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MICRONUTRIENT ZINC DEFICIENCY AS A POSSIBLE CO-FACTOR IN THE TRANSMISSION AND PROGRESSION OF HIV/AIDS IN KENYA

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ABSTRACT

Thirty-four HIV/AIDS patients at various stages of disease progression volunteered to manage their health using a nutritional supplement that contained several micronutrients that included a 15 mg daily dose of elemental zinc. This initial publication only focuses on trends in the serum zinc levels and the observed biochemical changes following intervention, considering the critical role this trace element plays in human immunity. At baseline and after 30 months of follow-up, the patients' serum zinc levels were determined as was their clinical status. Four women who were found to be HIV negative at baseline and who had lost their husbands to HIV/AIDS, yet they had regularly had un-protected sex with them, had a mean serum zinc level of 116.2 ± 32.7 mcg/100 ml. The serum zinc levels of asymptomatic, moderately symptomatic and severely symptomatic HIV/AIDS patients in the cohort reduced from baseline to post intervention levels of 92.5±12.1 to 78.0 ± 8.2 mcg/100 ml (P = 0.056); 81.9± 17.6 to 73.2 ± 12.2 mcg/100 ml (P = 0.267) and 72.7± 8.0 to 66.8 ± 14.3 mcg/100 ml (P = 0.022), respectively, all being far below the mean serum zinc level of 120.0 ± 22.0 mcg/100 ml reported in normal control subjects in Western literature. For all patients combined, the serum zinc levels fell from 79.2 ± 14.5 to 71.0 ± 13.0 mcg/100 ml (P= 0.016) notwithstanding that the patients had used zinc supplements at recommended daily allowances (RDA) over a period of 30 months. Notably, micronutrient zinc sufficiency plays a key role in promoting cell-mediated immunity and it is probably partly due to this reason that the high-risk women in this study, who also had comparably high serum zinc levels, remained negative for HIV antibodies despite repeated exposure to the virus. Thus, from this preliminary data that shows HIV/AIDS patients to be deficient in zinc in a manner consistent with their status of disease progression and considering that this trace element is recognized to possess antiviral and antibacterial properties, it is now apparently evident that zinc supplementation may play a key role in the fight against HIV/AIDS not only in Kenya but also in other African countries where this disease has reached epidemic proportions against a background of rampant malnutrition.

Keywords: Micronutrient zinc, underutilized arsenal, combating, HIV/AIDS, Sub-Saharan Africa

FRENCH

DEFICIENCE EN MICRONUTRIMENTS DE ZINC EN TANT QUE CO-FACTEUR POTENTIEL DE TRANSMISSION ET DE PROPAGATION DU VIH/SIDA AU KENYA

NOTE DE SYNTHESE

Trente-quatre patients du VIH/SIDA se trouvant à divers stades de progression de la maladie ont accepté de prendre en charge leur santé en utilisant un supplément alimentaire contenant plusieurs micro-substances nutritives dont 15 mg de dose quotidienne de zinc élémentaire. Ces

