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The Interplay Between Socio-demographic Variables, Nutritional and Immune Status of HIV-positive/AIDS Patients

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Abstract: This study examined the association between socio-demographic factors (educational level and employment status) and the nutritional and immune status of 35 HIV-positive/AIDS patients at baseline. Assessment of selected macro-and micronutrient dietary intake was done using a validated food frequency questionnaire. Evaluation of anthropometric profiles (body mass index, waist-hip ratio and percentage of body fat) was also evaluated. A questionnaire was applied to obtain information on the educational level and employment status of the patients. The $CD4^{+}$T-cell counts and viral loads of the same patients were determined using the flow cytometry and Polymerase Chain Reaction (PCR) method respectively. An association between educational level and dietary intake was significant ($p<0.05$) for total dietary fibre, selenium and vitamin C. There was no significant ($p>0.05$) association between the two socio-demographic variables (education and employment) and anthropometric profiles. The association between education, employment and $CD4^{+}$T-cell count was not significant ($p>0.05$). The viral load showed a significant ($p<0.05$) association with employment status but not correlated with education. The sample size or certain inherent biological and social factors probably affected the outcomes of the interplay between the two selected socio-demographic factors and the nutritional and immune status. It is suggested that the results of this study should be interpreted with caution. Further studies with larger sample sizes are recommended.

Key words: Interplay, socio-demographic variables, nutritional status, immune status, HIV/AIDS

INTRODUCTION

Infection with Human Immunodeficiency Virus (HIV) can be divided roughly into three phases: acute infection, the chronic phase and the final phase characterised by collapse of the immune system and opportunistic infections (Baltimore and Feinberg, 1989). Although half of the infected persons develop AIDS within 10 years of infection, there is a considerable degree of variability in the rate at which individuals progress through these phases. Little is known about the factors that interact to influence the rate of progression for individual persons (Munoz *et al*., 1989; Hessol *et al*., 1989). A link between lower socio-economic factors and higher rates of morbidity and mortality is becoming apparent for several diseases including HIV/AIDS. Even when cause-specific mortality rates have fallen, the disparity in mortality rates among social classes has widened (Wilkinson, 1992; Wilkinson and Moore, 1996; Wilkinson and Davies, 1997; Villamor *et al*., 2002). HIV infection and AIDS are leading causes of premature mortality and the relationship between indicators of low socio-economic status and HIV-associated mortality is of growing concern (Ahmed *et al*., 1998; Hogg *et al*., 1994). Class differences have become important in determining the outcome of HIV infection as the HIV/AIDS epidemic shifts towards the more socially and economically disadvantaged population, especially in developing countries (Hogg *et al*., 1994; Schechter *et al*., 1994). It has been shown that low social status is a consequence of a more rapid HIV disease progression, rather than a predisposing factor. For instance, with HIV infection, infected men and women are significantly less likely to remain fully employed than are sero-negative men and women, or to maintain their pre-HIV infection income over the course of infection (Kass *et al*., 1994). It may be that men and women whose HIV infection progresses most rapidly may also experience the sharpest decline in income; this would give rise to an association between lower socio-economic status and more rapid HIV morbidity (Kass *et al*., 1994).

The interaction between nutrition, infection and immune function has been well documented

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(Kennedy *et al*., 1996; Madebo *et al*., 1997; Waibale *et al*., 1999). The relationship between HIV and nutrition was observed to be more complicated than the relationship between nutrition and other infectious diseases, because the virus directly attacks and destroys the cells of the immune system (Young, 1997). In HIV/AIDS persons, malnutrition strongly predicts patient survival (Cimoch, 1997). Nutrients are known to influence immune function directly via processes such as protein synthesis, or indirectly via their roles in various enzyme syntheses and function. When macro- (total energy, carbohydrate, protein and fat) and micronutrient (minerals and vitamins) intake are insufficient to meet metabolic needs, protein calorie malnutrition and deficiencies of micronutrients develop. These deficiencies impair the synthesis of molecules necessary for the immune response. The nutritional status of individuals may also be a mediator between socio-economic status and HIV-associated outcomes since it can affect the immune function (Cimoch, 1997; Chandra, 1997). In populations in which malnutrition is highly prevalent, poor socio-economic background is a strong predictor of weight loss and other nutritional complications (Achadi *et al*., 1995; Ahmed *et al*., 1998; Jackson, 1990).

