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Determinants of viral load status among HIV positive children on ART at Zewditu Memorial Hospital, Addis Ababa: A case control study

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Abstract

Introduction: Human Immunodeficiency Virus causes an immense amount of problems throughout the world, especially in sub-Saharan countries. Recently viral load is thought to be a good indicator in assessing HIV progression. Complementary feeding practice and type of complementary food are the major factors that affect VL Status. However, in Ethiopia there is paucity of evidence on the factors that could affect viral load among HIV exposed infants. Therefore, this study aimed to identify factors that affect VL Status among HIV positive children on ART at Zewditu Memorial Hospital (ZMH), Addis Ababa, Ethiopia using a case control study design.

Methods: Institution based unmatched case- control study was employed among a total of 241 (71 cases and 170 controls) children attending for follow up in ZMH ART clinic from July to August 2020. The interviewer conducts a face-to-face interview for 24 hour's dietary diversity from mothers using standardized and pre tested questioner. SPSS 20 was used for data entry and cleaning, while Stata 14 was used for data analysis. Backward stepwise logistic regression analysis was used to determine the association of the factors with the outcome variable. A P-value ≤ 0. 05 was considered statistically significant at 95% confidence level throughout the study.

Result: Out of 241 children, 71 of them had high VL status, while the rest 170 of them had low VL status. Poor dietary diversity increases the risk of high VL on ART children [AOR= 4. 37, 95% CI: 2. 12-10. 71]. The risk of high VL increase on children whose mother's marital status was single [AOR=4, 95% CI: 1. 40, 9. 70], among children who have a daily laborer mothers [AOR= 10. 6, 95% CI: 3. 20, 21. 67], and working on nongovernmental organizations [AOR=5. 32, 95% CI: 1. 68, 10. 51]. Children on WHO clinical stage 3 and 4 [AOR =15. 22, 95% CI: 4. 1, 39. 41], those children who started complementary feeding lately (after 6 months) [AOR= 4. 69, 95% CI: 2. 35, 13. 6] and children with poor Infant dietary diversity score [AOR= 4. 37, 95% CI: 2. 12-10. 71].

Conclusion: Maternal marital status, maternal occupation, WHO clinical stage, late initiation of complementary feeding practice, and infant dietary diversity score are the factors affecting VL status in HIV positive children on ART at Zewditu memorial hospital.

Keywords: Viral load; Complementary feeding; HIV positive children on ART; Zewditu memorial hospital

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1. Introduction

Human immunodeficiency virus (HIV) is a virus that causes Acquired immunodeficiency syndrome (AIDS), grouped under Retroviridaes (human retrovirus), and two types of HIV virus called HIV 1 and HIV 2 in which globally about 160,000 children acquired in 2018 [1,2]. The coverage of ART was 41% and the global burden of HIV was estimated to be 38. 8 million all over the world in 2015, in which 2 million new cases were expected in 2016 [3]. Most of the burden of HIV in the world lies on developing countries, especially Sub-Saharan countries. As they account for 74% of 1. 5 million AIDS related deaths in 2013 [4]. Sixty percent of adolescents and children with HIV are found in southern and eastern Africa. In 2017 about 94,000 children aged from 0 to 9 were newly infected with HIV [5]. In Ethiopia HIV prevalence among men and women aged 15-49 years was 0. 9% in 2018 [6].

In 2016, the number of AIDS-related deaths of children from 0 to 14 years (0 -14) were 120,000 and about 160,000 new childhood infection (0-14) have occurred. Of these Sub-Saharan Africa accounts for about 90% of the burden of the problem [7]. Out of 800 million people who are chronically undernourished globally, 35 million are living with HIV/AIDS. Human immunodeficiency virus affects nutritional status through increasing energy expenditure, decreasing food intake, and affects absorption and metabolism which eventually affects CD4 cells [7, 8, and 9].

