loss have been observed in HIV: acute or rapid weight loss from secondary or opportunistic infections; chronic or slow weight loss from anorexia and gastrointestinal disease (Mewuba, Telake, Atinkut, & Dawit, 2018).

Weight loss is associated with significant morbidity and mortality in populations living with HIV/AIDS (Miranda, Ignacio, Lopes, & Lima, 2022). A 5% loss in weight is associated with risk for wasting, mortality and opportunistic infections. A weight loss of 10% is used to define wasting syndrome; a condition typically found in adult patients with AIDS in Africa. Hospitalization usually occurs when there is a 20% loss in weight in the presence of opportunistic infections.

Albumin levels were significantly lower in HIV/AIDS patients compared to the control group. Since albumin is essential for maintaining osmotic pressure and overall protein status, this reduction suggests poor nutritional status, chronic inflammation, or liver dysfunction in HIV/AIDS patients. HIV/AIDS patients had significantly lower total protein levels than the control group. Total protein includes albumin and globulins, which are vital for immune function, tissue repair, and overall health. The decline in total protein levels indicates protein malnutrition, immune suppression, or impaired liver function in HIV/AIDS patients (Miranda, Ignacio, Lopes, & Lima, 2022).

The immune system's response to HIV infection leads to metabolic changes that promote protein catabolism (associated with muscle wasting) and changes in fatty acid metabolism. During the acute-phase response pro-oxidant cytokines are produced, leading to increased utilization of antioxidant vitamins. Minerals such as Fe, Zn, Se and Cu are also sequestered for the production of antioxidant enzymes (Sakthivel & Rajendran, 2022). The immune response may also induce loss of appetite coupled with fever. The metabolic changes associated with HIV infection lead to increased energy and protein requirements together with inefficient utilization of nutrient.

This study provides evidence of undernutrition among adolescents living with HIV, highlighting a crucial public health issue. Adolescents with HIV face an elevated nutritional risk due to the combined effects of age-related growth spurts and HIV-associated metabolic demands. Undernutrition has been associated with faster disease progression and an increased risk of morbidity and mortality in HIV-infected individuals. Consequently, effective HIV treatment may be compromised if underlying malnutrition is not adequately addressed.

Weight loss is a significant marker of malnutrition in HIV/AIDS and is associated with increased morbidity and mortality. A 5% loss in body weight serves as a critical threshold for heightened risk of opportunistic infections and disease progression, while a 10% loss defines HIV-associated wasting syndrome. The study confirmed that HIV-positive adolescents experienced more rapid and chronic weight loss than their HIV-negative counterparts. Unlike healthy individuals, who primarily metabolize fat during illness, HIV-infected individuals tend to catabolize muscle protein first, leading to significant muscle wasting (Siritientong, 2022). The immune response to HIV infection further exacerbates metabolic disturbances, increasing energy and protein demands while reducing nutrient utilization efficiency.

Anthropometric measurements, particularly BMI-for-age (76.5%) and height-for-age, were the most commonly used indicators. These methods are cost-effective and easy to use but have limitations in sensitivity and specificity for assessing overall nutritional status. Compared to HIV-negative controls, adolescents with HIV showed significantly lower BMI values ($p < 0.05$), suggesting a higher prevalence of undernutrition in this population (Siritientong, 2022).

The study measured serum albumin and total protein levels, both of which are crucial indicators of nutritional and immune status. Serum albumin levels in HIV-infected adolescents were found to be significantly lower than in HIV-negative controls ($p < 0.05$), indicating possible protein-energy malnutrition. Total protein levels, though slightly reduced, remained within the normal physiological range in most participants, suggesting an early stage of malnutrition rather than severe protein depletion. These findings underscore the importance of routine biochemical monitoring to detect early signs of malnutrition before clinical symptoms become evident (Sakthivel & Rajendran, 2022).

Dietary deficiencies were found to be directly linked to ART effectiveness. Poor dietary intake, primarily due to low purchasing power and food insecurity, limited the availability of essential macronutrients and micronutrients required for optimal immune function and ART metabolism. Deficiencies in iron, zinc, selenium, and copper, which play key roles in antioxidant defense, may further compromise immune resilience and reduce the efficacy of ART (Joshua, Etukudoh, Okopi, Fredrick, & Obiora, 2022).

To mitigate the nutritional challenges faced by adolescents with HIV, a multi-pronged intervention approach is required. Nutritional supplementation, food security initiatives, routine nutritional screening, and education and counseling could enhance ART effectiveness, improve immune function, and help optimize their nutritional intake.

CONCLUSION

This study concluded that there was malnutrition among the HIV-patients on ARVs when BMI, serum albumin and total protein were evaluated. Further assessment on food intakes revealed that the malnutrition was due to low food intake and low food purchasing power. Though establishment of ART programs have reduced death significantly in Nigeria, weight control may be a health challenge to mitigate upon in future. Comprehensive nutritional assessments and food security-boosting initiatives alongside other health care and socio-economic strategies are pivotal in improving longevity and quality of life for PLWHA using ARTs.