informations initiales se portent seulement sur les tendances dans les niveaux de sérum de zinc et les changements biochimiques observés à la suite de l'intervention, étant donné le rôle critique que jouent ces oligo-éléments dans l'immunité humaine. A la situation de départ et après 30 mois de suivi, des tests ont été faits pour faire état des niveaux de sérum de zinc ainsi que de l'état clinique des patients. Quatre femmes qui au départ ont un statut sérologique négatif par rapport au VIH et qui ont perdu leurs maris au VIH/SIDA, mais qui ont toutefois eu régulièrement des rapports sexuels non-protégés avec ces derniers, ont présenté un niveau de sérum de zinc moyen de 116,2 + 32,7 mcg/100 ml. Les niveaux de sérum de zinc chez la cohorte de malades asymptomatiques, modérément symptomatiques et sévèrement symptomatiques du VIH/SIDA ont diminué de la situation de base jusqu'après les interventions de respectivement 92,5+12,1 à 78,0 + 8,2 mcg/100 ml (P = 0,056); 81,9 + 17,6 à 73,2 + 12,2 mcg/100ml (P=0,267) et 72,7 + 8,0 à 66,8 + 14,3 mcg/100ml (P=0,022). Tous ces niveaux sont de loin inférieurs au niveau moyen de sérum de zinc de 120,0 + 22,0 mcg/100ml de l'échantillon témoin des sujets annoncés dans la littérature Occidentale. Pour l'ensemble des malades, les niveaux de sérum de zinc ont chuté de 79,2 + 14,5 à 71,0 + 13,0 mcg/100 ml (P=0,016) bien que les malades aient pris pendant 30 mois la dose journalière recommandée de suppléments de zinc. La quantité suffisante de micro-nutriments de zinc joue un rôle essentiel dans la promotion de l'immunité catalysée par la cellule. C'est probablement à cause en partie de cette raison que les femmes à haut risque de cette étude, qui ont également des niveaux comparativement élevés de sérum de zinc, sont restées séronégatives aux anticorps VIH, malgré le contact répété avec le virus. Ainsi, si l'on considère ces données préliminaires qui montrent des patients de VIH/SIDA, déficients en zinc d'une manière que l'on peut associer à leur statut par rapport à la progression de la maladie et si l'on considère aussi que cet oligo-élément est reconnu pour ses propriétés antivirales et antibactériennes, il est maintenant évident que le supplément de zinc peut jouer un rôle important dans la lutte contre le VIH/SIDA non seulement au Kenya, mais aussi dans d'autres pays africains où cette maladie a atteint des dimensions épidémiques dans un contexte de sous-alimentation généralisée.

Mots-clés: Micronutriment de zinc; arsenal sous-exploité; lutte; VIH/SIDA; Afrique subsaharienne

INTRODUCTION

Of the over 40 million people infected with HIV/AIDS globally, 70% are from Sub-Saharan Africa, posing great health and socio-economic challenges. Despite development of HIV/AIDS guidelines by UN agencies, this disease has subjected humanity to all forms of stigmatization and suffering as people are denied access to basic human rights such as employment, international travel, medicare, education and insurance purely on the basis of their HIV status and anticipated loss of work productivity. Considering that majority of people living with HIV/AIDS are in the developing countries, it is unfortunate that it is also in these countries where there is the fewest interventions [1].

While it should be recognized that various co-factors are known to influence the rate at which HIV progresses to AIDS, nutrition is one of the most important, especially micronutrients that have antioxidant properties. In fact, as early as 1989, it was documented that micronutrient zinc possessed anti-viral, anti-bacterial and anti-cancer properties and that zinc deficiency symptoms were similar to those of HIV/AIDS patients [2]. This led some workers to suggest that unless the role of the micronutrient zinc and other nutrients with which it worked in concert was mainstreamed into biomedical research and clinical practice, a solution to the HIV/AIDS problem could remain extremely elusive for many years to come, especially in Sub-Saharan Africa [3]. Despite these observations, it was not until January 2000 that it was possible to conduct a pilot study to evaluate the possible role of zinc and other nutrients with enhanced antioxidant properties in the possible transmission, progression and management of this disease in the Kenyan population.

Considering that many people in Kenya and in other parts of Sub-Saharan Africa continue to become infected with HIV/AIDS and that very few patients have access to antiretroviral (ARVs) drugs and that drug resistance and adverse health effects are recognized drawbacks, there is need to explore alternative and less toxic management options with a view to developing home-grown solutions that are affordable, effective and user friendly. Emerging data from observational and epidemiological studies do suggest that nutrition either used alone or in combination with ARVs could hold a key to the realization of better quality of life for HIV/AIDS patients in the developing countries.

In the circumstances, there is increasing evidence that vitamin and mineral deficiencies may play an important role in HIV transmission and progression for a number of reasons. Notably, HIV-patients are under oxidative stress from the infection and loss of CD4 counts while a number of micronutrients are required for fighting infection [4-7]. Also, a number of HIV-associated clinical conditions decrease appetite while other conditions increase demand for nutrition [8-10].

There are studies that have reported an association between low micronutrient level and faster HIV-disease progression. While low serum or plasma vitamin A level has been described as a risk factor for mortality during HIV-infection, high intakes of micronutrients has been associated with reduced progression to AIDS and improved survival [11-14]. Other studies have shown normalization of plasma levels of zinc and selenium to be associated with decreased progression and HIV/AIDS related mortality [15-17]. In a controlled study of HIV/AIDS patients, the average viral load was approximately 1.0 log copies/ml lower in the group of patients receiving vitamin supplements. This compares favourably with the reduction in viral load obtained when using a single ARV for 12 weeks [18,19].