Studies on the relationship between socio-demographic factors, nutritional status and the immune status of HIV-infected persons in a setting where HIV infection poses new challenges to the nutritional status of the population, have been very scarce, for instance in South Africa, hence the aim of this study to examine socio-demographic variables as correlates of nutritional and immune status in HIV-positive/AIDS patients.

MATERIALS AND METHODS

This study involved a clinical trial consisting of 35 HIV-positive/AIDS patients. Validated questionnaires were used to determine the socio-demographic profile and food consumption patterns. The study also involved measurements of the anthropometric indices of the patients. Baseline $CD4^{+}$T-cell counts and viral loads were determined by flow cytometry and polymerase chain reaction (PCR) (Wilson, 1990), respectively.

An approval from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ETOVS 32/03) was obtained. The patients signed the consent form after they had been informed the purpose and detail of the study. The inclusion criteria included male and female patients between 18 and 65 years of age that were HIV positive; willing to undergo a pre-study physical examination; were not anti-retroviral therapy, had a $CD4^{+}$T-cell count of 100-350 cells mm^{-3}; able to comprehend and willing to sign the statement of informed consent.

Administration of questionnaires: Medi Inn clinic and Tsepo home-based care were chosen as centres for the study. The patients at Tsepo home-based care were seen at the home-care centre while patients from the South African Red Cross home-based care, Bloemfontein, were transported to Medi Inn clinic where they were examined.

Socio-demographic details such as age, gender and residential address were obtained from each patient with the aid of questionnaire. Information concerning financial and employment status, level of education, marital status, type of house, monthly income, amount spent weekly or monthly on food, available cooking utensils, smoking habit, number of children (live or dead) and number of persons living in the house were obtained and recorded. Where respondents could not speak English, interpreters were used in completing the questionnaires.

Dietary intake: This was assessed by the use of a food frequency questionnaire. At baseline, a validated food frequency questionnaire (adapted from the Transition and Health During Urbanisation of South Africans (THUSA) study 2002 (Potchefstroom University) was used to determine the habitual types and quantities of food and drink consumed by respondents over the six months prior to data collection and to determine the habitual intakes of total energy, macronutrients and micronutrients. Both traditional and western foods were included in the food frequency questionnaire. A food frequency questionnaire was chosen to determine the dietary intake because it is believed to be a suitable method for use in describing the intake of groups rather than for individuals (Dwyer, 1998) and is commonly used in epidemiological studies to determine the relationships between diet and disease (Willett, 1990; Paton *et al*., 1996). It also provides an overall picture of food intake which was found to be relatively cheaper and more representative of the usual food intake than a few days of diet records (Hammond, 2004).

Food models were used to assist with the accuracy of the size of food portions described by the respondents. Each respondent was asked to demonstrate the quantity of a given food that he/she consumed on a daily, weekly or monthly basis via an interview. The food frequency questionnaire was completed by the research scientist and four members of the research team.

The portion sizes were estimated using household measures and converted to grams using the conversion figures in the Medical Research Council (MRC) of South African Food Quantities Manual (Langenhoven *et al*., 1998). The quantities of food consumed on a daily basis were entered accordingly. The quantities of foodstuffs not selected by the respondents per day were calculated as food in grams consumed per week divided by 7 days, or food in grams consumed per month divided by 30 days. The recorded food items were coded by means of food composition tables of the MRC. Complex dishes not appearing in the food composition tables were broken down into individual ingredients and weights and coded as such. The dietary data were analysed by means of a computer software programme applying MRC food composition tables. The energy intake was compared with the estimated energy requirement. Macro-and micronutrient intakes were compared with the Recommended Daily Allowances (RDA) or Adequate Intake (AI) (USA Food and Nutrition Board, 2001) A value of <67% of the RDA/AI was considered to be inadequate (USA Food and Nutrition Board, 2001).