In 2012, 10. 3% of HIV infected children were malnourished in southern part of Africa[11]. In 2015 in western Africa, the prevalence of malnutrition was about 40% [12]. In 2017, an estimated 10 million people developed TB, from these approximately 9% were living with HIV [13].

Viral load (VL) is the measure of amount of virus found in the body, specifically in the blood stream and it is known to be the single best indicator of the amount of virus and disease progression [14]. When the viral amount exceeds 1000mg/dl it is considered as high viral load. A study done in Swaziland, WHO stages 3 or 4 of the disease and immunosuppression are some other factors found to affect viral load in HIV positive children [15]. The other factor affecting viral load status in children is complementary feeding practice [11]. Complementary feeding is defined as early and timely initiation of safe and nutritious foods in addition to breast feeding one of the predictor is infant dietary diversity which is defined as the number different food groups over a given reference period [16,17]. Evidence showed that poor complementary feeding practice is the cause of death on children and increases the risk of high viral load through decreasing adherence to ART [18,19]. Apart from these factors such as being male, low level of adherence (< 85% on second line treatment) [20], WHO staging 3 and 4 [15], children who have treatment interruption [30], and high level of essential protein found from diet diversity, especially tryptophan [25] were the factors associated with high VL. On the other hand, a diet complemented with foods rich in selenium [22], zinc rich diet [22, 23], children on Highly active antiretroviral therapy (HAART) [22] proper breast feeding practices [20], children who received optimal complementary feeding [26, 29], and children who were complemented by Vitamin A [23] had statistically significant association with lowering VL

However, a cross sectional study in Addis Ababa on HIV infected adults showed there is no association between Vitamin A, Zinc supplement towards improving CD4+ cells as well as lowering VL [24]. The findings of the previous studies were inconsistent across studies. In addition, there is also a paucity of evidence in this particular area mainly in Ethiopia. Moreover, most of the studies done in Ethiopia used a cross-sectional study design in assessing the association between VL status and complementary feeding. Therefore, this study aimed to assess the association between complementary feeding and VL status among HIV positive children on ART at Zewditu Memorial Hospital (ZMH), Addis Ababa, Ethiopia, 2020 using a case control study design.

2. Material and methods

2.1 Study design and period

Health institution based unmatched case-control study design was employed. The study was carried out from July, 2020 until September, 2020.

2.2 Study area

Zewditu Memorial Hospital is one of the leading hospitals in Addis Ababa that initiated ART in Ethiopia. The CDC-Ethiopia helped in launching the first ART program at ZMH in Ethiopia in July 2003, and renovate in March 2005. Zewditu Memorial Hospital has become the largest HIV clinic in Ethiopia with a total of 14000 HIV positive patients who are on chronic HIV care and the hospital is treating over 6000 HIV positive patients on ART monthly and from this about 1500 are children.

2.3 Source and Study Population

All children on ART clinic were source population and those children attend on ART clinic for follow-up during the study period were the study population. All children attended during data collection period were included but Children who were seriously ill and whose mothers/guardians could have hearing impairment were excluded from this study.

- **Cases:** were children with high VL that means greater than or equal to 1000 copies/ml.
- **Controls:** were children with low VL that means below 1000 copies/ml.

2.4 Sample size determination

The sample size was determined by double proportion formula by using EPI info stat calculator by taking 80% power of the test, 95% confident level, and case to control ratio 1:2. Odds ratio 2. 64 was taken to calculate the sample size. This estimate was taken from the previous study that identified from practice of appropriate complementary feeding as a risk factor for viral load status. The proportion of practice of appropriate complementary feeding used as exposure in the control group was taken to be 95% and percent of case with exposure was 21. 7% from the same literature (18). Based on the assumptions, shown above the calculated sample size was 307; case =102 and control 205. But the total number of children in ZMH ART clinic was 251. Out of those a total of 251 children, 73 were cases and 178 were controls.