In view of the foregoing, it was found justifiable to conduct an assessment on some nutritional formulations in the management of HIV/AIDS patients in Kenya, starting with a special multi-micronutrient product (VIUSID) with enhanced anti-oxidant properties and which had been piloted elsewhere and demonstrated to have some potential benefits. Thus, this paper focuses on the association between serum zinc levels and biochemical trends observed in HIV/AIDS patients on a 30 months nutritional supplementation program with VIUSID. The study was

undertaken in Kenya between January 2000 and September 2002. MATERIALS AND METHODS this was an open-labelled prospective study of 34 HIV/AIDS patients at various stages of disease progression. The aim of the study was to clinically and biochemically evaluate the benefits of managing HIV/AIDS patients using a nutritional preparation (VIUSID) whose daily dosage complied with United States Recommended Daily Allowances (RDA) for most of the ingredients. It contained malic acid (2.0 g), arginine (2.0 g, 100% RDA), glucosamine (2.0 g), glycine (1.0 g), cynacobalamin (0.1 mcg, 50% RDA) pyridoxal (1 mcg, 82% RDA), calcium pantothenate (6 mg, 86% RDA), vitamin C (0.06 g, 100% RDA), folic acid (200 mcg, 50% RDA), glycirrhizinic acid (0.1 g), zinc (15 mg, 100% RDA) with honey, lemon, mint and sodium methylparaben as excipients. The observations of this study were undertaken following the development of a research protocol that was subjected to the normal scientific and ethical clearance procedures of the Kenya Medical Research Institute (KEMRI) that approved its commencement in January 2000. Going by the Central Limit Theorem underlying the normal distribution in statistics, a sample size of 30 patients and above was considered adequate for an open-labelled study intended to generate empirical data on a pilot scale that would be useful in guiding the design of more elaborate controlled micronutrient interventions with a special focus on the role of micronutrient zinc in the management of HIV/AIDS patients in Sub-Saharan Africa. The study was located in the outskirts of the City of Nairobi at The Association of People Living with AIDS in Kenya (TAWAK). Consenting HIV positive persons were recruited into the study, having been guided through study objectives and benefits and consent seeking protocols whereby they signed an informed consent form. The inclusion criteria were that a person was HIV-1 infected and aged 18-50 years and living in proximal reaches of the study area. Patients using antiretroviral drugs and those using other nutritional supplements were excluded from participation as were patients with kidney and liver dysfunction. The project clinicians screened and enrolled patients who met the inclusion criteria. The patients were examined and their bio data and clinical review data obtained on specified patients' forms. At baseline and at 30 months post intervention, blood (20 ml) was obtained from the patients and immediately dispatched to relevant KEMRI laboratories for various analyses.

A daily dose of the supplement was distributed into 3 sachets, each taken in a glass of water every 8 hours. To promote compliance, patients were educated on the importance of uninterrupted use of the supplements provided. Sharing of products within or without the patients in the study was discouraged. To additionally tighten on compliance, patients were asked to return used containers of the supplements for replenishment. Every two-weeks, patients were clinically examined and details of HIV-associated opportunistic infections recorded. Diagnosis followed the CDC criteria of 1993 for staging HIV-AIDS patients at every clinical examination conducted [22]. In this criteria, Category A patients were asymptomatic, Category B were moderately symptomatic, while Category C were severely symptomatic. Treatment of any conditions requiring clinical management was also undertaken.

Baseline and post-intervention blood samples were analyzed in KEMRI laboratories under strict observance of traditionally established Good Laboratory practices. The specific tests undertaken were as briefly described below:

i) HIV status & HIV-1 RNA viral load tests: 5 ml blood was collected in EDTA vacutainers and delivered to KEMRI for analysis. Both rapid and Eliza tests were performed for confirmation of the patients' HIV status and the viral load determined using BDNA kits.

ii) CD4 &8 counts and CD4/8 ratios: 2 ml blood was collected in EDTA vacutainers and stored at room temperature and delivered to KEMRI where they were analysed using Cytometer (Facscalibur supplied by Becton & Dickson).

iii) Serum zinc: 5 ml of blood was collected in acid washed vacutainers covered in aluminium foil. The serum zinc levels were determined using Flame Atomic Absorption Spectrometer (FAAS).

iv) Kidney/Liver Function Tests: 5 ml of blood was collected in a non-additive vacutainer and delivered to the KEMRI laboratories for analysis. The tests were undertaken using the Sigma Kits in a 410 Photometer and a Hitachi or Corning Flame Photometer.