Anthropometric measurements: The following anthropometric indices were determined and included Body Mass Index (BMI) calculated from body weight and height in metres squared; Waist-Hip Ratio (WHR) calculated from waist circumference and hip circumference and skinfold thickness to estimate percentage body fat. All anthropometric measurements were done according to standard procedures (Lee and Nieman, 1996; Laquatra, 2004).

Laboratory investigation: The $CD4^{+}$/$CD8^{+}$T-cell counts were measured using a principal method called flow cytometry in which blood cells passed through a specially designed flow chambers and the physical characteristics of the cells measured with laser technology. The four-colour direct immunofluorescence technique with a suitably equipped flow cytometer for $CD3^{+}$, $CD4^{+}$ and $CD8^{+}$T-cell counts supplied by Becton Dickinson (BD Ltd, South Africa) was used for this study. The Multi TEST programme on the FACSC Calibur flow cytometer automatically gates the lymphocyte population from a CD45 against side scatter display (Jackson, 1990). The Amplicor HIV-1 Monitor Test, version 1.5 (v 1.5) was used for the quantitation of HIV RNA in this study (Roche Diagnostic Systems, Inc, USA).

Statistical analysis: The continuous variables were described by using median and standard deviation while categorical variables were described by frequencies and percentage. The statistical significance for the study was put at $p<0.05$.

RESULTS

The median age of the study population was 34±7.5 years. Eight of the 35 patients who completed the questionnaires were male (22.9%) while 27 (77.1%) were female. The high percentage of females reported here probably represented the demographic distribution of HIV-infection prevalence in this region. Nineteen (54.3%) of the study population were unmarried, 5 (14.3%) married, while 1 (2.9%) was divorced and 10 (28.6%) were widowed. In terms of room density, the median value was 2 persons per room. Nine (25.7%) of the population did smoke cigarette or related substances with a median of 2 cigarettes per day per person. For the statistical analyses of the results, only two of the socio-demographic variables (education level and employment status) were considered because of the direct relevance of these two variables to dietary intake and indirect link to immune status/function. The educational level was categorised into two groups: none/primary education and secondary/tertiary education. The employment status was likewise divided into two groups: unemployed and employed.

The Table 1 also shows the frequencies and percentages of patients with an intake of less than 67% or greater than 67% of RDA/AI for the corresponding nutrient. The results show that there is an association between energy intake, educational level and employment status, but the association was statistically insignificant ($p>0.05$). An association between the socio-demographic factors and macronutrients was observed as well, but such an association was only significant between educational level and total dietary fibre ($p<0.05$).

Table 1: The relationship between socio-demographic factors (educational level, employment status), energy intake and selected macronutrient intakes of HIV-positive/AIDS patients

Socio-demographic	Energy intake		Total protein		Total carbohydrate		Total fibre**	
factors	<67%	>67%	<67%	>67%	<67%	>67%	<67%	>67%
None/primary education (n = 9)	2 (22.2)	7 (77.8)	1 (11.1)	8 (88.9)	1 (11.1)	8 (88.9)	4 (44.4)	5 (55.6)
Secondary/tertiary education** (n = 26)	1 (3.8)	25 (96.2)	0 (0)	26 (100)	0 (0)	26 (100)	1 (3.9)	25** (96.2)
Unemployment (n = 30)	3 (10)	27 (90)	1 (3.3)	29 (96.7)	1 (3.3)	29 (96.7)	5 (16.7)	25 (83.3)
Employment (n = 5)	0 (0)	5 (100)	0 (0)	5 (100)	0 (0)	5 (100)	0 (0)	5 (100)

** $p<0.05$, others not significant $p>0.05$. Values in parenthesis show percentage

Table 2: The relationship between socio-demographic factors (educational level, employment status) and micronutrient intakes of HIV-positive/AIDS patients