2.4.1 Sampling procedure

Since the total number of children in ZMH ART clinic was 251 all of them were eligible in the study Hence no sampling technique was employed. So the total of 73 hospitals based cases and 178 hospital based controls were assumed to be included in the study.

2.5 Data Collection Procedure

The interviewer conducted face-to-face interview to collect 24 hours dietary history of children using standardize and pre tested questioner. Two professional nurses from different health institution were recruited to collect the data after they received training for 2 days.

2.6 Data analysis

Bivariate and Multivariate logistic regression analysis were employed to identify the factors associated with the outcome variable. All of the variables that had a P-value of < 0. 2 in bivariate analysis were further analyzed in the multivariate analysis to control the effect of confounding variables. The result of multivariate logistic regression analysis with adjusted odds ratios (AOR) were reported as statistically significant with a p-value < 0. 05 throughout this study.

2.7 Ethical consideration

Ethical clearance was obtained from Rift Valley University ethical review committee with a reference number of RVU 309/2020. The person in charge of the facility and care providers were informed and their agreement received before the onset of data collection. Moreover, the purposes and importance of the study was explained and informed consent was secured from the study participants, confidentiality was maintained at all levels of the study, and participant's involvement in the study was on a voluntary basis.

3. Results

3.1 Socio-demographic characteristics of study participants

The total number of study participants who enrolled in this study was 241 with a response rate of 96. 02%. The mean age of all mothers of children who participated in the study was 32. 54 years old. Out of the 241 children in this study, 61 (25. 3%) of children were aged 6 to 11 month and 180 (74. 7%) were 12 to 23 months. Out of 71 children who were high VL level, 14 (19. 7%) of them were under the age 6 to 11 month, and out of 170 children who were low VL level, 123 (72. 4%) were the age 12 to 23 month. Out of those 71 mothers whose children VL level was high, 27 (38 %) of them were complete secondary school, and out of those 170 mothers whose children viral load level was low, 44 (25. 9%) of them were complete diploma and above on their education. Of 148 mothers who were married, their children with high VL level and low VL level were, 34 (47. 9%) and 114 (67. 1%) respectively. Out of 190 mothers whose monthly income level were less than five thousand, 53 (74. 6%) of their children was high VL level and 137 (80. 6%) of children was low viral load level. Out of 71high VL children, 28 (16. 5%) of children whose mother occupational status was labor work, and out of 170 low VL children, 62 (36. 5%) of children whose mother occupational status was a house wife. Out

of 71 children who had high VL level 37 (52. 1%) was male and out of those 170 children who had low VL level, the proportion of male and female was equal which was 85 (50%) (Table1).

Table 1 Socio-demographic characteristic of respondents at ZMH

Characteristics	Cases (%)	Controls (%)	Total (%)
Maternal Age category			
18-30	29 (40. 8)	70 (41. 2)	99 (41. 1)
31-45	41 (57. 7)	99 (58. 2)	140 (58. 1)
46-55	1 (1. 4)	1 (0. 6)	2 (0. 8)
Marital status of mother			
Single	10 (14. 1)	13 (7. 6)	23 (9. 5)
Married	34 (47. 9)	114 (67. 1)	148 (61. 4)
Divorced	26 (36. 6)	36 (21. 2)	62 (25. 7)
Widowed	1 (1. 4)	7 (4. 1)	8 (3. 3)
Maternal Educational status			
Cannot read and write	8 (11. 3)	15 (8. 8)	23 (9. 5)
Can read and write	9 (12. 7)	33 (19. 4)	42 (17. 4)
Primary school	10 (14. 1)	35 (20. 6)	45 (18. 7)
Secondary school	27 (38. 0)	43 (25. 3)	70 (29. 0)
Diploma and above	17 (23. 9)	4425. 9)	61 (25. 3)
Maternal Occupational status			
Jobless	2 (2. 8)	4 (2. 4)	6 (2. 5)
Labor work	28 (16. 5)	12 (16. 9)	40 (16. 6)
House wife	15 (21. 1)	62 (36. 5)	77 (32. 0)
Governmental	16 (22. 5)	43 (25. 3)	59 (24. 5)
Nongovernmental	21 (29. 6)	27 (15. 9)	48 (19. 9)
Merchant	5 (7. 0)	6 (3. 5)	11 (4. 6)
Maternal Income level			
<5000	53 (74. 6)	137 (80. 6)	190 (78. 8)
5000-10000	15 (21. 1)	31 (18. 2)	46 (19. 1)
>10000	3 (4. 2)	2 (1. 2)	5 (2. 1)
Sex of child			
Male	37 (52. 1)	85 (50)	122 (50. 6)
Female	34 (47. 90	85 (50)	119 (49. 4)
Age category of child			
6-11 month	14 (19. 7)	47 (27. 6)	61 (25. 3)
12-23 month	57 (80. 3)	123 (72. 4)	180 (74. 7)