Data coding, entry and analysis was undertaken at the Centre for Public Health Research (CPHR, KEMRI). The SPSS/PC+ Vers. 7.5 programme was used for analysis. Variables that did not conform to normality such as viral load were transformed using log10 (x+1) transform. To test for continuous variables such as serum zinc between baseline and 30 months post-intervention, paired t-tests were used.

In this paper, we provide a general description of the bio data of the patients and give a comparison of the means of some of the biochemical data obtained at baseline and after 30 months of supplementation with levels of significance provided, focusing on serum zinc levels and its association with specific disease management outcomes. In Table 2, we have grouped the patients into those who showed significant viral load reduction (log10 viral load copies/ml reduction >0.5) at 30 months of follow-up and those with insignificant changes to be able to draw some insights on attendant changes in their serum zinc levels at baseline and after 30 months of follow-up.

RESULTS

The study population of 34 patients was evenly distributed across the age bracket of 18-51 years, with females constituting 73% of the cohort. By marital status, 50% of the patients were married while widows and widowers constituted 20% of the cohort. Seventy percent of the cohort had been either to secondary or college while the rest were either illiterate or of primary education. In terms of awareness of HIV status, 60% had known of their infection in the last four years while 40% had known of their HIV status for the last 5-12 years. Majority of the women had come to know of their HIV status from the routine check-ups at antenatal clinics while few had been diagnosed while seeking employment, insurance or because of poor health. Majority of the clients (52%) were employed in the informal sector, as 40% worked for Non-Governmental Organizations (NGOs) especially as HIV/AIDS counsellors, while 19% were jobless and the rest were employed in Government Departments.

Despite being counselled appropriately, majority of the study patients continued in their unprotected sexual relationships with their spouses or friends who were not in the study. Some women said that despite informing their husbands or friends that they were HIV positive and that they should use condoms, some men were against this; opting otherwise, supposedly for greater sexual satisfaction. In some cases, the patients did not disclose their HIV status for fear that they could be divorced. A case in mind is one male patient who got divorced by his HIV negative wife when she learned about his status.

By the guidelines of the Centre for Disease Control (CDC) classification of HIV/AIDS patients of 1993, 4(11%) of the subjects were found to be HIV negative at baseline, 4 (11%) were in stage A (asymptomatic), 13 (33%) were in stage B (moderately symptomatic) while 17 (45%) were in stage C (severely symptomatic) (Table 1). The four persons who were HIV negative were women whose husbands had died of AIDS and were subsequently weaned from the study. Their mean serum zinc level of 116.2 +_ 32.7 mcg/100 ml (Range = 95.0-164.8) was found to be generally higher than that of the HIV/AIDS patients. The stage A, B and C patients had baseline mean serum zinc levels of 92.5 + 12.1 mcg/100 ml (Range = 78.4 - 107.9); 81.9 + 17.6 mcg/100 mls (Range = 59.6 - 106.6) and 72.0+ 8.0 mcg/100 ml (Range = 48.3 - 109.4), respectively.

Although 80% of the patients had clinically improved from their opportunistic infections, experienced improvements in appetite and felt much better within three months of supplementation, it was remarkable that half the patients reduced their viral load by 50% after 24 months of this supplementation alone. However, it was notable that patients who substantially reduced their viral loads to undetectable (n = 6) levels had a mean serum zinc level of 111.0+ 17.1 mcg/100 ml (Range = 92.5- 130.6) after 24 months of follow-up. Also, their acquired immunity as measured by the optical density (O.D) of HIV anti-bodies increased substantially after supplementation, indicating a stimulation of their humoral immune responses.

From these findings, it was evident that persons immune to HIV had serum zinc levels as high as 165 mcg/100 ml while patients in the terminal stage of this disease, who at baseline were diagnosed with many opportunistic infections such as TB, pneumonia, fungal and other bacterial infections, had as low as 48 mcg/100 ml of serum zinc. While these preliminary results allude to a severe zinc deficiency problem amongst AIDS patients in Kenya, studies conducted elsewhere have found this micronutrient to be a critical co-factor in the maturation of T-lymphocytes and in the efficient functioning of the immune system [2].