Socio-demographic factors	Zinc		Selenium**		Vitamin A		Vitamin E	
	<67%	>67%	<67%	>67%	<67%	>67%	<67%	>67%
None/Primary Education (n = 9)	1 (11.1)	8 (88.9)	7 (77.8)	2 (22.2)	2 (22.2)	7 (77.8)	2 (22.2)	7 (77.8)
Secondary/Tertiary Education (n = 26)**	1 (3.9)	25 (96.1)	7** (26.9)	19 (73.1)	3 (11.5)	23 (88.5)	2 (7.7)	24 (92.3)
Unemployment (n = 30)	2 (6.7)	28 (93.3)	13 (43.3)	17 (56.7)	5 (16.7)	25 (83.3)	4 (13.3)	26 (86.7)
Employment (n = 5)	0 (0)	5 (100)	1 (20)	4 (80)	0 (0)	5 (100)	0 (0)	5 (100)

Table 2: Continued

Socio-demographic factors	Vitamin C**		Vitamin B_6		Vitamin B_{12}		Thiamine	
	<67%	>67%	<67%	>67%	<67%	>67%	<67%	>67%
None/Primary Education (n = 9)	4 (44.4)	5 (55.6)	1 (11.1)	8 (88.9)	0 (0)	9 (100)	1 (11.1)	8 (88.9)
Secondary/Tertiary Education (n=26)**	2 (7.7)	24** (92.3)	1 (3.9)	25 (96.1)	0 (0)	26 (100)	1 (3.9)	25 (96.1)
Unemployment (n=30)	6 (20)	24 (80)	2 (6.7)	28 (93.3)	0 (0)	30 (100)	2 (6.7)	28 (93.3)
Employment (n=5)	0 (0)	5 (100)	0 (0)	5 (100)	0 (0)	5 (100)	0 (0)	5 (100)

**p<0.01 for selenium. **p<0.02 for vitamin C, others not significant p>0.05. Within each variable, numbers on the row represent frequencies while values in parenthesis represent percentages

Table 3: The relationship between socio-demographic factors (education, employment) and anthropometric profiles of HIV-positive/AIDS patients.

Socio-demographic Factors	BMI			WHR		Fat (%)	
	<18.5	>18.5	25-29	<0.88	>0.88	<20	20 ≤ 25
None/Primary Education (n = 9)	1 (11.1)	7 (77.8)	1 (11.1)	4 (44.4)	5 (55.6)	9 (100)	0 (0)
Secondary/Tertiary Education (n = 26)	7 (26.9)	17 (65.8)	2 (7.7)	16 (61.5)	10 (38.5)	23 (92)	2 (8)
Unemployment (n = 30)	7 (23.3)	20 (66.7)	3 (10)	15 (50)	15 (50)	27 (93.1)	2 (6.9)
Employment (n = 5)	1 (20)	4 (80)	0 (0)	5 (100)	0 (0)	5 (100)	0 (0)

The association was not significant for all the parameters p>0.05

Table 4: The relationship between socio-demographic factors (educational level, employment status), $CD4^+$T-cell count and Viral Load

Socio-demographic factors	$CD4^+$T-cell count			Viral load*		
	<200	>200	≤200 000	200000-400000	600000	800000
None/Primary Education (n = 9)	4 (44.4)	5 (55.6)	2 (22.2)	1 (11.1)	1 (11.1)	5 (55.6)
Secondary/Tertiary Education (n=26)	14 (53.8)	12 (46.2)	12 (46.2)	3 (11.5)	2 (7.7)	9 (34.6)
Unemployment (n=30)	17 (56.7)	13 (43.3)	10 (33.3)	5 (16.7)	2 (6.7)	13 (43.3)
Employment* (n=5)	3 (60)	2 (40)	3* (60)	0 (0)	2 (40)	0 (0)

*The association was significant between viral and employment status, p<0.05)

An observation of the results shows (Table 2) an association between the socio-demographic factors and dietary intake but this was insignificant (p>0.05) except for selenium (p<0.01) and vitamin C (p<0.02) that demonstrated an association with the level of education (Table 2).

Also there was no significant association between the socio-demographic factors and the anthropometric factors (Table 3).

The results showed a significant (<0.05) relationship between employment status and viral load (Table 4).

DISCUSSION

In the present study, the association between socio-demographic variables (educational level and employment status) and the nutritional and immune status was examined. In the studied population, observation tended to show the association between level of education, energy and dietary intakes (macro-and micronutrients) as being higher in patients with a higher level of education. However, the association was only significant for total dietary fibre, selenium and vitamin C.