From the total study participants 50. 62% of the child was male, while the rest 49. 38% were female. Of those 122 male children, 30. 3% (37) had high viral load level, and also 28. 6% (34) female children had high viral load level from total of 119 (figure 1).

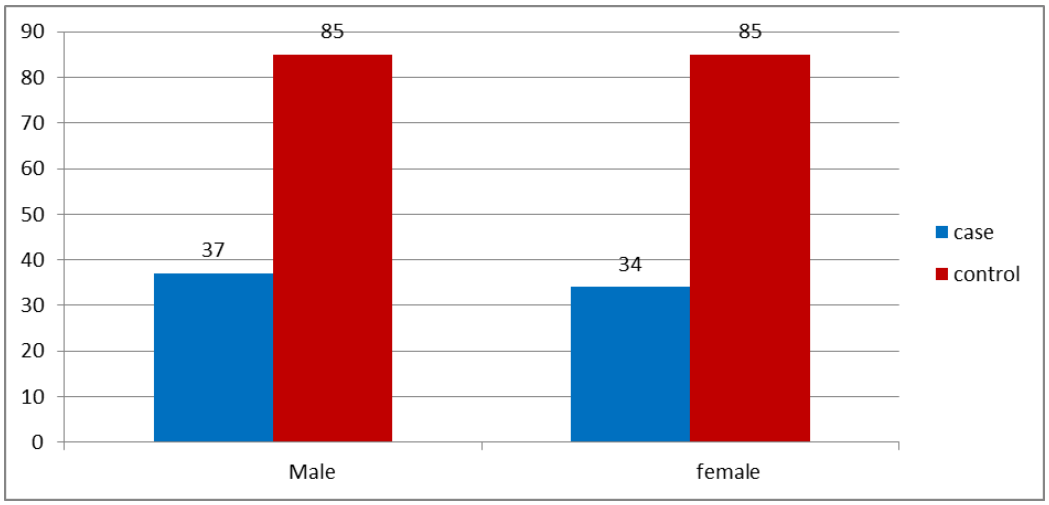

Figure 1 Sex of children on ZMH ART clinic

3.2 Complementary feeding Practice

One hundred seventy (70. 54%) of children had low viral load status, while 71 (29. 46%) children had high viral load status. Out of those 71 children with high viral load, 21 of them initiated complementary feeding timely at 6 months of time while the rest 50 started complementary feeding practices after the age of six months. Out of 71 high viral load status children, 34 of them had good infant dietary diversity score, and the rest 37 children had poor diversity of diet. Concerning good optimum complementary feeding practice of the study participants, among those with high viral load status, 9 of the 71children were good optimum complementary feeding practice, while the rest 62 children were poor optimal complementary feeding practice (table 2).