A comparison of the mean serum zinc levels at baseline and 30 months is presented in relation to specific biomarkers of progression of the HIV disease as well as outcomes of management of 29 patients as 5 had succumbed to the disease during the follow-up (Table 2). Of the five patients who died during the 30 months follow-up, four were class C patients and one a class B patient at baseline, the deaths often being due to respiratory complications with pneumonia as the main killer. Apparently, fatalities were largely noted in patients with poor compliance in product intake. Patients with CD4< 500 counts/microlitre at baseline had lower serum zinc levels than those with higher counts. Similarly, lower CD8 counts at baseline were associated with lower

serum zinc levels, this being consistent with observations that CD8 cells are the cytotoxic killer cells that empower the body to fight HIV. A high CD4/8 ratio at baseline was also associated with relatively higher serum zinc levels while patients with significant viral load reductions had relatively high zinc levels at baseline.

Overall, this study demonstrated that the mean log10 viral load copies/ml of the patients using the supplement reduced from 4.382 + 0.955 to 3.678 + 1.166 (P=0.000); corresponding to an overall 60% absolute mean viral load reduction (0.704 log10 viral load copies/ml which was significant) in 30 months of follow-up. Further, the mean serum zinc levels in the cohort reduced from 79.3 + 14.5 to 71.0+ 13.0 mcg/100 ml (P=0.016) after 30 months follow-up (Table 1 and 2). Notably, the patients with an absolute increase in viral load after 30 months of supplementation also experienced the most drastic reduction in serum zinc levels from 71.0 + 0.86 to 55.6 + 9.8 mcg/100 ml over the same period.

DISCUSSION

From the immunological data obtained (Table 2), it was notable that high CD4 and CD8 counts were associated with high baseline serum zinc levels as were high CD4/8 ratios. Similarly, significant viral load reductions were noted after 30 months of supplementation in patients with higher baseline serum zinc levels as well as high CD4 and CD8 counts. These observations further alluded to the fact that zinc was crucial in promoting efficient function of the human immune system as indeed a deficiency in this trace element is recognized to initiate a premature transition from the efficient cellular (Th-1) immune function to the less efficient humoral (Th-2) one [21]. It was also apparent that patients with higher CD4 and CD8 counts at baseline and also higher CD4/8 ratios also experienced more significant reductions in serum zinc levels during follow-up, possibly alluding to better utility of this trace element in meeting increased immunological needs. Though the patients with lower immunological biomarkers had on average lower zinc levels at baseline, this did not decline significantly with time, probably alluding to possible replenishment from zinc reserves in tissues and organs to meet increasing immunological demands.

However, it is notable that in all categories of outcomes, the patients generally experienced a fall in the serum zinc levels with time; an indication that zinc is consumed during the HIV disease and that adequate supplementation is desirable to cope with the increased immunological demands. From these findings, it is also evident that zinc supplementation in close proximity to the US RDA values may not necessarily be adequate to meet the needs of HIV/AIDS patients in Kenya and other parts of Sub-Saharan Africa where nutritional deficiencies are rampant. Thus, studies are now needed to establish the supplementation regime and dosages that could lead to sustaining serum zinc levels of HIV/AIDS patients at optimum levels that are a prerequisite in the promotion of an efficient immune function. In the population, zinc deficiency can partly be attributed to the secretion of human body fluids such as sweat and semen that contain high levels of this micronutrient as well as to losses due to infestation with intestinal parasites, these scenarios being common occurrences in many parts of the African continent.

The finding that four women who were HIV negative, despite losing their husbands to HIV/AIDS, had a mean serum zinc level of 116.2 + 32.7 mcg/100 ml that was much higher than that of all the seropositive patients is probably a pointer to the role micronutrient zinc might play in preventing HIV infection in persons who may become exposed to this virus. This observation is not unusual given that there are reports in literature to the effect that zinc has useful functions such as protein biosynthesis, is required in hundreds of enzymatic activities, is needed in production of interferons and thymulin and in the maturation of T-lymphocytes; giving it unique and unparalleled anti-viral and anti-bacterial properties [2]. It is also recognized that micronutrient zinc plays a crucial role to mop out free radicals generated by major enzymatic systems by inhibiting the zinc-thiol protease activation in the virus coat and also in inhibiting the toxins-depletion activity of thiol cells or of the mixed function oxidase (MFO) system. Either way, zinc functions as an anti-protease with potential antiviral activity [20].