HIV infection is a significant factor regarding nutritional complications and immune dysfunction, particularly in people of low socio-economic status (Cimoch, 1997). According to Villamor *et al.* ((2002), socio-demographic factors correlated with nutritional and immune status. In populations where malnutrition is prevalent, a poor socio-demographic background is a strong predictor of nutritional status (poor nutritional status) and indirectly so for immune status (poor/weak immune status) (Ahmed *et al.*, 1998).

It is commonly agreed that HIV/AIDS has contributed to the range of problems faced by households in Southern Africa. It is however, not yet clear the extent of such contribution and how it varies with the demographic/socio-demographic structure. It has been shown that these households suffer from low-income generation (Food Economy Group, 2002; Laquatra, 2004).

In addition, there seems to be an association between employment status, energy and dietary intake being higher in the employed group than in the unemployed group (that is more patients fell into the unemployed category and consumed less food). However, the association was not significant.

This study also observed a significant association between employment status and viral load. However, no significant association was noticed between socio-demographic variables, $CD4^{+}$T-cell count and anthropometric profiles, probably because of the small sample size. Additional studies may be needed to demonstrate if a significant relationship exists between socio-demographic variables and anthropometric profiles in people living with HIV/AIDS.

Results of this study indicated a significant correlation between the demographic (level of education and employment status) factors and the viral load. It is believed that education influences the choice and quality of diet (Baqui *et al*., 1994). According to Baqui *et al.* (1994), HIV-infected individuals with a higher level of education and who are employed consume more food and appear healthier than those HIV-infected individuals with a low level of education and without employment. In addition, education could affect the choice of health facilities and frequency of visit by the patient since the patient has access to information on the availability of health services in a particular location. In line with the findings of Islam *et al.* (1994) a higher educational level could potentially be related to improved nutrition and, in turn, improved immune function through mechanisms such as enhanced hygienic practices; better knowledge about food and food preparation; earlier identification and treatment of infections and better management of household resources. A significant association between education and immune status was not observed in this study. The association observed between educational level and dietary intake is similar to that reported by Baqui *et al.* (1994) and Villamor *et al.* (2002).

The result of this study demonstrated a significant association between employment status and viral load in which employed patients show lower viral load than do unemployed. Unemployment is known to limit the purchasing power of individuals including those living with HIV/AIDS, thus contributing to poor nutrition. The relationship between poor nutrition and immune dysfunction is well established. Unemployment contributes to poverty which in turn affects good nutrition and subsequently impaired immune function. Treatment of opportunistic infections common in HIV-infected persons may be hampered if patients cannot afford the transportation fare to health facilities, especially when these health facilities are not within reach or pay the medical fees where health services delivery is not free. The continual presence of opportunistic infections because of lack of treatment will affect dietary intake due to oral pathology, malabsorption (resulting from gastrointestinal infection) with negative effect on the immune function.

Poverty-ridden households affected by HIV/AIDS are forced to resort to a number of negative coping mechanisms, which may ameliorate the immediate problem, but can ultimately undermine long-term nutritional status and the family's ability to remain food secure. Furthermore, chronic ill-health resulting from HIV/AIDS and the eventual death of productive adults can lead households to divert their assets and savings while earning less; increase malnutrition among members of the household and cause declines in agricultural production and productivity with subsequent negative effects on nutritional status and general well-being (World Food Programme, 2003; Oguntibeju *et al*., 2005).

The observation from this study is supported by findings that HIV-positive/AIDS persons with a low socio-economic status resulting from unemployment, poverty and low educational level experienced higher rates of mortality, in consequence of poor nutrition and immune dysfunction.

Limitations of the study: This study was limited by a number of factors. Firstly, the cross-sectional nature limits the possibility of establishing a reasonable degree of association between socio-demographic variables and nutritional and immune status. Secondly, single measurement was used for socio-demographic variables and dietary intake obtained at baseline and this may have introduced some misclassification in relation with the association.

CONCLUSION

The results of this study support the view that improved education and employment among HIV-positive/AIDS patients could be related to improvements in their nutritional status and, in turn could positively affect the immune function.

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