3.3 The result of factors associated with high VL

After controlling the effect of covariates, marital status of mother, maternal occupation, WHO staging, complementary feeding initiation and infant dietary diversity score were variables that have statistically significant associated with high VL in the multivariate analysis. The likelihood of having high VL status remained significantly higher among children whose mother's marital status was single compared to married [AOR=4, 95% CI: 1. 4, 9. 7], children whose mothers were working on a daily laborer were also higher risk of excess VL compared to children with housewife mothers in their occupation [AOR= 10. 6, 95% CI: 3. 20-21. 67]. Concerning maternal occupation, children whose mothers were working in the nongovernmental organizations were more likely to have high VL compared with house wife mother [AOR=5. 32, 95% CI: 1. 68-10. 51].

Apart from this the likelihood of having high viral load status remained significantly higher among children whose WHO staging was stage 3 and 4 compared to stage 1 and 2 [AOR=15. 22, 95% CI: 4. 1-39. 41]. Likewise, children who started complementary feeding after the age of 6 months were more likely to have high VL compared to children who start complementary feeding at 6 months [AOR=4. 69, 95% CI: 2. 35-13. 6]

Moreover, the odds of having high VL status remained significantly higher among children with poor infant dietary diversity [AOR=4. 37, 95% CI: 2. 12-10. 71] compared with good infant dietary diversity. However optimum complementary feeding practice and minimum meal frequency, medication interruption of child, and maternal information about child medication were did not show any significant association with high VL status (table2).

Table 2 Multiple Logistic Regression: factors associated with viral load status of children on ART at ZMH

Characteristics	Case	Control	COR (95%CI)	AOR (95%CI)	P-value
Maternal marital status					
Married	34	114	1. 0		
Single	10	13	2. 58 (1. 04-6. 40)	4 (1. 4- 9. . 7)	0. 023
Divorced	27	43	2. 42 (1. 29-4. 56)	1. 8 (0. 45-7. 250	0. 406
Maternal Occupation					
House wife	17	66	1. 0		
Labor work	28	12	9. 05 (3. 71-24. 27)	10. 6 (3. 20-21. 67)	0. 011
Governmental	16	43	1. 44 (0. 69-3. 44)	2. 66 (096 - 4. 21)	0. 150
Nongovernmental	26	33	3. 06 (1. 44-7. 17)	5. 32 (1. 68-10. 51)	0. 027
WHO Staging					
Stage 1and 2	53	160	1. 0		
Stage 3 and 4	18	10	5. 43 (2. 36-12. 50)	15. 22 (4. 1-39. 41)	0. 001
Complementary feeding initiation					
At 6 months	21	126	1. 0		
Greater than 6 months	50	44	6. 82 (2. 67-16. 02)	4. 69 (2. 35-13. 6)	0. 002
Infant dietary diversity score (IDDS)					
Good	34	142	1. 0		
Poor	37	28	5. 52 (2. 98-10. 23)	4. 37 (2. 12-10. 71)	0. 034
Optimum complementary feeding (OCF)					
Good	9	131	1. 0		
Poor	62	39	23. 1 (10. 6-50. 7)	2. 3 (0. 16-13. 1)	0. 550

4. Discussion

The result of this study showed that marital status of mothers was significantly associated with viral load. In this study children whose maternal marital status was single was significantly associated with high VL status compared to married study participants. The finding of this study was similar with the study done in Senegal [26] the study reported that those children without partners' single moms were significantly associated with higher viral load count [26]. Other literatures have also reported the relationship between single motherhood and poor physical/mental health, including malnutrition and a higher risk of mortality for under-5 children as compared to children raised in two-parent households [31]. The possible explanation might be due to the low economic status of single motherhood to provide optimal nutrition for their children might contribute for higher VL

Similarly, the odds of VL among children were higher among children whose mothers were working as a daily laborer and nongovernmental organizations compared to house wife mothers. Children whose mother were working as a nongovernmental organization were 5. 32 times more risk of developing high VL status compared to those whose mother was housewife [AOR=5. 32, 95% CI: 1. 68-10. 51]. The reason might be due to working status of mothers had an effect on continuation of breastfeeding up to 6 months and longer as well as complement diet. Most of the mothers return to work soon as a result the child cannot get adequate breast milk and other complementary diet. This might contribute for higher VL