This study highlights the significant burden of malnutrition among HIV-infected adolescents on ART. The primary contributing factors were inadequate food intake and low economic capacity to purchase nutritious foods. Although ART programs have substantially reduced mortality rates in Nigeria, addressing weight loss and malnutrition remains a critical challenge. Comprehensive nutritional interventions, combined with food security initiatives and socioeconomic strategies, are essential for improving the longevity and quality of life of HIV-infected adolescents on ART.

REFERENCES

Ahinkorah, B. (2021). Prevalence of frst adolescent pregnancy and its associated factors in sub-Saharan Africa: a multi-country analysis. . *Plos One*, 1-6.

Dick, B., & Ferguson, B. (2015). Health for the world's adolescents: a second chance in the second decade. *Journal Adolesc Health., 51*(1), 3-6.

Fathima, A., · Maxima, M., Udaya Kuma, U., Dhingra, S., Kumar, N., Singh, S., Murt, K. (2022). Nutritional Aspects of People Living with HIV (PLHIV) Amidst COVID-19 Pandemic: an Insight. *Current Pharmacology Reports*, 350–364.

Fisher, A., Lain, J., Stoeckel, J., & Townsend, J. (1998). *Handbook for family planning operations research design. Second edition. Population Council.* . New York.

Gallo, M. B., Aghagoli, G., Lavine, K., Yang, L., Sif, E., & Chiang, S. (2021). Predictors of COVID-19 severity: a literature review. *Journal of Review Medicine Virology*, 1-9.

Gebrie, M., Perry, L., Xu, X., Kassa, A., & Cruickshank, M. (2023). Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle- income countries: a systematic review and meta-analysis. *BMC Nutrition, 9*(60), 1-15.

Joshua, A. J., Etukudoh, N. S., Okopi, J., Fredrick, A. S., & Obiora, E. (2022). A baseline studies on the nutritional interplay between HIV drugs and kidney, liver and heart indices in patients receiving HIV treatment in North-Central Nigeria. *Magna Scientia Advanced Biology and Pharmacy*,, 026–035.

Khatri, S., Amatya, A., & Shrestha, B. (2020). Nutritional status and the associated factors among people living with HIV: an evidence from cross-sectional survey in hospital based antiretroviral therapy site in Kathmandu Nepal. *BMC Nutrition*, 22-23.

Khatri, S., Amatya, A., & Shrestha, B. (2020). Nutritional status and the associated factors among people living with HIV: an evidence from cross-sectional survey in hospital based antiretroviral therapy site in Kathmandu. *Nepal. BMC Nutr, 6*(12), 1-19.

Mahlangu, K., Modjadji, P., & Madiba, S. (2020). The Nutritional Status of Adult Antiretroviral Therapy Recipients with a Recent HIV Diagnosis; A Cross-Sectional Study in Primary Health Facilities in Gauteng, South Africa. *Healthcare (Basel)*, 22-40.

Mewuba, S., Telake, A., Atinkut, A., & Dawit, J. (2018). Assessment of nutritional status and its associated factors among people affected by human immune deficiency virus on antiretroviral therapy: A cross sectional study in Siltie zone, South Ethiopia. *Healthcare in Low-resource Settings* , 25-32.

Miranda, G. L., Ignacio, A., Lopes, A. C., & Lima, C. F. (2022). Changes in the nutritional status of elderly patients with HIV diagnosis undergoing antiretroviral treatment. *Brazilian Journal of Health and Biomedical Sciences*, 85-100.

Mugenda, O., & Mugenda, A. (2003). *Research Methods: Qualitative and Quantitative Approaches.* Kenya: Acts Press, Nairobi.

Regina Saka, E. A., Domfeh, F. E., Hayford, A., Matilda Asante, A. G., Amoah, G. A., Asare, E. K., et al. (2023). Nutritional status and effect of highly active anti-retroviral therapy (HAART) on selected trace elements in people living with HIV in Ghana,. *Scientific African*, 50-62.

Sakthivel, R., & Rajendran, S. S. (2022). The effect of nurse initiated nutritional counselling with hatha yoga on nutritional status of HIV infected adolescents: Randomized controlled trial. . *Journal of Nursing and Midwifery Sciences*, 180-190.

Siritientong, T. (2022). Deterioration of Nutritional Status and Its Negative Association with Depression Among Older HIV-Infected Asian Population: A Four-Year Longitudinal Study. *AIDS Research and Human Retroviruses*, 592–600.

WHO. (1995). *Global Health Observatory (GHO) data repository. Body mass index (BMI).* Geneva: WHO, (http://apps.who.int/gho/data/node.main.BMIANTHROPOMETRY?lang=en)