Immunologically, zinc deficiency leads to premature transition from the efficient Th-1 dependent cellular antiviral immune function to the less efficient Th-2 dependent humoral immune function [21]. Notably, via the Th1/Th2 balance, zinc determines transmission and progression outcomes of many infectious diseases. Thus, it is no wonder that the four women in this study were repeatedly sexually exposed to HIV by their infected husbands yet they remained un-infected, most probably because their relatively high serum zinc levels enabled them to mount an effective Th-1 type of immune response that prevented the undesirable transition to HIV-antibody production that is characteristic of the less efficient Th-2 humoral immune response. Thus, the fact that there was also a clear declining trend in serum zinc levels in the cohort right from the high risk un-infected women, to those infected but asymptomatic, to those infected with moderate symptoms and to those infected and severely symptomatic is probably indicative that this phenomenon was not an occurrence by mere chance (Table1). From this pilot study, it is now highly likely that zinc may indeed be a critical co-factor in determining infection at exposure as well as progression dynamics and outcomes in the HIV disease.

It is particularly noteworthy that a study conducted on 200 apparently healthy volunteers from a cancer detection centre and 1,500 consecutive unselected patients with various pathological conditions admitted at the same Hospital in New York observed mean serum zinc levels of 120 + 22 mcg/100 ml for controls; 108+ 27 mcg/100 ml for those with pneumonia; 114+ 23 mcg/100 ml for those with asthma and 110 + 26 mcg/100 ml for those with chronic alcoholism [19]. These results clearly indicate that there is a slight fall in serum zinc levels during mild infection, alluding to the susceptibility of this biological marker to stressful and inflammatory conditions. Nonetheless, the serum zinc values for normal controls in this USA cohort compared favourably with the HIV seronegative women in this Kenyan study (Table 1).

Thus, in view of the importance of zinc in human immunity, it is worrisome that the mean serum values of this trace element were not only low at baseline in this HIV/AIDS cohort but also decreased from 79.28+ 14.45 mcg/100 ml to 70.99 + 12.98 mcg/100 ml ($P = 0.016$) despite daily supplementation with zinc over a period of 30 months. Similar results have also been reported in a longitudinal study on 108 homosexual men in the US, where serum zinc levels of HIV patients with CD4 counts less than 500 counts (x 106/L) at baseline declined from 94.0 + 65.0 to 72.0 +

12.0 mcg/100 ml [15]. Thus, it is now evident that because of such a large zinc deficiency in both cohorts, the patients lacked one of the major prerequisites for mounting an effective Th-1 type of cellular immune response, suggesting the need for higher zinc supplementation dosages for HIV/AIDS patients not only in developing countries but also in affluent countries such as the USA; thereby raising concerns on the relevance of strictly complying to the USA RDA in supplementing HIV/AIDS patients. As zinc deficiency in the population is a phenomenon likely to be replicated in other Sub-Saharan countries, this might partly explain the reportedly huge burden of this disease on the African continent as the population could largely be mounting the less efficient Th-2 type of antibody-driven immunological responses to viral and bacterial infections.