Children whose WHO stages 3 or 4 were found to be high viral load status the risk of high viral load were almost 15. 22 times more compared to those children grouped in WHO stages 1 or 2 (AOR= 15. 22, 95% CI: 4. 1-39. 41). The findings of this study was in line with the study done in Swaziland, the study reported that WHO stages 3 or 4 affect VL status significantly in HIV positive children [15]. It is well known that WHO clinical stage-3 or stage-4 indicates the severity of the disease. The increase in disease severity contributes for the increase in VL. As per the suggestion of WHO, recognition of clinical stage-3 or stage-4 included is an important method for identifying HIV-infected individuals at high risk for mortality and warrants for the immediate initiation of antiretroviral therapy.

In this study assessing optimum complementary feeding practice as one of the determinants affecting VL status. Timely initiation of complementary feeding practice, one of the standardized indicators used to measure optimum complementary feeding practice, did show a protection against high VL status. While those who started complementary feeding at 6 months were found to be protected from high viral load status by a very significant amount, almost 4. 7 times than those who started complementary feeding after 6 month of age with a P-value <0. 002. So, timely initiation of complementary feeding practice alone does protect children from risk of developing high VL.

This study revealed that having poor dietary diversity score increased the risk of high VL status by 4. 37 times when compared to those with good infant dietary diversity score (AOR = 4. 37, 95% CI: 2. 12-10. 71) hence getting diversified diet ensures that children body is gaining nutrients from their diet, which is useful in enhancing their immunity, leading to decreased VL status. Poor complementary feeding practice was found to be significant in 26. 9% of children. Study done in western Africa, Senegal, showed similar finding as this study, complementary feeding was found to be significant in 11. 6% of the children in the study [26].

In studies previously done in assessing the factors affecting high VL status, optimal complementary feeding practice was not assessed using the 3 standard indicators; hence it was difficult to compare the findings with other studies.

Limitation of the study

Recall bias was inevitable since due to the case control study design nature. The sample size was relatively small which might affect the generalizability of the study findings. There might have social desirability bias, since the data collectors selected from the same hospital due to COVID 19 pandemic.

5. Conclusion

Marital status of the mothers, occupational status of mothers, WHO stages of children, timely initiation of complementary feeding practice, and infant dietary diversity score are the determinants found affecting viral load status in HIV positive children on ART at ZMH.

Concerned stake holders should be involved in promoting health on children. Such as Addis Ababa health bureau, health care workers and center for disease control (CDC) Ethiopia.

Providing health services that are fully trained and updated on the effect of nutrition is needed by the government, and other factors as a whole, and health care workers should assess the children status, and measure all measurement indicating malnutrition at every appointment.

Reaching only those who are present at time of their children appointment is not enough, as the personnel present and the time given are limited. Hence child health, especially dietary diversity and HIV, should be give more attention in the countries health extension program, so that health extension workers could and must educate the community.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declared that they have no competing interests.

Statement of ethical approval

We got ethical approval to undertake this study from Rift Valley University Institutional Review Board. The support letter and formal permission also obtained from Zeweditu Memorial Hospital. This is because the research did not produce any aspect of information that could lead to criminal prosecution of the participants and or the university. In addition, all the source materials used in this thesis have been duly acknowledged. Since the research couldn't introduce any human subject as well as any aspect of difficulty that give rise to any form of harm to the study participants, we used only verbal consent from the study participants.

Authors' contributions

HJ has contributed in the design, data collection and write up of the study protocol, ME and YK has contributed in the design, manuscript development and revisions. SM, AO, and RZ has also contributed in the revision and write up of the draft manuscript.

Availability of data and materials

The data used for analysis could be made available up on request.

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