CONCLUSION

The low zinc levels at baseline, and the continued significant fall on supplementation pose a major challenge to the prudence of administering zinc to HIV/AIDS patients in Kenya and elsewhere in Sub-Saharan Africa at values close to the US RDA. It would appear that sustainable restoration of the serum zinc levels to an optimum value of about 120 + 22 mcg /100 ml, as established by this pilot study, requires greater dosages of the more absorbable zinc supplements. Thus, supplementation with zinc should be considered in Sub-Saharan Africa as a possible strategy of combating HIV/AIDS, especially where it is confirmed that populations are at risk of zinc deficiency. Probably, by keeping serum zinc levels at above 120 mcg/100 ml, while periodically monitoring for any possible toxic effects, in a transformation from the less efficient Th-2 immune function to the more efficient Th-1 cellular immunological responses may occur with simultaneous reduction in the occurrence of new HIV infections in the general population as well as the rate of disease progression amongst those already infected. However, there is need to also include in such a supplementation programme appropriate dosages of other micronutrients such as vitamin A, vitamin B12 and selenium that work hand in hand with zinc in the normalization of human immunity [15]. It is also important to take note of the stressful nature of this disease and to simultaneously address the need to revive a healthy neuro-endocrine system as part of the wider initiative to combat this disease. This way, the nutritional management of HIV/AIDS patients with VIUSID as well as many other preparations entering the market could be made even more effective and probably achieve even better management outcomes at much shorter supplementation time frames. Further, as it is now clearly evident that micronutrient zinc is a crucial nutrient in the HIV disease, its monitoring should be made a routine public health requirement with a view to effectively guiding clinicians on how best to manage not only HIV/AIDS patients but also others with other pathological conditions whose underlying cause may actually be attributable to a zinc deficiency related immunosuppression. Finally, it is quite remarkable, that through antioxidant therapy with VIUSID, significant clinical benefits and viral load reductions have been observed and sustained in a cohort of HIV/AIDS patients in Kenya over a 30 months observational period with hardly any demonstrable side effects. This does provide another angle from which management of HIV/AIDS must be viewed from within the perspective of resource-constrained nations of the World. Having said that, a lot still remains to be done by way of undertaking randomized placebo controlled clinical trials to further confirm these preliminary observations and to open room for other players on related nutritional

intervention activities. In the circumstances, while awareness raising remains one of the cornerstones in the effective management of HIV/AIDS, sufficient global resources and thrusts should now be mobilized and redirected towards addressing the nutritional agenda of this disease which has hitherto been greatly underestimated to our own peril.

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TABLES

Table 1:

Zinc status of study cohort at baseline and after 30 months of supplementation with VIUSID

CLIENT CLASSIFICATION AT BASELINE	MEAN SERUM ZINC LEVELS (mcg/100 ml)		P-VALUES
	Baseline	30 months	
Normal USA controls cited in the literature [19]	**120 ± 22.0**	-	-
HIV Negative AIDS widows (n = 4)	**116.2±32.7**	**Weaned off**	-
Class A (Asymptomatic, n = 4)	**92.5± 12.1**	**78.0± 8.2**	**0.056**
Class B (Moderately Symptomatic, n = 13)	**81.9± 17.6**	**73.2± 12.1**	**0.267**
Class C (Severely Symptomatic, n = 17)	**72.7± 8.0**	**66.8± 14.3**	**0.091**
All Patients Combined (N = 29)	79.3± 14.5	71.0± 13.0	0.016

Table 2:

Comparison of serum zinc levels of HIV/AIDS patients with selected biochemical characteristics at baseline and after 30 months of supplementation

BIOCHEMICAL CHARACTERISTICS OF PATIENTS WITH SELECTED MANAGEMENT OUTCOMES	CHANGES IN SERUM ZINC MEANS ± SD (MCG/100ML)		P-VALUE (2-tailed)
	BASELINE	***30MONTHS***	
Immunology			
CD4 < 500 counts/mcL at baseline (n = 18)	76.3 ± 14.1	70.0 ±14.3	0.215
CD4 >= 500 counts/mcL at baseline (n = 11)	83.4 ± 14.5	72.4 ± 11.4	0.018
CD8 < 1000 counts/mcL at baseline (n = 15)	76.4 ± 14.1	69.0 ± 14.2	0.201
CD8 >=1000 counts/mcL at baseline (n = 14)	82.7 ± 14.7	73.2 ± 11.6	0.014
CD4/8 ratio < 0.3 at baseline (n = 14)	72.5 ± 12.1	68.8 ± 15.8	0.564
CD4/8 ratio>= 0.3 at baseline (n = 15)	84.2 ± 14.3	72.6 ± 10.8	0.002
CD4/8 ratio> 0.7 at baseline (n = 6)	87.3 ± 12.5	74.8 ± 7.8	0.024
Virology (at 30 months)			
Patients showing absolute viral increase (n = 5)	71.0 ± 0.86	55.6 ± 9.8	0.129
Patients showing absolute viral decrease (n = 24)	80.4 ± 15.1	73.0 ± 12.1	0.049
Patients showing significant viral decrease (n =14)	80.2 ± 14.4	72.1 ± 12.9	0.392
All patients combined (N = 29)	**79.3 ± 14.5**	**71.0 ± 13.0**	**0.016**

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